

THE MARFA LIGHTS

***Examining the Photographic
Evidence (2003-2007)***



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FOTOCAT Report #8

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DEDICATION

To Avideh Zakhor

Manuel Borraz Aymerich

Para María Asunción, mi amor de siempre

Vicente-Juan Ballester Olmos

All diagrams, graphs, simulations, composite pictures, and picture correlations are
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INTRODUCTION

We can find chronicles on the recurrent apparition of mystery lights in many parts of the world going back a long time. Serious and less serious literature on this topic abounds, and we feel that local events should be investigated by examining local conditions and field characteristics in depth, as probably the origin of every phenomenon is different according to the place where it originates. A non-comprehensive listing of some of these regular phenomena would include, for example, the “Hessdalen phenomenon” of Norway (Notes 1-4), the “Brown Mountain lights” of North Carolina (Notes 5-7), the annual “Naga fireballs” of the Mekong River, Thailand (Notes 8-10), the “Mafasca light” of Fuerteventura, Canary Islands (Notes 11-14), the “ghost lights” of Silver Cliff, Colorado (Note 15), the “Corps-Candles” of Wales (Notes 16-17), the “Min Min lights” near Boulia, Australia (Notes 18-21), the “Spook light” of Hornet, Missouri (Notes 22-24), the “Spook light” of Long Valley, New Jersey (Notes 25-27), and the “Paulding light” of Michigan (Notes 28-29). As a matter of fact, a researcher has produced a list of 30 different locations for clusters of mystery lights in North America alone, in 20 U.S. States and 2 Canadian provinces (Note 30).

Over the years, reports of the display of a phenomenon called “Marfa Lights” have been studied by both amateurs and academics. The earliest reported sighting of a mysterious light on the Marfa plain, Texas, was made by Robert Reed Ellison and dates as far back as 1883, yet no first-hand account exists, only a story relayed by some members of his family. Ellison, then a 16-year-old cowboy, was herding cattle through Paisano Pass in March of 1883, to visit his father, when he saw lights in the distance that he took for Indian campfires, although no traces were found later. In 1937, Ellison described this trip in his memoirs. As scholars Robert and Judy Wagers recount (Note 31), he noted that on the first night that he camped on the Marfa plain “a little while after night came, a full moon rose up” and illuminated the mountains south of him. He also remarked that the mountains seemed to have moved closer to him. Except for this illusion—probably caused by an atmospheric refraction phenomenon (“looming”), according to the Wagers—Ellison made no reference to seeing any mysterious lights at all.

One of the problems of Marfa Lights—akin to UFO phenomena—is to distinguish the authentic reports (i.e., those which appear to be inexplicable, if any) from the usual mistakes. But, unlike UFO sightings, known to be mostly caused by a wide array of misinterpreted stimuli, the most stable pattern in MLs is their occurrence at ground level in the form of a very distant luminous spot moving straight, thus appearing as a bright linear track in photographic time-exposures. Not surprisingly, therefore, the Marfa Lights are repeatedly explained away as lights of vehicles driving on local roads.

The scope of the present work does not include showcasing a comprehensive review of the literature. Not pretending to be exhaustive, however, we will next list a few papers, articles, web sites and books that have covered this topic as a

research assignment, noting a summary of their findings, as an added value for the interested reader.

In March 1975, Don Witt, physics professor at Sul Ross State University in Alpine, Texas, coordinated a group of physics students, community members, local pilots, radio amateurs and a few outside professionals to locate the lights' source. "The monumental effort...was positively unable to form any sort of conclusion [other than]...artificial lights from area ranches or automobile headlights merely passing behind unseen obstructions along distant Highway 67" (Note 32).

In 1976, Elton Miles, professor of English at Sul Ross State University, published a celebrated book on the folklore of the Texan "Big Bend" region. One chapter was devoted to this type of local occurrence, recounting old stories where reports are mixed with cowboy and Indians mythology. Miles writes: "The appeal of the unknown in these lights is strong enough to arouse sensible men to elaborate an expensive investigative action in their determination to conquer the mystery of the Marfa Lights and lay bare their natural disposition" (Note 33).

McDonald Observatory, located 40 miles from Marfa, is a research unit of The University of Texas at Austin. In the June 1987 issue of its bulletin *StarDate*, contributing editor Diana Hadley reviewed the ML reports and arrived at this conclusion: "Headlights of cars on roads south of the plains southwest of Marfa are normally not visible. However, when a layer of cold air forms over the southwest plains, the headlight beams are bent back toward the earth and thus visible to observers on Highway 67 [the shared stretch of highways 67 and 90] and Mitchell Mesa [she probably meant Mitchell Flat] east of Marfa. Furthermore, the lights appear to be coming from the sky and will move around and change, both because the properties of the boundary layer are changing and because the cars are moving" (Note 34). This explanation was criticized on the grounds that, in normal conditions, "automobile headlights are decidedly and easily visible on Highway 67 south of Marfa between Marfa and Shafter Pass" (Note 35).

In 1989, *Unsolved Mysteries*, the well-known TV series on crime, drama, and mystery, hosted by Robert Stack, featured an episode on the Marfa ghost lights. To that purpose, scientists from McDonald Observatory and Sul Ross State University were called to examine the lights for the program, headed by astronomer Edwin Barker, chemistry professor Avinash Rangra and a geologist. As expected for a TV show, the phenomenon remained not solved. Intriguingly, one midnight, the team's night-viewing equipment recorded in the middle of Mitchell Flat a globe of light which disappeared, came back, and faded again. "Observers were certain the light did not come from a man-made source" (Note 32). In recent correspondence, Dr. Barker added: "I am certain that the light was from the rotating headlamp of a passing train. Mysteries had to remain Unsolved" (Note 60).

The same year, well-known Texan geologist and naturalist Judith Brueske presented a compilation of first-hand Marfa Lights reports in a 50-page publication that soon became essential reading for students of this phenomenon (Note 36).

Also, in 1989, Professor Yoshi-Hiko Ohtsuki, a Japanese plasma physicist at Tokyo's Waseda University, paid his first visit to Marfa. Two years later, Ohtsuki would become well known for reporting in *Nature*, with H. Ofuruton, the first successful production of something akin to ball lightning in the laboratory. He believed that ball lightning had much in common with mystery lights like those of Marfa and, in general, with the vast majority of UFOs. Ultra-sensitive video cameras kept a 24-hours a day vigil, succeeding in capturing a 10-second image of an unidentified light that was “long and thin like a string” at first and shortened into a ball afterward. Ohtsuki's study was documented by the television crew of “The Chase”, a Japanese TV show somewhat similar to the American program “Unsolved Mysteries” (Notes 61-62).

Ohtsuki returned to Marfa in the summer of 1992 with a team of researchers, a great deal of measuring and recording equipment, and a Buddhist priest, who performed some rituals. They were joined by Edson Hendricks, a San Diego engineer expert in “sferics” (electromagnetic pulses caused by atmospheric phenomena). The popular TV series “Sightings” ran a 10-minute feature on the Marfa lights, covering the investigation and including some footage of “dancing multicolored lights” captured on September 1 by its own production crew (Notes 63-67).

Between March 6-15, 1994, British “earth-lights” searcher Paul Devereux and US physicist (and parapsychologist) Hal Puthoff visited the area under the auspices of the International Consciousness Research Laboratories. Devereux summarized the findings of the expedition as follows:

We were eventually able to dismiss a number of luminous effects popularly assumed to be “Marfa Lights”: occasional mirage effects can raise lights normally hidden over the horizon into visibility, sometime reproducing the same lights in tiers, and lights of vehicles 30 miles or more away on the Marfa-Presidio road are so distorted that they can appear anomalous. We also determined that lights on vehicles negotiating rough tracks belonging to isolated ranches on the undulating desert-scrub area known as Mitchell Flat can look like mysterious lights skimming the ground, fusing, and parting. Nevertheless, interviews with local witnesses convinced us that genuine anomalous lights probably did sporadically appear in the vast region (Note 68).

In 1999, physics teacher Steve Simpson and a group of physics students from Lexington High School (Illinois) spent their spring break at Marfa to conduct on-site experiments with a spectrometer to analyze the frequencies of the sighted lights, balloons equipped with instruments to measure temperature inversions (a failed experiment), and, naturally, visual observation and photographic recording. Distant, mysterious lights were seen to appear and disappear, but the team concluded that the on-off period checked correlated with automobile lights. They tested the theory by driving tens of miles where the lights were observed, and flashing lights regularly to the crew standing at the viewing area. They found out that the MLs—visible toward the southwest in a published time exposure—“were only passing headlights weaving in and out of the mountains” (Note 37). In a longer reference, directly provided by Simpson's Physics Class, they summed up their conclusions in a very sincere way: “We scientifically proved with a number of experiments that the

Marfa Lights we saw were indeed only headlights coming from a distant road in the mountains. We were told, however, that the 'Marfa Lights' we saw were not the only recorded type of them seen. It is said that there have been mysterious lights seen in the horizon to the left of the 'headlights' that are unexplainable" (Note 38).

On August 25, 2000, Alto Technology Resources, Inc., a Houston-based industry specialized in providing hyperspectral remote-sensing imaging, performed a one-day airborne field work to study the MLs. One of their major findings follows: "We combined the computer-generated soil distribution with the US Geological Survey topographic maps and Digital Elevation Models (DEM) that allowed us to view the soils and the topography as they would be seen from the Marfa Lights Observation Site. From our analysis, we believe that car headlights shining in the direction of the Observation Site, reflected along the concave surface of soil alongside of Highway 67, are the source of the Lights. The highly reflective soil acts as a mirrored surface that creates the observed phenomena" (Note 39). As noted in the abstract of an article by the main writer, published by Weatherford Laboratories (Houston, Texas): "Light behavior such as blinking, splitting, combining, unusual movements, dimming and gaining brightness, have confounded researchers for fifty years. While ground video recorded the Lights, the airborne hyperspectral (as well as the crew) saw nothing from above. The only mechanism capable of this is reflection along a curved surface" (Note 40).

The Alto Technology hypothesis (that, admittedly, had "not been tested," and was "simply a first pass at interpreting a new data set") deserved, however, a well-founded criticism: "Their ground person could see car lights turning on and off and varying in intensity but from the airplane they looked like normal car lights. Alto Technology failed to understand that the variable intensity and On and Off states of car lights observed from the View Park were due to terrain obstructions and changes in road direction. They incorrectly concluded that what their ground observer was seeing was reflected car lights when he was actually seeing car lights directly. It was a misunderstanding of facts leading to incorrect conclusions concerning visible automobile traffic on Highway 67" (Note 41).

Let us introduce now a remark in passing. It is nothing new how popular culture (groundless or not) materializes in the form of public attractions. One of the best-known examples is Roswell, New Mexico, of flying saucer crash myth fame. In 2001, the State of Texas installed a roadside rest area designed as a "viewing station" for light-hunting visitors, the Marfa Lights Viewing Center (MLVC), a pavilion located 9 miles east of the town, on the south side of U.S. Highway 67/90, overlooking Mitchell Flat, at coordinates 30.0°, 16.5' N, 103.0°, 53.1' W. This tourist attraction expanded a previous pull-off already used as an "observation area," located by the old airfield.

In 2001, NASA astronomer Sten Odenwald created a web resource on "ghost lights," trying to establish indisputable facts and common features (Note 30). In the extensive section dedicated to the Marfa lights, he indicated: "car lights on distant roadways account for virtually all of the sightings from the Marfa Lights Visitor

Center, but local residents know about these and say that the true Marfa Lights are not these, but more mysterious and very rare lights seen on the flatlands” (Note 69).

Surprised by the long distances at which the lights of vehicles on Highway 67 were seen, Odenwald postulated some kind of atmospheric amplification related to the so-called “highway mirages” caused by temperature gradients above a heated roadway. He did a preliminary study showing very shallow angles between the road surface and the line-of-sight from the Viewing Area, compatible with his proposed scenario. He also provided plots of the viewing angle and the headlight angle along the path of Highway 67 to illustrate their effects on the angular speed and the brightness of the observed lights (Note 70).

Another publication on this subject addressed primarily to a scientific audience was released in December 2005 by The Society of Physics Students at the University of Texas at Dallas. Experiments consisted of obtaining video records of the light patterns, making U.S. Highway 67 traffic volume measurements, and sending a chase team to the highway in order to determine the location of any mystery light relative to the chase car as both were observed from the viewing area. This—extremely limited—work concluded that “all of the mystery lights observed by this group on the nights of 11 and 13 May 2005 can be reliably attributed to automobile headlights traveling along US 67 between Marfa and Presidio, Texas” (Note 42).

Out of the innumerable list of articles on MLs, we are selecting here just a minor sample of works made under scientific criteria or sources thought to be complete and balanced. In 2006, Michael Hall published an essay in a Texas magazine with little-known details of the history of the phenomenon, local ranchers’ sightings (including two from notorious Kerr Mitchell), and even an episode involving Venus (Note 43).

In June 2008, *Weatherwise*, a popular science and technology magazine covering weather and climate, released an article on the subject that focused on the car headlights on Route 67 as the source of the ghostly lights. The author, a corresponding editor of the journal, concluded that “a number of phenomena can be at the root of the mystery...from simple refraction to a variety of mirages.” They would explain the shimmering and strange behavior of the lights (blooming, shrinking, jumping, splitting into two...), observed by the author himself (Note 44).

Although the Route 67 traffic is a widely accepted explanation for the lights seen southwest of the Marfa Lights Viewing Center, controversy remains concerning rarer lights seen in other directions, sometimes referred to as the “genuine” Marfa Lights. In May and June 2008, members of the Texas State University conducted a 20-night field investigation using a portable telescope and a CCD-array spectrometer, but no objects were sighted “that met the criteria for genuine Marfa lights.” In their paper, published in the *American Journal of Physics* the following year (Note 45), they concluded that a much more extended effort would be

required due to the phenomenon's low frequency of occurrence. As they pointed out, such objects had been recorded previously on about only 0.9% of the total number of nights monitored with a camera system by James Bunnell between November 2000 and May 2008. Incidentally, Bunnell is to become a central part of the present report, as will soon be evident.

Probably the single more outstanding reference in the study of the Marfa Lights is the book published in 2013 by Robert and Judy Wagers (Note 31). The authors have a distinguished career in electronics engineering and business administration, respectively, during a lifetime. Their joint 250-page book *Mysteries of the Marfa Lights Revealed* covers the history of mysterious light observations in the region of Marfa, from the earliest folklore (before Marfa existed and before Texas was a part of the United States) up to the present. The Wagerses point out that "most of the lights seen from the MLVC [Marfa Lights Viewing Center] have been proven to be vehicle headlights traveling toward Marfa on US67," and put the focus on other selected intriguing cases. The book presents a scientific basis for the observations reported. Intelligently written for the layman, it pedagogically teaches complex scientific issues, needed for the study of a phenomenon as difficult to analyze as the MLs.

Lights arriving on the Marfa plain over the decades ranged from matches, candles, campfires, and lanterns to the electrical lights of homes, autos, and railroad trains. The properties of these lights are analyzed and reveal the incredible distances from which lights can be seen by human eyes. Analysis of atmospheric temperature fluctuations demonstrates how such variations can bend and guide a ray of light propagating in the air. This distortion from a straight-line path can lead to seemingly mysterious behavior of observed lights. In particular, looming can make objects appear higher than they really are. Looming can also enable seeing over the horizon. If the looming is time-varying, it can cause lights to appear to turn on and off. Colliding air masses can cause lights to move upward and downward in a short time. One such collision occurs when warm Chihuahuan Desert winds encounter katabatic cold air sliding down the side of the Davis Mountains, north of Marfa. The Wagerses condense their work as follows: "These facts were combined with spectral information, geographical information, and meteorological facts at the times the sightings occurred, to produce likely explanations for the bizarre light sightings."

The purpose of our own report is to study the so-called "genuine" (i.e., unexplainable) Marfa Lights reports, these are the true alleged mystery lights, through the analysis of the acquired photographic evidence. To this end, we have selected what we consider to be one of the best sets of images and related testimony. Initially motivated by a plan of one of us (VJBO) to write a book review of James Bunnell's 2015 book, *Strange Lights in West Texas* (Figure 1), it developed into a painstaking investigation of the photographs and eyewitness accounts reported by Bunnell in an exquisitely produced and seriously researched volume. This volume complements his prior book on the subject, representing the

most sustained and exhaustive field research that has been carried out to date¹ (Note 46).

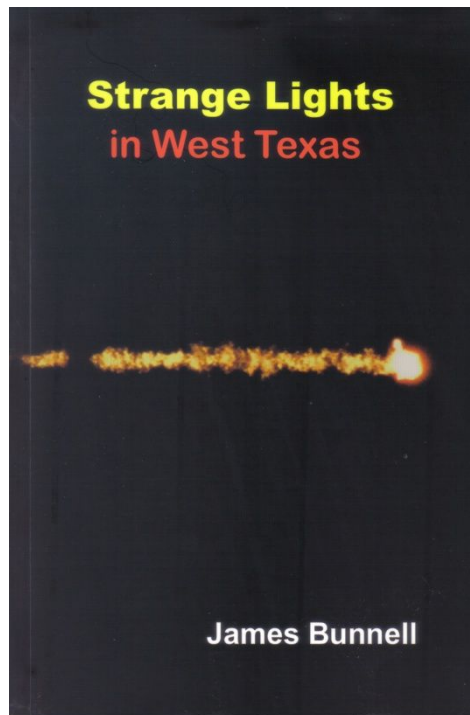


Figure 1. Book cover.

Bunnell held a 37-year career in the aerospace industry and has written a total of four books on these mystery lights. It was not for nothing that he grew up in the town of Marfa. This most recent book condenses in 174 pages full of color pictures and diagrams “a twelve-year tenacious investigation,” something that is truly supported by the facts. Right in the Introduction, the author explains that he has written this final book to provide “my answers, my explanations of what they are, how to see them, and why they are important” (p. 7).

Standing in the Marfa Lights Viewing Center, whose viewing platform faces southwest, Bunnell dismisses any MLs appearing other than in the arc drawn from southeast to south (135° to 180°). As the background mesas (horizon) are between 26km and 32km away, if this is exact, then it roughly covers an area as large as $\sim 290\text{km}^2$ (see Figure 2). That is the land where the mysterious lights develop. Looking toward the SSE from the MLVC, for example, the terrain horizon is 27km away and the horizon is 170m above the MLVC location. In fact, we have verified that distant mesas around that direction subtend an angle of $\sim 0.25^{\circ}$ and most of lights appear below this tiny limit.

(1) Certainly, a good book for the library of any student of alleged mystery lights reports: www.marfalightsresearch.com

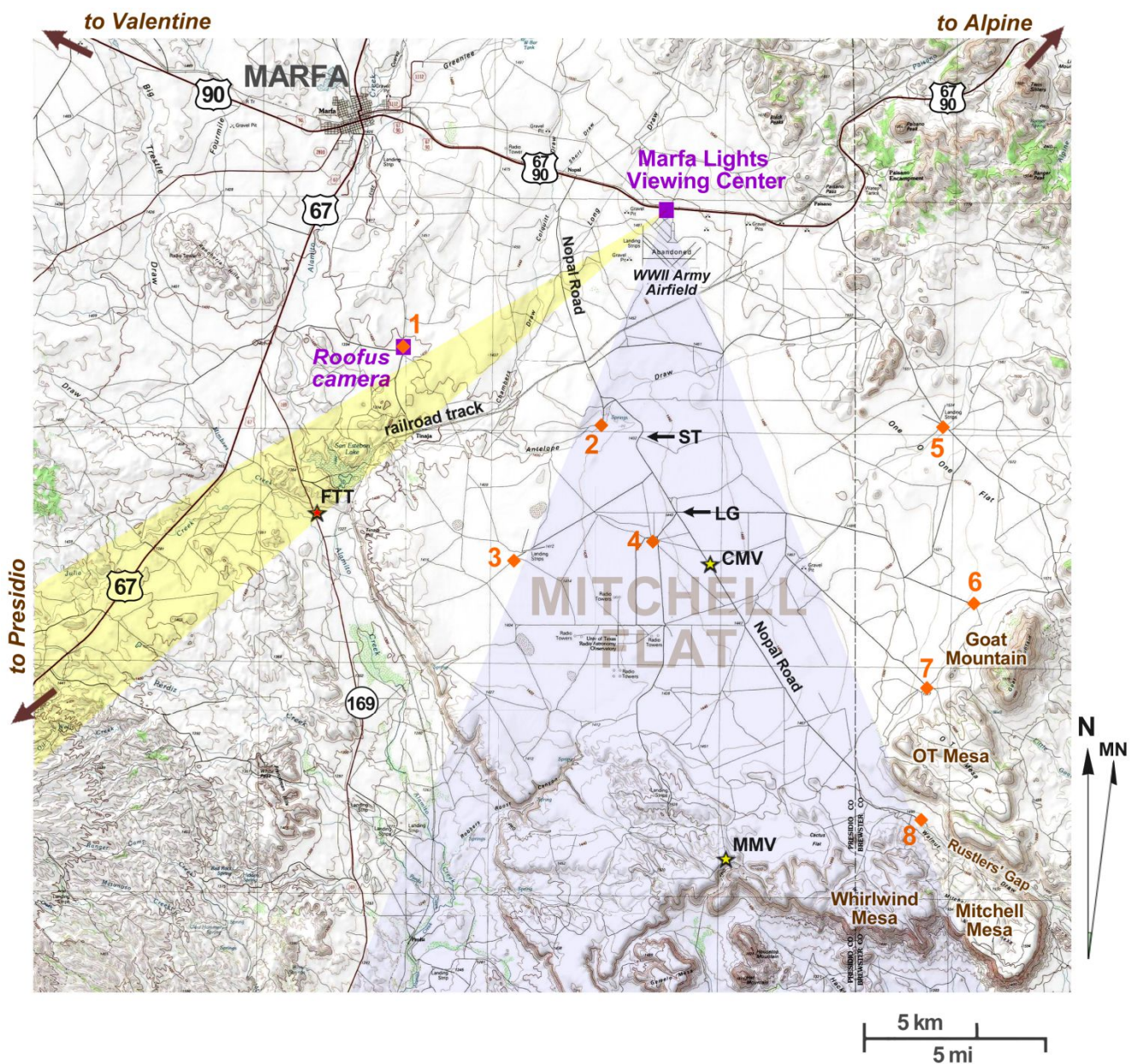


Figure 2. Map of the region of interest (base map: USGS).

Most pictures of “mystery lights” taken from the Marfa Lights Viewing Center only show automobile headlights traveling along U.S. Route 67, observed within the *yellow sector*. On the contrary, the alleged true mystery lights here under examination—photographed by Bunnell from that same place—were visible within the *blue sector* (mostly in its eastern subsector). Magnetic north according to the magnetic declination when Bunnell’s book was written ($+7.3^\circ$ in 2014).

Ranches (*numbered orange diamonds*):

- | | | | |
|--------------------|---------------------------|-------------------|---------------------|
| 1.- Mitchell Ranch | 2.- Antelope Spring Ranch | 3.- McGuire Ranch | 4.- Barlite Ranch |
| 5.- 101 Ranch | 6.- Harry Wells Ranch | 7.- Crosson Ranch | 8.- Escondido Ranch |

Reference features:

- | | |
|-------------------------------------|---|
| FTT: red flashing telephone tower | CMV: center mercury vapor ranch light |
| MMV: mesa mercury vapor ranch light | LG: locked gate on Nopal Road (dirt road) |
| ST: S-turn on Nopal Road | |

Note: Strictly speaking, the southernmost section of “Nopal Road” is called Escondido (Ranch) Road. Throughout this work, however, we will often refer to the entire road as Nopal Road, for simplicity’s sake.

Bunnell defines MLs as “rare, but very real, physical phenomena with nighttime displays...capable of remarkable behaviors” (p. 12). The author’s views about MLs are that they “defy conventional explanations” and “are natural phenomena in need of a serious scientific study” (p. 13). Bunnell trusts this will be corroborated by the “honest photography and investigative details” presented in this book. It is evident that the investigator has invested lots of time, expense, and deductive work in the study of this old enigma. Pages 16 to 30 cover some selected eyewitness stories that the author admits “show great diversity” yet not what would be expected to be car headlights on the road. However, MLs seem to contain some common elements, like brightness variances, split, horizontal movement, white/yellow-orange color, silence, or showing no response to wind.

Chapter 4, with the nice title of “The art of rejecting ordinary lights” (i.e., screening IFOs in ufology), is educational and may help reducing the number of wrong reports. What is it that normally causes false MLs? Vehicle lights on roads, trucks on the terrain, ranch, building and other field structure lights, including a beacon light on a radio tower, for example.

Chapter 6 is key in the contents of the book as it attempts to exhibit the best evidence of the MLs phenomenon. To this end, Bunnell offers it “in the form of high-resolution color photographs along with location and time information derived from automated night cameras, plus observational details recorded on-site after each event” (p. 72). Therefore, it is the fair geographical analysis of these images what will allow us to assess whether there is a true need to suggest a new phenomenon or not.

By 2006, Bunnell had installed three automated monitoring stations in the Mitchell Flat region, equipped with nine cameras, with the purpose of triangulating the lights and find the exact location of the events. On top of this (between 2003 and 2007), Bunnell visited the MLVC many times and took a series of interesting pictures during events occurring on February 19, 2003, May 7, 2003, May 8, 2003, May 8, 2004, August 11, 2006, October 19, 2006, and July 23, 2007. As this is the most precious anomalistic proof, both eye-witnessed and captured on film by himself, we decided to analyze in detail this best evidence, specifically the events covering the period 2003-2004, in line with the data collection entry terms of FOTOCAT ([Note 47](#)). For the purpose of doing this in the best possible manner, with the best available data, one of the authors (VJBO) has exchanged numerous emails with James Bunnell from September 2017 to December 2018 to clarify certain points and receive further information. It has been added to the case abstracts below. Quotes not linked to book pages are extracted from this correspondence.

Additionally, before finishing this report, we have had a look at the events of the period 2006-2007. A review of them is included as Appendix 3.

We will now review the four major sets of events (best evidence) taking place in 2003 and 2004, presented by the author to support the hypothesis that Marfa Lights are a phenomenon new to science.

During our investigation of the Marfa Lights photographed by James Bunnell, we discovered a very important problem in the input information. The following paragraph attempts to highlight the key relevance it has for all calculations made and the conclusions reached by the author in some of the cases.

Bunnell gives all directions in magnetic degrees. The author correctly explains that the difference between the geographical meridian (true north) and the magnetic north is called magnetic declination. "Declination varies by geographic location and can vary also over time. In Mitchell Flat, declination is 7.3 degrees" (p. 32). This corresponds to the declination in Marfa when the book was written (Note 48), that is, the number of degrees that must be added to the magnetic bearings mentioned in the book to obtain the true bearings. However, we have found that the reported magnetic values are not correct when dealing with directions close to the SSE (specifically, Bunnell's magnetic readings from 147.8° to 151.7° correspond in fact to true bearings between 157.5° and 162.4°, instead of the expected values from 155.1° to 159°.) He is well aware that "the View Park Pavilion has steel rebar in the concrete floor, steel railings, steel columns plus steel overhead and all that steel has potential to degrade compass accuracy" (pages 32 & 34). For that reason, all his compass readings were taken "on the grounds to the south of the Pavilion, usually near the western-most plaque," which he calls "SW Plaque." Yet something must have gone wrong. Regarding the landmarks in the background mesas used by Bunnell as reference points, we have independently estimated their azimuths from the photographs by using Google Earth (see example in Figure 3) and found errors ranging from 2.4° to 3.7° in his compass readings. This is a major flaw in Bunnell's work: any radials around SSE calculated from his magnetic readings are wrong and inconsistent. The difference in azimuth means a geographical deviation of more than 800m when the distance to the observer is over 20km. It is a fatal error for any further calculation and triangulation performed to look for the actual locations of the lights in the terrain in those cases. Except for the first one, this affects all the other events reviewed below.

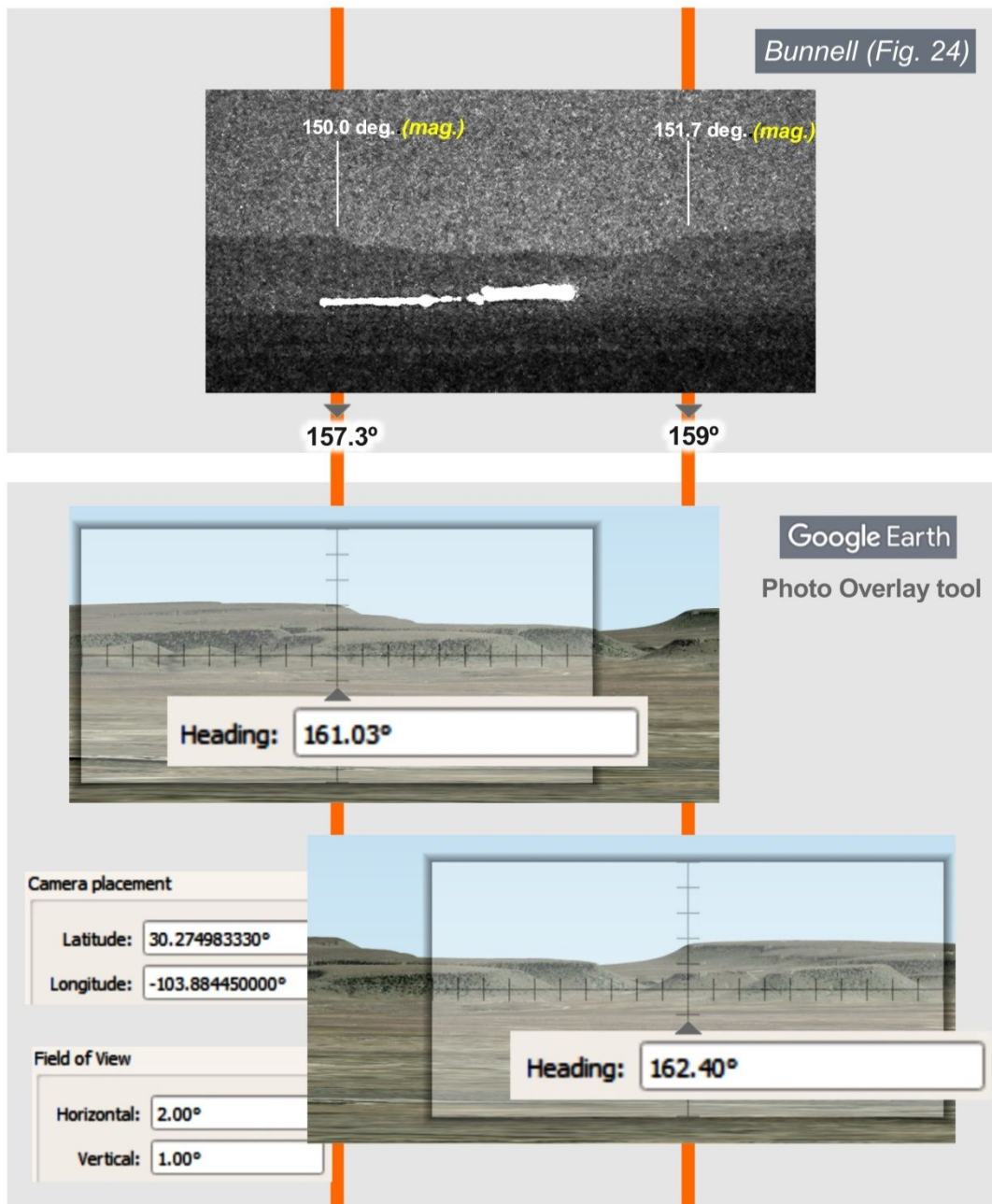


Figure 3. Checking Bunnell's azimuth data with the help of Google Earth.

Top: magnetic bearing of two characteristic features of the background mesas photographed from the Viewing Center (SW Plaque), according to figure 24 of Bunnell's book. Equivalent true bearings: 157.3° and 159.0° (considering a magnetic declination of +7.3°, i.e., 7.3° East).

Bottom: virtual view of the same part of the landscape from the position of the real camera, made with Google Earth's Photo Overlay tool. The overlaid rectangle with the crossed scales is 2° wide and 1° high (0.1° per division). Its center has been pointed to each of the two reference features in order to measure their actual true bearing ("Heading" in the figure). The obtained values (161.03° and 162.40°) differ significantly from Bunnell's data (157.3° and 159.0°). (Images: Google, Landsat/Copernicus.)

To give an idea of the significance of the aforementioned errors, **Figure 4** presents the initial azimuth of some of the MLs photographed from the Viewing Center, comparing the data supplied by Bunnell to the actual values measured from the photographs.

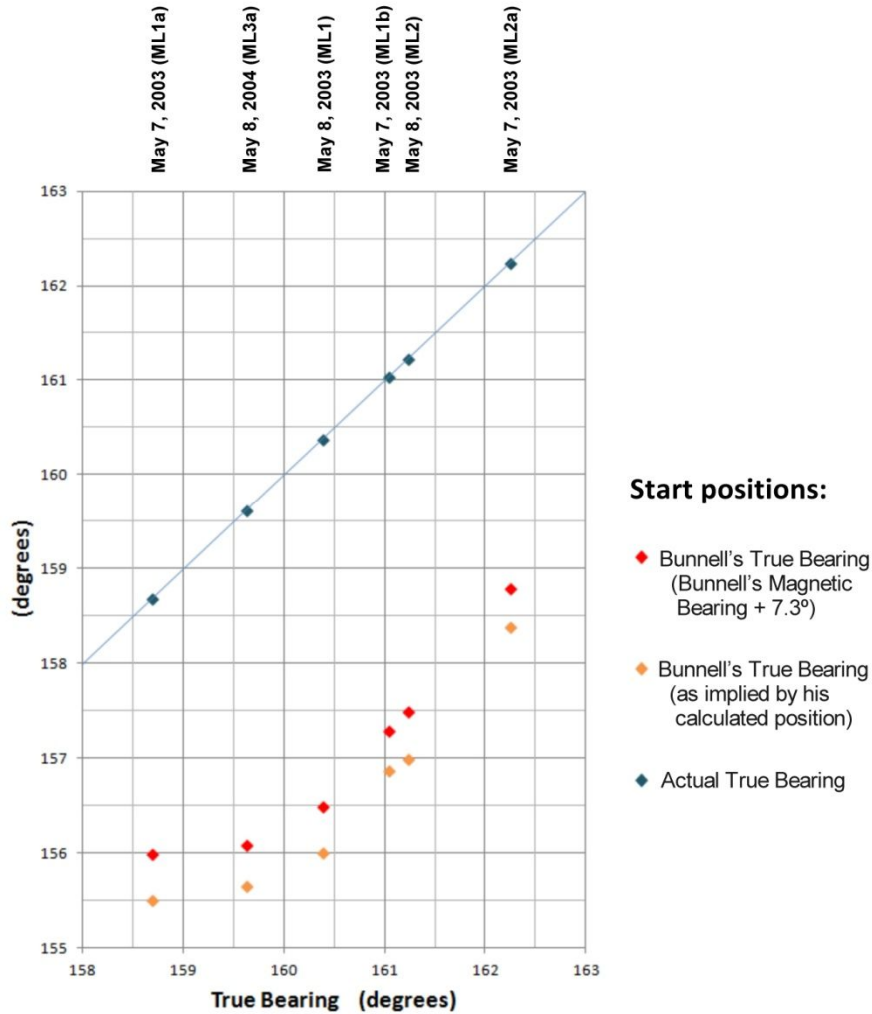


Figure 4. Comparison of the actual true bearing (blue diamonds) of some Marfa Lights at their starting positions, according to the photographs, with the true bearing derived from Bunnell's numerical data. The differences found here range from 2.7° to 4.3°, pointing to errors in his magnetic readings.

Note: since Bunnell has supplied two separate sets of data—expressed either as bearings or as calculated coordinates of position—which are not identical, we have chosen to represent both series of data (red and orange diamonds).

For the purpose of following a clear order in the citation of photographs in the present paper (17 pictures are cited in total), we have established a simple, sequential numbering. The following table links this arbitrary sequence to their event date, Bunnell's ID, and the Bunnell book's figure number.

Photo #	Date	Bunnell's start time	Bunnell's ID	Bunnell's book figure #	Camera lens
1	Feb. 19, 2003	20:20 CST	-	Figure 19 (zoomed image)	70-300 mm
2	"	>20:20 CST to ~20:30 CST	-	Figure 20 (zoomed image)	"
3	"	"	-	Figure 21 (zoomed image)	"
4	May 7, 2003	21:55:34 CDT	ML1a	Figure 23 (zoomed image)	"
5	"	21:58:50 CDT	ML1b	Figure 24 (zoomed image)	"
6	"	22:02:30 CDT	ML2a, ML2b	Figure 25	"
7	"	>22:02:30 CDT to 22:11:23 CDT	ML1b, ML2b	Figure 26	35-80mm
8	"	"	ML1b, ML2b	Figure 27	"
9	May 8, 2003	22:15:55 CDT	ML1	Figure 28 & 29 (zoomed images)	70-300 mm
10	"	22:19:38 CDT	[ML2]	not included	"
11	"	>22:19:38 CDT to 22:33:35 CDT	ML2	Figure 30	35-80mm
12	"	"	[ML2]	not included	"
13	"	"	[ML2]	not included	"
14	May 8, 2004	21:04:31 CDT	ML2	Figure 31	1250mm (spotting scope)
15	"	>21:04:31 CDT to ~21:08:25 CDT	ML3a	Figure 34 (composite image)	"
16	"	"	ML3b	Figure 32 & 34 (composite image)	"
17	"	"	ML3c	Figure 33 & 34 (composite image)	"

All these photographs were shot with 35mm film SLR cameras (model *Pentax ZX-30*), mounted on a tripod, with remote shutter release. Three different camera lenses were used: *Tamron AF 70-300 mm*, *Pentax 35-80mm* and *Celestron C5 Schmidt-Cassegrain*, 5" aperture, 1250mm (spotting scope).

Later pictures from 2006 and 2007 also presented in Bunnell's book were taken using a digital *SLR* camera. We have reviewed this additional photographic evidence in Appendix 3.

EVENTS ANALYZED

Event dated February 19, 2003, 20:20 hours (CST). Photos #1, #2 and #3

Starting direction is 174.0° (*all directions in degrees magnetic, unless indicated otherwise, as given by Bunnell*), final direction is 186.0° ("probably accurate to 1-2 degrees"), total duration is unknown but much less than 10 minutes. Three pictures were taken with an undetermined time gap between photo #1 and photo #2. The photographer was standing at a spot near the SW corner of the fenced area by the MLVC: "no one else was in sight on this cold windy night," Bunnell declares. The light was ambiguously "close" for the photographer, who estimated the height over ground level "on the order of 3 to 5 meters." The ball's color was yellow/orange.

When the light was first seen, it moved horizontally westward (left to right) until it ended with a flash, captured in photo #1. The camera was mounted on a tripod with remote shutter release. The light went out completely, and the camera direction was manually rotated to the right to keep the advancing light and a second exposure was started. The light reappeared almost immediately with a second bright flash and continued moving westward following the same track as before. Photo #2 finished when the light moved beyond where the camera was pointed. The camera was immediately repositioned and started photo #3, with the light moving farther away to the right along the same line until it moved out of view. When a fourth photo was attempted, the light had vanished.

The pictures do not show any background. The photographer had a lens of 70 to 300mm, used it at the maximum zoom and no background reference points are seen. In addition to be a dark night, "the originals have some noise that was suppressed by enhancing the contrast to better show details of the combusive process [*sic*] that was taking place," Bunnell informed us. He also reports the way the azimuths were measured: "I made a mark in the ground with my foot at the start of the first photograph and again at the end point of the last. After the event, I determined the magnetic angles."

According to Bunnell, given the unusual level of camera-recorded detail, the phenomenon had to be close to his location. During 2003-2004, the main period we plan to study, Bunnell had installed a night video camera to track light directions and elevations over time (*Roofus*, "a primitive, security type camera, set to low resolution," placed at coordinates 30° , 13.316°N , 104° , 0.118°W , 4,589 feet elevation). As this camera did not record the incident, no triangulation was possible, and no distance or position could be calculated.

We have combined three uncropped, un-zoomed pictures in a continuous collage, so that the reader may watch the scene as it developed (see [Figure 5](#)). Remember that it is not an aerial, high-sky light but a light that moves at ground level, following a linear motion (at least during the visible part).



Figure 5. Photos #1, #2, #3, February 19, 2003, 8:20pm, Mitchell Flat, Marfa (Texas). Actual motion is from left to right. The spatial separation between photos #1 and #2 is unknown. © James Bunnell.

For the photographer, the images reveal energy decay and “on/off states of illumination as well as ongoing combustive processes” (p. 74) and the observed features are “uncharacteristic of automobile headlamps” (p. 79).

We think differently. As shown in **Figure 6** and **Figure 7**:

- A road (Nopal) intersects in the range of the starting/finish points of the lights.
- The movement of a vehicle along an S-turn existing in that precise stretch of the road (points A and B in the figure) would reasonably explain the images (headlamps “flashing” when briefly pointing toward the observer).
- These points are located some 10km away, which is consistent with the fact that the lights were not recorded by *Roofus* monitor station. As Bunnell managed to verify driving with lights on high beam, that camera would not see a vehicle being on Nopal Road west of the locked gate, this is to say north of the gate, one which limited his camera-testing drive. The locked gate is located at some 13km south of the Viewing Center.

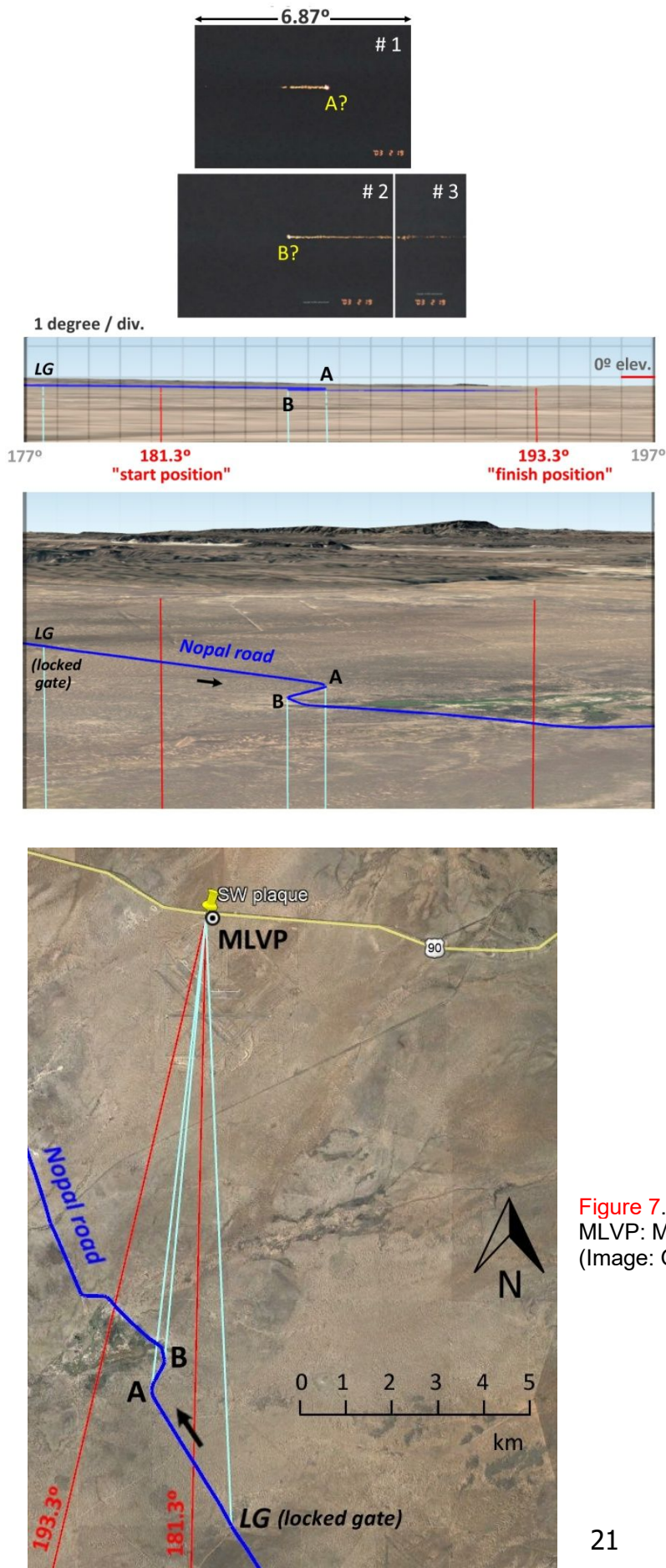


Figure 6. On top, for comparison purposes, the pictures taken reproduced at the same angular scale. (6.87° angular width in the photo corresponds to a 35mm picture achieved with a 300mm focal distance lens.) In the center, Nopal Road as seen from the observation point (SW plaque of the MLVC). At the bottom, a simulated aerial view from directly over the observation spot. (Image: Google, Landsat/Copernicus.)

Figure 7. Map of the area of interest. MLVP: Marfa Lights Viewing Center (Image: Google, Landsat/Copernicus.)

Bunnell puts forward several reasons to question that hypothesis. No vehicle was seen driving through the locked gate (located two miles before the S-turn). He wonders “why a vehicle driving through the S-turn on a dark night would risk turning their lights off at the beginning of the S and then on again just before exiting the S-turn.” In his opinion, it also seems strange that there was no evidence of either the taillight or “the head light beam lighting up desert brush ahead of the vehicle.” Ultimately—“experience matters”—Bunnell maintains: “I have observed vehicles on Nopal driving through the S-turn probably more than a thousand times. This light source was much different.” He also asserts: “The picture is devoid of vehicle characteristics that would have to be present for a vehicle close enough to show so much detail.”

Figure 8 allows us to compare the luminous tracks in photos #1, #2 and #3 with similar tracks captured in pictures of the area of interest taken in May 2003. As we will see later, lights appearing in these latter photos (#8, #12 and #13) can be confidently identified as headlamps of vehicles traveling north on Nopal Road.

For completeness' sake, we present two other possible scenarios in **Figure 9** and **Figure 10**. Each of the scenarios proposed so far has its own merits and drawbacks. Objectively, no accurate estimate or analysis can be performed, as no reliable information exists on the actual location of the lights. Bunnell’s opinion is based on personal interpretation, not on testable data. Allegedly, the light was “too far north to be seen by *Roofus*,” therefore closer to the observer than other lights he would see and photograph at later dates, but at an imprecise distance. Knowing the exact bearings of the flashes that appear in the photographs, allowing for a comparison with the curves of Nopal Road, would have helped to settle the question.

As it stands now, the verdict is: possibly the lights of a vehicle traveling along Nopal Road.

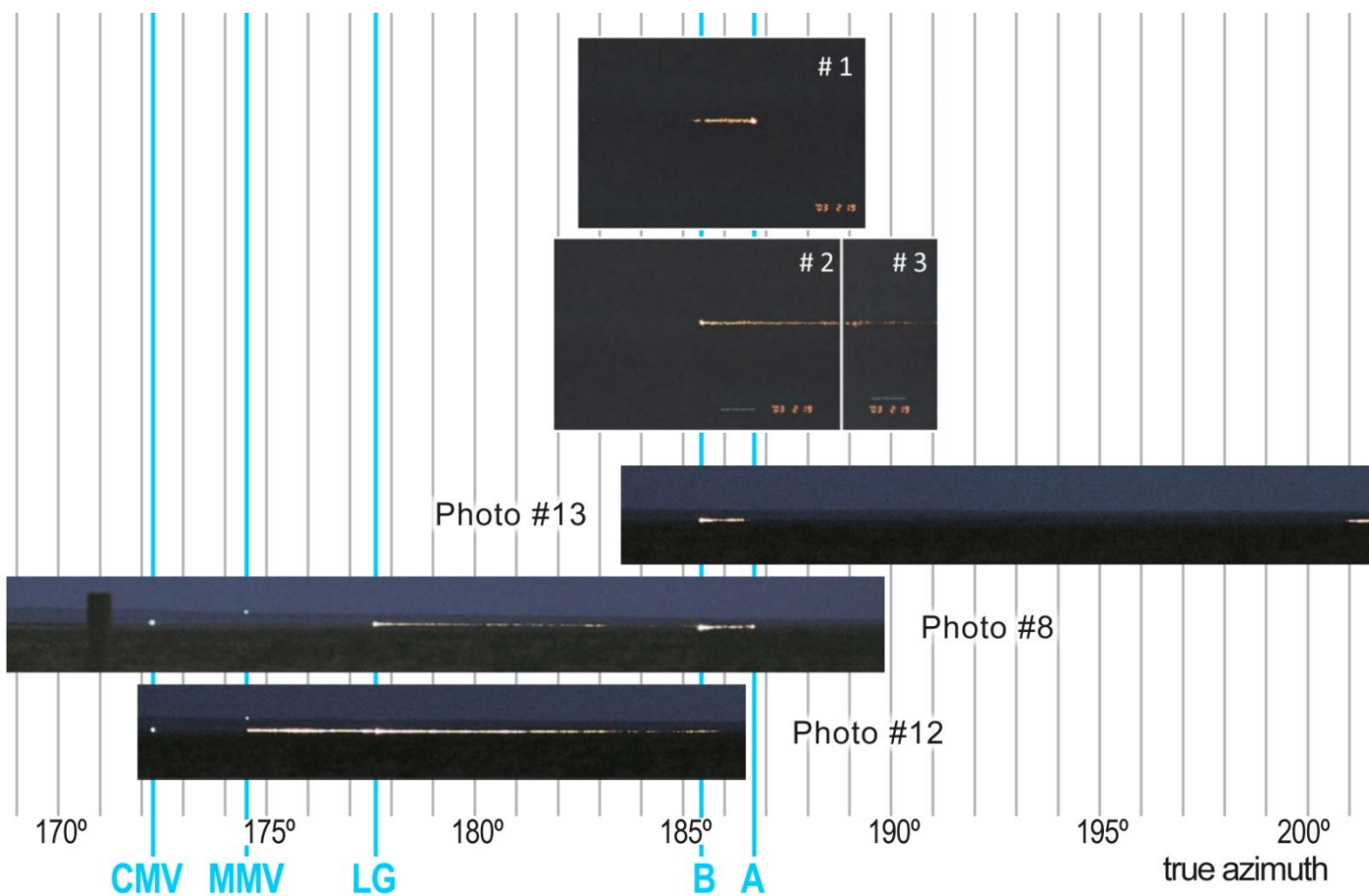


Figure 8. Light tracks in photos #1, #2 and #3 alongside similar tracks caused, likely, by the headlamps of vehicles traveling on Nopal Road (photos #8, #12 and #13, from May 2003). All the images have been arranged to fit the azimuth scale. The precise azimuth of the lights appearing in photos #1, #2 and #3 is not known: in this figure—as in previous **Figure 6**—it has been assumed that the two “flashes” visible in photos #1 and #2 coincided with the turning points (**A** & **B**) in the S-turn of Nopal Road. Besides, an angular width of 6.87° has been considered for these photos (#1, #2 and #3), as they were shot using the maximum zoom, namely a focal distance of 300mm.

Note that this scenario does not seem to account for the final part of the light track, captured in photos #2 and #3, which extends from the apparent location of the S-turn to the right. After the S-turn, vehicle lights are not expected to be seen again from the Viewing Center until reaching a position some 15° to the right, as photo #13 suggests.

CMV: center mercury vapor ranch light.

MMV: mesa mercury vapor ranch light.

LG: locked gate on Nopal Road.

A, B: turning points in the S-turn of Nopal Road, as seen from the Viewing Center.

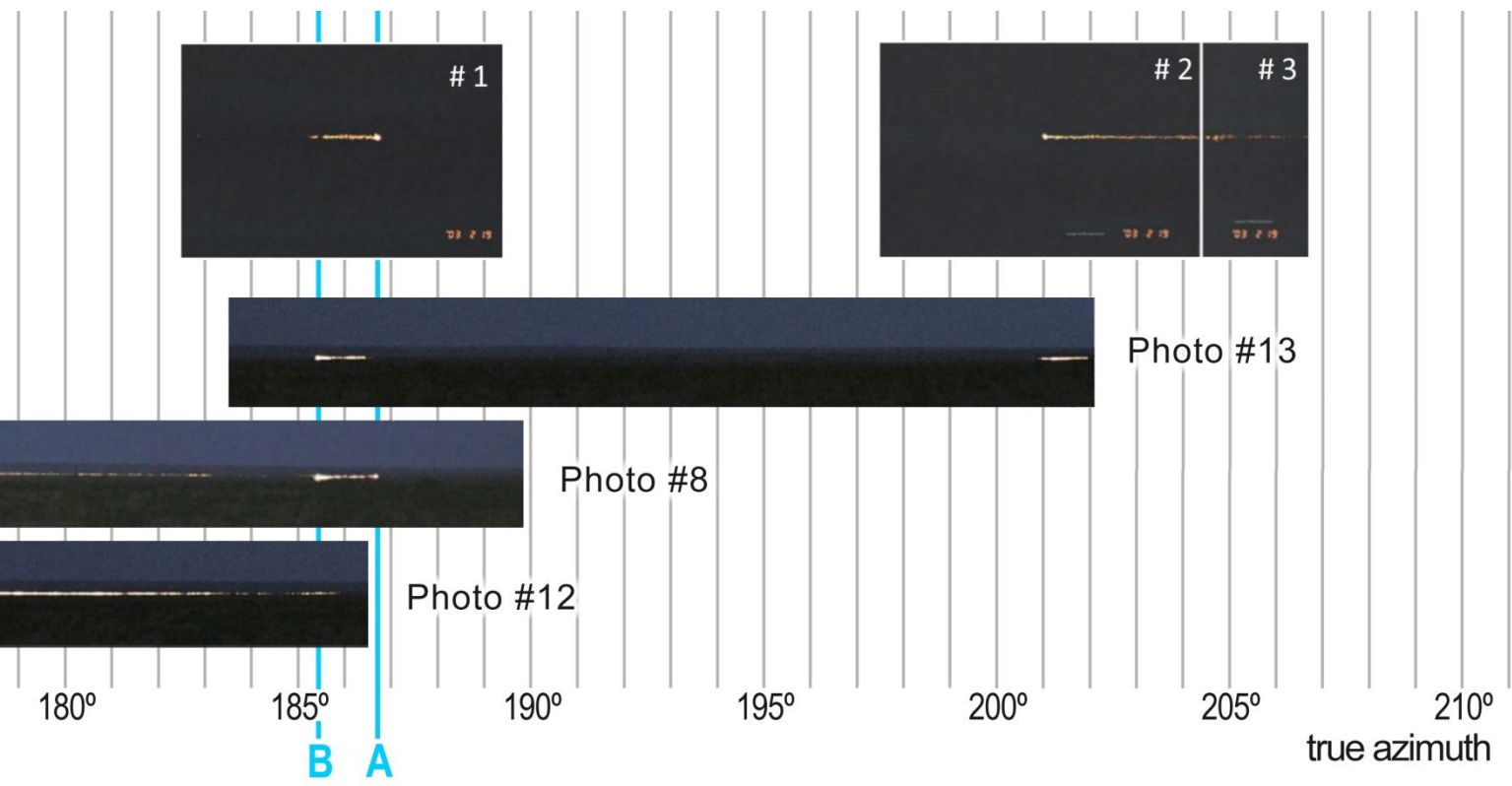


Figure 9. Car lights on Nopal Road: a second scenario. The figure displays light tracks in photos #1, #2 and #3 alongside similar tracks in photos #8, #12 and #13 (see caption of **Figure 8** for more details) by way of comparison. As in the previous figure, we have positioned the first “flash” (photo #1) at the turning point **A**, yet we have moved the second “flash” (photo #2) farther north, to the stretch of Nopal Road where vehicle lights are expected to reappear after the S-turn. This scenario would easily explain the transient disappearance of the light, but it has also some issues. The angular distance between the two “flashes” (14°) seems too big. Furthermore, the very existence of a second “flash” at an azimuth of around 201° is hard to justify. A, B: turning points in the S-turn of Nopal Road, as seen from the Viewing Center.

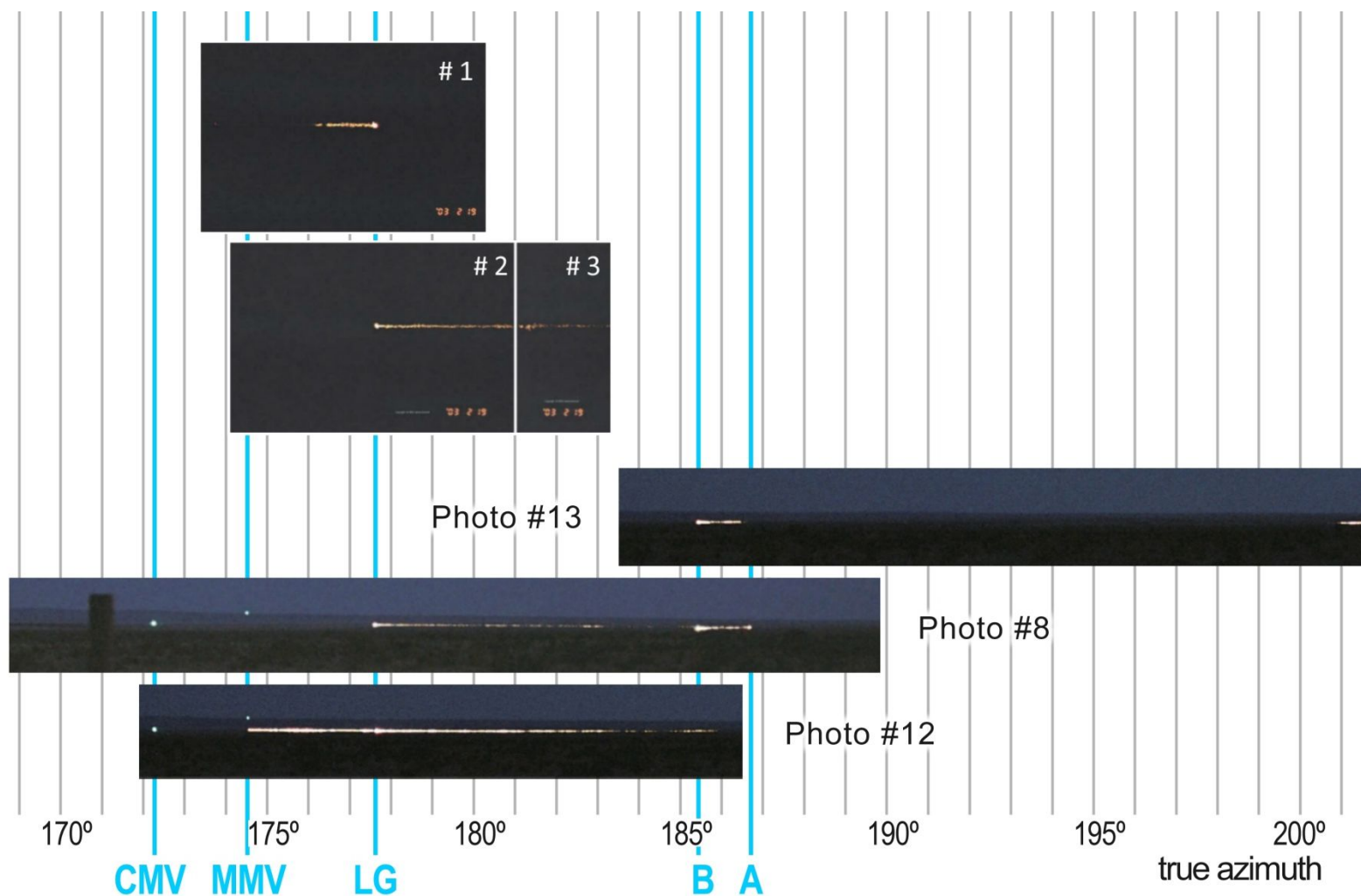


Figure 10. Car lights on Nopal Road: a third scenario.

The figure displays light tracks in photos #1, #2 and #3 alongside similar tracks in photos #8, #12 and #13 (see caption of **Figure 8** for more details). This time, we have positioned the two “flashes” appearing in photos #1 and #2 at the locked gate, assuming that there were no actual flashes to be observed. The increase in brightness would be visible only in the photos, because of a longer exposure of the headlights because of the vehicle stop at the locked gate.

This scenario would imply that the mesa mercury vapor ranch light (MMV) was off when pictures #1 and #2 were taken, since they did not capture it. Also, the driver would have turned off the lights of the vehicle at some point while it was stopped at the locked gate.

The appearance of the light track compares very well with those showing up in photos #8 and #12. However, it is not clear whether the lights should have been recorded by *Roofus* at least partly, which did not happen, according to Bunnell.

CMV: center mercury vapor ranch light.

MMV: mesa mercury vapor ranch light.

LG: locked gate on Nopal Road.

A, B: turning points in the S-turn of Nopal Road, as seen from the Viewing Center.

Event dated May 7, 2003, 21:55:34 hours (CDT). Photo #4

Azimuth of the sighting is 148.7° , full duration ~ 2 minutes. One single picture (photo #4) was taken, as the light went out after taking this image. It was correlated with video achieved from the automated camera, located 12.8km from the MLVC. (Bunnell withheld the location of his video camera—*Roofus*—on the basis that it would lead to unwarranted visits and illegal intrusions to the private property where it was placed. We now know its exact position, as it is already dismantled.) Estimated distance from Bunnell's position at the MLVC was 15 miles (24.1km): "that range resulted from the computed intersection of *Roofus* and my tripod mounted camera directions." Nevertheless, he also specifies the event location as being 30.1032° N, 103.794° W, a spot 20.9km away from the MLVC.

It was a bright light moving "mostly or only" to the right (west), creating the elongated image inserted in [Figure 11](#). The light was "white-yellow color in the center with orange to reddish surrounding it." An initial flare, that dimmed and went out before it could be photographed, was previously sighted on a different location.



Figure 11. Photo #4, May 7, 2003, 9:56pm, Mitchell Flat, Marfa (Texas), uncropped image. © James Bunnell.

We asked the photographer about the exposure time but Bunnell did not keep this precise data in his logbooks. He reports, however, that most camera-selected exposure times were on the order of about 5 seconds, "in this case, obvious movement of the ML suggests that the shutter was open significantly longer."

We were quite interested to see images from the recording station, but it proved hopeless. Bunnell explained to us the process he followed and the reason why

automated camera images were not available this time. *Roofus* and (years later) *Snoopy* and *Owlbert* cameras were all B&W video cameras that ran all night. The resultant videos were saved to hard drives; time and direction of any candidate lights would be recorded in logbooks and the drives would be reformatted and swapped out for reuse. The color pictures taken by Bunnell from the Viewing Center were then correlated with the logged video surveillance, and computed intersections in time determined where potential MLs were located at specific times. Bunnell obtained time data from his digital video recorders. These recorder clocks were “uncontrolled and found to drift,” he admitted. This made matching video frames with pictures taken from the Viewing Center, and elsewhere, “too imprecise.” It was not until 2006 that he could pull accurate times from satellites.

Regarding the actual altitude above the terrain of this moving mass of light, Bunnell made *ad hoc* calculations to respond to our question and the figure he provided was ~44m, with the following reasoning (see [Figure 12](#)):

I used a DeLorme² tool to create a terrain profile along the 156° true [148.7° magnetic plus 7.3° declination] radial from the Viewing Center in order to find the horizon elevation along that radial. The terrain profile provides elevation above sea level for the maximum point that can be seen behind and above the ML picture. We already know from the prior intersection data terrain altitude below where the ML was located at that moment. We then use the picture to approximate relative location of the ML above visible terrain and the maximum terrain elevation behind the ML. This ratio gives us a reasonable approximation of the ML's height.

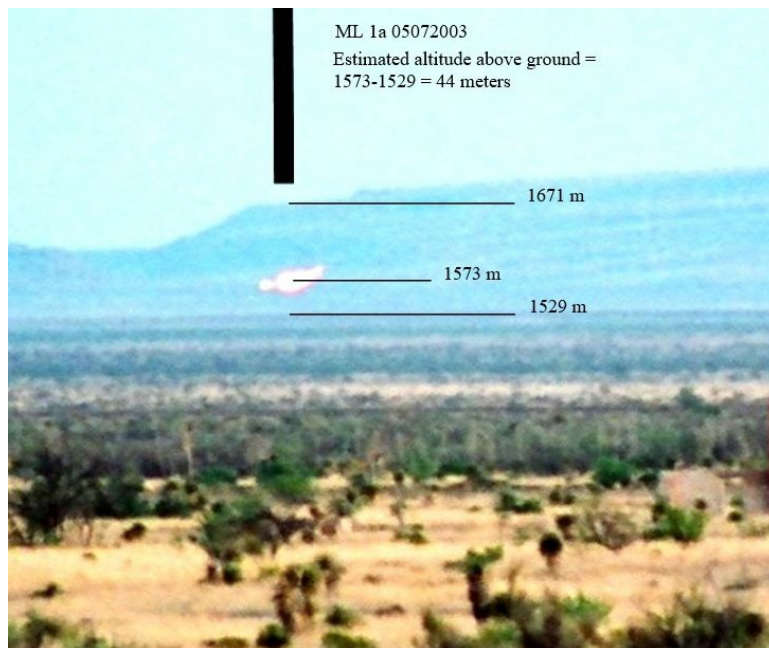


Figure 12. Photo #4, May 7, 2003, 9:56pm, Mitchell Flat, Marfa (Texas). This zoomed photograph illustrates Bunnell’s calculation of height above land. © James Bunnell.

⁽²⁾ Bunnell refers to DeLorme XMap, a professional mapping software that can be used to produce elevation profiles of the terrain. Now discontinued.

In our opinion, this estimate is flawed from the start. Having simulated the landscape with the Google Earth computer program (see [Figure 13](#)), we can affirm that the reported azimuth is wrong. The light was actually visible in the position 158.7° true north, or 2.7° away from the azimuth that Bunnell had calculated and 3.2° away from the azimuth implied by his estimated coordinates. For distances greater than 20km, this causes the estimated position to be misplaced by more than 900m. This error allows questioning Bunnell's result that the light was floating a little over 40m from the ground.

Moreover, if we project the light's position onto the background landscape, we see it coincides with a track that descends from one of the mesas. Besides, the inclination of the light also agrees with the apparent inclination of the path. In conclusion, it seems reasonable to think that he photographed the lights of a vehicle traveling through said path, marked **w** in [Figure 13](#) and [Figure 14](#).

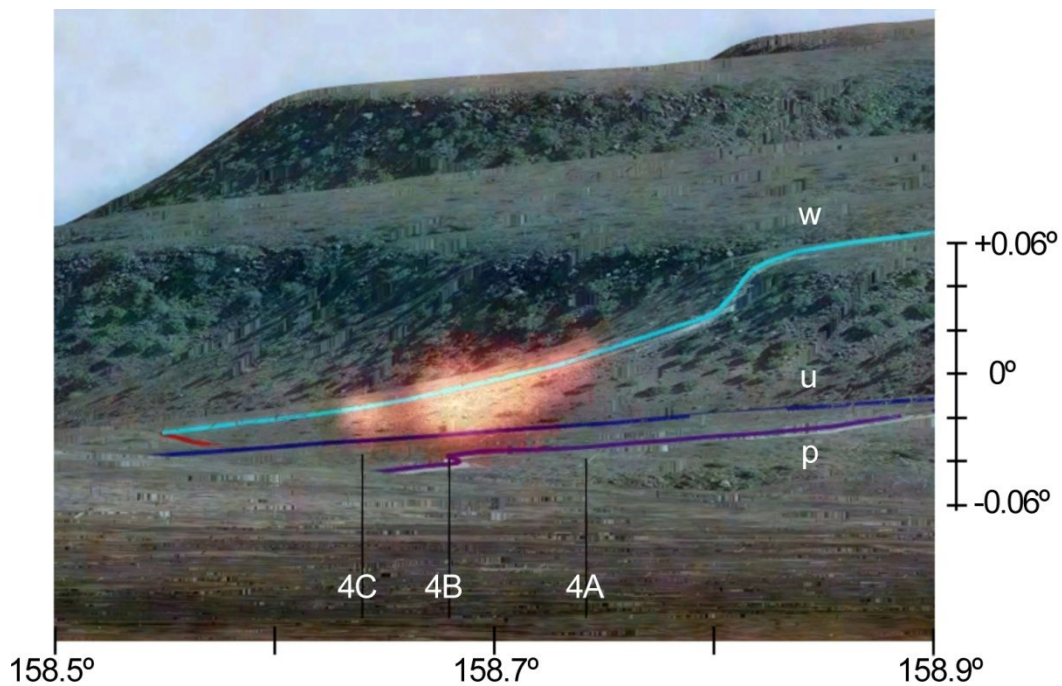


Figure 13. Photo #4, May 7, 2003, 9:56pm, Mitchell Flat, Marfa (Texas). Google Earth simulation with actual position of the light in relation to the road tracks located near the spot, as visible from the MLVC. Horizontal scale: true azimuth. (Image: Google, Landsat/Copernicus.)

Nevertheless, as we will see time and again when checking the rest of the pictures, the luminous trail might be slightly displaced upwards due to atmospheric light refraction effects (looming). Therefore, the vehicle could also have been traveling either **u** or **p** road tracks. All in all, we do not have enough data to choose one of the three possible stretches of road, which have lengths about 56 meters (**w** and **u**) and 130 meters (**p**), implying a time exposure of seconds. In any case, it should be noted that the “S-turn” in the road marked **p**, forcing a car's headlamps to point

toward the camera for an instant, could well account for the increased brightness found in the picture in the 4B direction.³

Whatever the path followed by the vehicle, the direction of displacement would be to the left (toward the NE), in any of the three cases, contrary to what Bunnell has indicated to us in correspondence (“moving mostly or only to the right”). Interestingly, the caption of figure 23 of Bunnell’s book just pointed out that “it was moving back and forth,” without specifying a rightward or leftward motion.



Figure 14. Photo #4, May 7, 2003, 9:56pm, Mitchell Flat, Marfa (Texas). Google Earth "aerial view" of the area where the light appeared, including situation of the existing road paths. The photographed light trail is between directions 4C and 4A, reaching maximum brightness at 4B. Probable explanation: headlights of a vehicle circulating on road stretches **w**, **u** or **p**. (Image: Google, Landsat/Copernicus.)

⁽³⁾ Our nomenclature **w**, **u**, **p**, etc., refer to certain stretches of road of interest in the analysis of the lights' displacement over the terrain. Our nomenclature "number of photo & letter" (for example 4A, 4B, or 4C above), refer to certain directions of interest associated with the lights, for example, pointing to the beginning, to the end, to a bright spot within a track, etc.

Let us observe that the stretches of road under consideration are 4.4km to 5.5km farther south of the position assigned to the phenomenon by Bunnell. We refer now to our **Figure 30** (see further below): please compare the alleged position of ML1a (Mystery Light 1a)—noted on the map as a red star—with the small stretches of road that we have just mentioned, visible next to the lower right corner of the figure.

Finally, we cannot overlook what appears to be an inconsistency in the reported time at which photo #4 was shot. The next picture (photo #5, to be dealt with in the next section) was taken only some three minutes later with the same camera and, presumably, using the same film, yet it shows something radically different: a view of a poorly lit landscape more akin to a night scene (see **Figure 15**). We know that photo #4 was computer enhanced to improve the terrain illumination,⁴ but this fact alone does not seem to completely account for the difference.

Photo #4 was taken, according to Bunnell, “after sunset but before it had become dark,” reportedly at 21:55:34 (CDT). Since sunset took place at 20:36 and the astronomical dusk occurred at 22:06, this would imply that the picture was taken almost at night (although not a real dark night as the Moon was up, albeit with only 35% of the disk illuminated). In short, the reported time seems more compatible with photo #5 than with photo #4.⁵ Therefore, we suspect that photo #4 was shot earlier than stated, at a time closer to that of sunset, when there was more ambient light.

It should be borne in mind that the time of the shot was estimated by correlating the appearance of the light in both the photograph and the *Roofus* footage, obtaining the time reference from the latter. Since the cameras were at two different locations and did not share the same perspective, it is possible that the *Roofus* camera failed to record the early occurrence of the ML while it was captured from the Viewing Center. If this were the case, it would have led to a wrong correlation of the photographic and video images and, hence, to a time mismatch.

(4) Bunnell writes that some of his images “look like they were taken in day light instead of night because I do use computer enhancement to bring out ground terrain whenever that is possible” (http://web.archive.org/web/20100302022522/http://www.nightorbs.net/are_these_pictures_valid.htm). In his books *Hunting Marfa Lights* and *Night Orbs*, respectively, he reports such “computer enhancement” or “photographic technique” to have been applied on photo #4.

(5) A proper comparison should also consider the exposure times of both photographs, but this information is missing. Obviously, a shorter exposure would result in a darker image, and a longer exposure would result in a lighter image.

Event dated May 7, 2003, 3 minutes, 16 seconds later. Photo #5

Another light turned up at 150.0° in a location estimated by the photographer as 30.0737° N, 103.7851° W (this is, 3.4km away), “to create an interesting display with both left and right directions of travel” (p. 81), as captured in photo #5. However, although the eerie light emerged from a separate location (~15 miles, or ~24.1km from the observation point), the author assumes both were a unique anomaly, now calling this phase ML1b. Bunnell also interprets that the vertical variation in the light track “suggests that the ML might have been trying to spiral” (p. 81) or to “shuttle left and right” (caption of Bunnell book’s figure 24, p. 82). Time exposure of photo #5 is unknown, as cameras operated in a mode in which exposure times were automatically selected based on light collection.



Figure 15. Photo #5, May 7, 2003, 9:59pm, Mitchell Flat, Marfa (Texas). Close-up picture. (Magnetic degrees here as given by Bunnell. These are equivalent to 161.03° and 162.40° true). © James Bunnell.

Considering the error affecting some of the azimuths handled by Bunnell, as shown in **Figure 3** and **Figure 4**, the 150° magnetic azimuth should read 153.73° , which corresponds to 161.03° true north. At distances on the order of 24km, this difference of 3.7° implies a position error of more than 1,500m (more than 1,700m in the case of the aforementioned coordinates, which correspond to a true north azimuth of 156.9°).

Again, we can test this observation. If we overlap the light trace on a land simulation created from Google Earth, we observe a good spatial match with some

local dirt roads (see [Figure 16](#)). Not only that, the picture shows a winding track that perfectly follows the same feature of the road. We do not think it is fortuitous but a direct relationship of cause and effect.

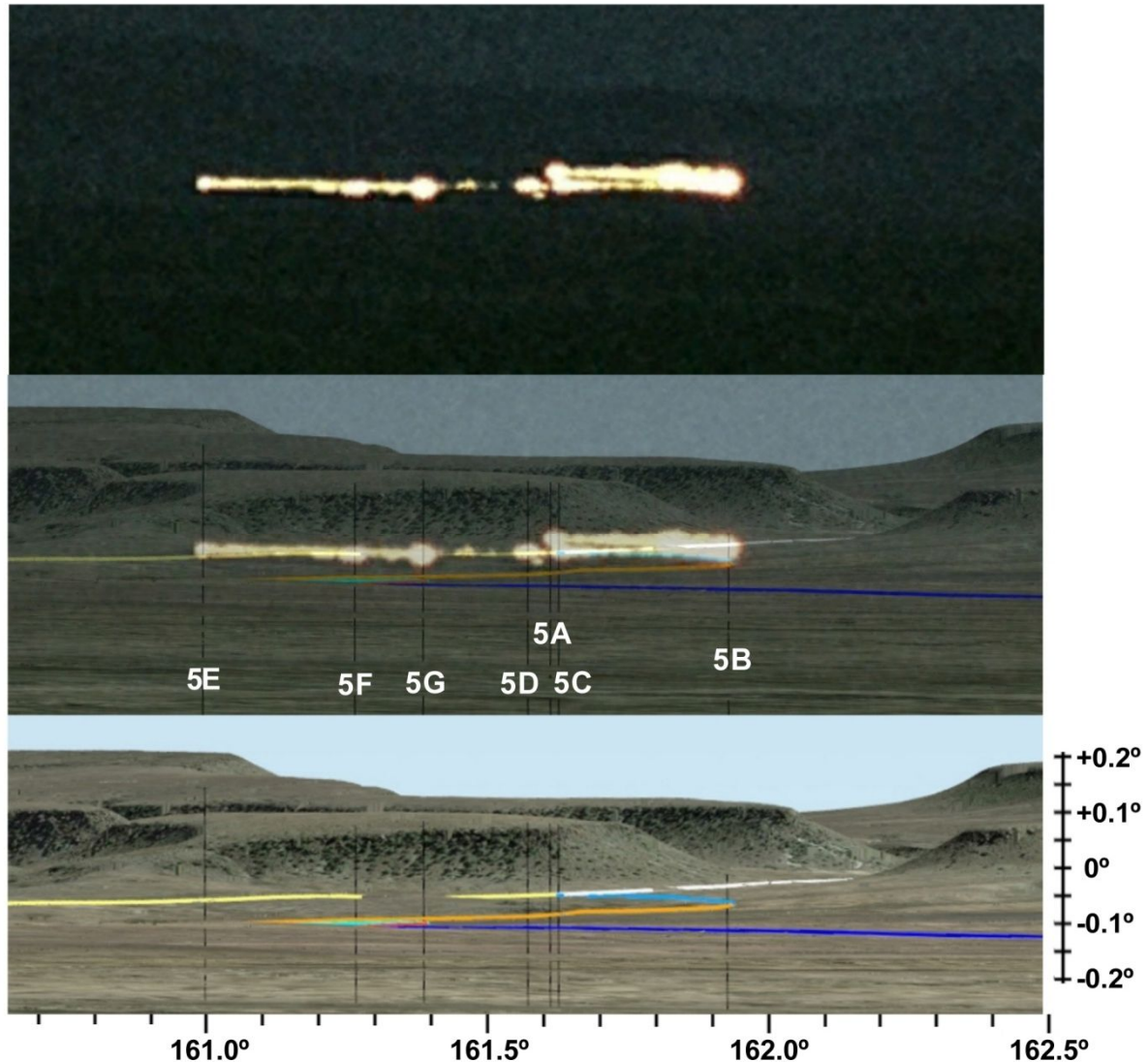


Figure 16. Photo #5, May 7, 2003, 9:59pm, Mitchell Flat, Marfa (Texas). Correlation between visible local roads and light track.
 Top: close-up of Bunnell's photograph.
 Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.)
 Center: combined image, as a comparison. Lines 5A to 5G are directions of special interest in the pictured luminous track (see their true north azimuths below).

For a better understanding, in the following [Figure 17](#) we have devised a more comprehensive view of the road layout as it would be seen by positioning the camera much higher and closer to the mesas. Fine black lines on the terrain indicate the directions in which the end-points and other features of the pictured light track were seen from the location of the camera at Viewing Center (do not be

misled by perspective: these lines converge in the Viewing Center direction, not toward the mesas zone).

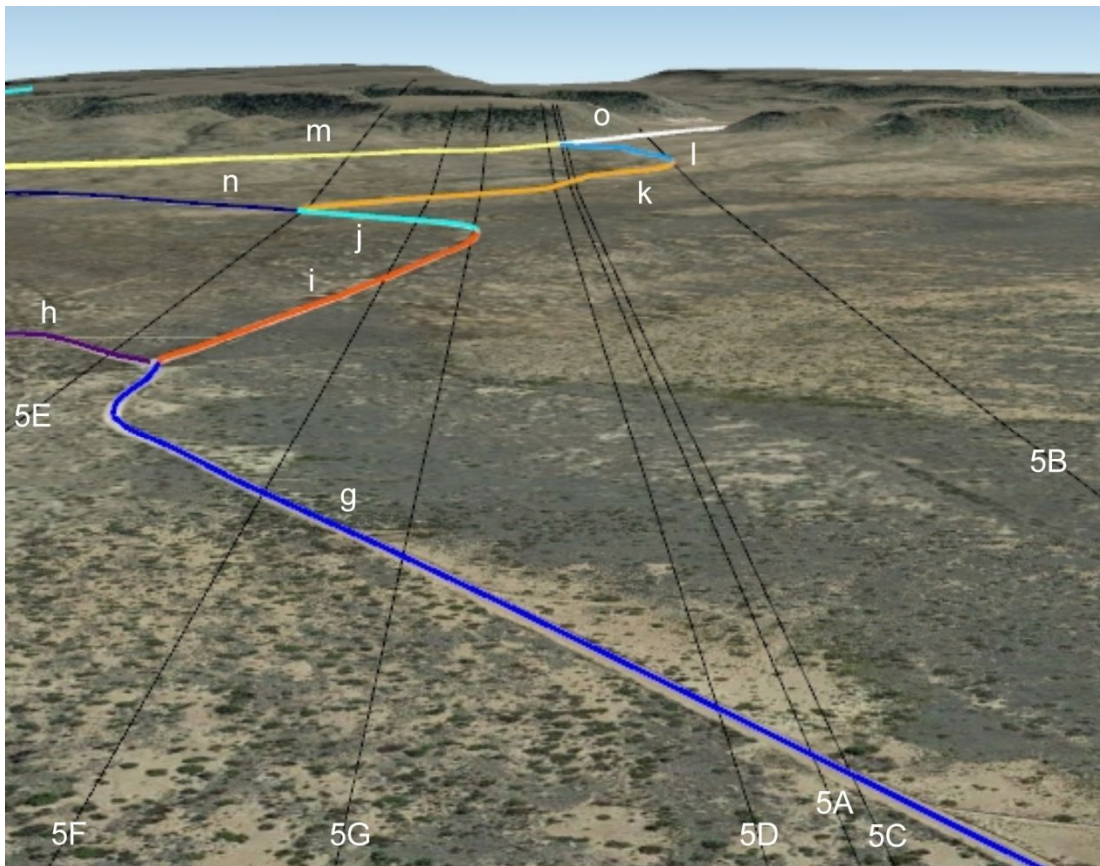


Figure 17. Photo #5, May 7, 2003, 9:59pm, Mitchell Flat, Marfa (Texas). Simulated bird's-eye view of the area of interest. The luminous track in photo #5 could be caused by the headlights of a car traveling through stretches **l**, **k**, **j**, and part of **i**, in sequence. Note that, in this area, the lights would move to the right in the blue stretches of road, and to the left in the others. (Image: Google, Landsat/Copernicus.)

The comparison suggests a drive starting at the beginning of the stretch of road **l** (at direction **5A**, which points to the upper right end of the light track), going down through **k** and **j**, and finishing some distance into the stretch of road **i** (at direction **5G** or more to the left, it cannot be established for sure). The apparent direction of motion reverses at least three times during that drive as seen from the Viewing Center, hence the reported zigzagging behavior of the light.

Some of the brighter spots in the photographed light track can be related to changes in the direction of the road that make a vehicle's headlights point toward the camera for a moment, namely at **5B** (**l/k** transition), **5E** (**k/j** transition) and **5G** (**j/i** transition).

It must be noted that, in our comparison, the light track does not overlay the simulated road tracks but runs “parallel” to them, hardly a few hundredths of

degree above. This is indicative of looming, an abnormally large refraction of light rays that increases the apparent elevation of distant objects, usually due to a temperature inversion (that is, air temperature increasing with altitude).

ML1 continued moving to the right (NW) until disappearing. This last phase of the phenomenon will be discussed below. But first we will look at the appearance of a second light.

Event dated May 7, 2003, 3 minutes, 40 seconds later. Photo #6

While the prior observation was still in progress and the photo #5 light followed its apparent linear course parallel to the ground, another light was sighted at 151.5° and photographed (ML2a in photo #6—see [Figure 18](#) below). Event location was at coordinates 30.0704° N, 103.7908° W. It was short-lived and stayed close to the starting point. During the time exposure (no information exists), it faded out and another light developed (ML2b in photo #6) to continue apparently the same straight track of ML2a. Both are recorded in a single picture. The total duration of this double sighting was 7 minutes, 57 seconds (“timing data comes from *Roofus*, and from that perspective it was not possible to tell if they started together or in sequence,” Bunnell wrote to us). We will deal with the final course of ML2b (not captured in photo #6) in the next section.

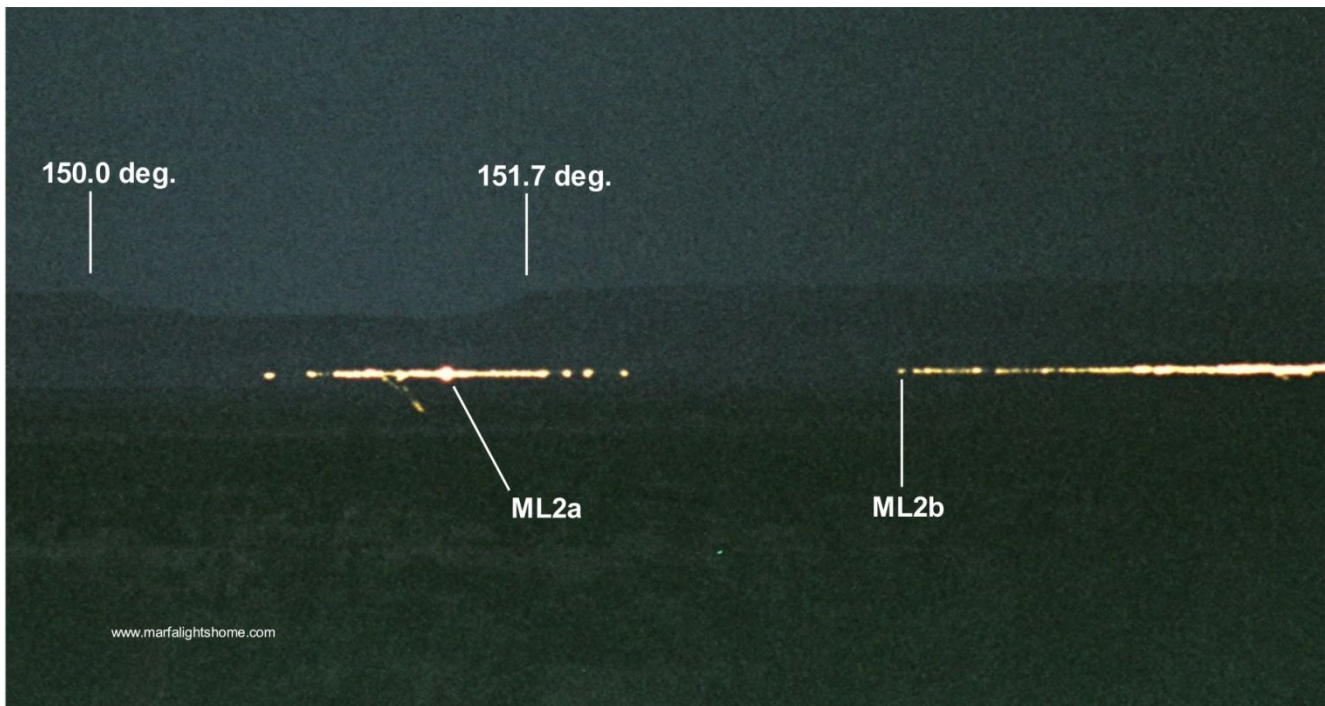


Figure 18. Photo #6, May 7, 2003, 10:02pm, Mitchell Flat, Marfa (Texas). (Magnetic degrees here as given by Bunnell. These are equivalent to 161.03° and 162.40° true). © James Bunnell.

The photo shows a couple of close, short, diverging lines of light below the major trace on the left side (ML2a). Bunnell believes it is due to “downward trajectories

created by two expelled particles that were evidently ejected as the ML was traveling to the northwest.” Based on this presumed material detached from a luminous object flying above the ground, he estimates its height at ~51m (“this is a minimum altitude above terrain because the ejected particles may have extinguished before reaching the ground,” p. 87). How did Bunnell guess this height? He informs us that “background terrain provided a convenient dimensional reference of 1.7 degrees from my position at the Viewing Center. Knowing distance to the ML (thanks to *Roofus*) gave me a scale at that range. I used that scale to estimate the vertical component of the descending light tracks.” Concerning the second image of photo #6 (ML2b), he feels it “started at the same apparent altitude” and was losing height up to reaching ~6m over the terrain as it moved west at a considerable distance.

We are certain that these altitude estimates are not reliable because they are based on wrong data. To start with, the angular width of the background gap is 1.4°, not 1.7°, therefore the scale adopted is wrong. On the other hand, the triangulated position of the light derives from an erroneous magnetic azimuth, the aforementioned 151.5°, which would imply a true north azimuth of 158.8° instead of the correct value of 162.2°. Note that for distances greater than 20km, as in this case, this error of 3.4° in azimuth leads to estimated positions more than 1,200m away from the right locations.

Let us now examine this event from zero. If we overlap the double-track picture of photo #6 with a terrain simulation from Google Earth, it becomes immediately evident that the two light traces show up along a road path (see **Figure 19**). By the way, we once again encounter the looming effect that makes the light track appear slightly above the path of the road displayed in the landscape generated by Google Earth.

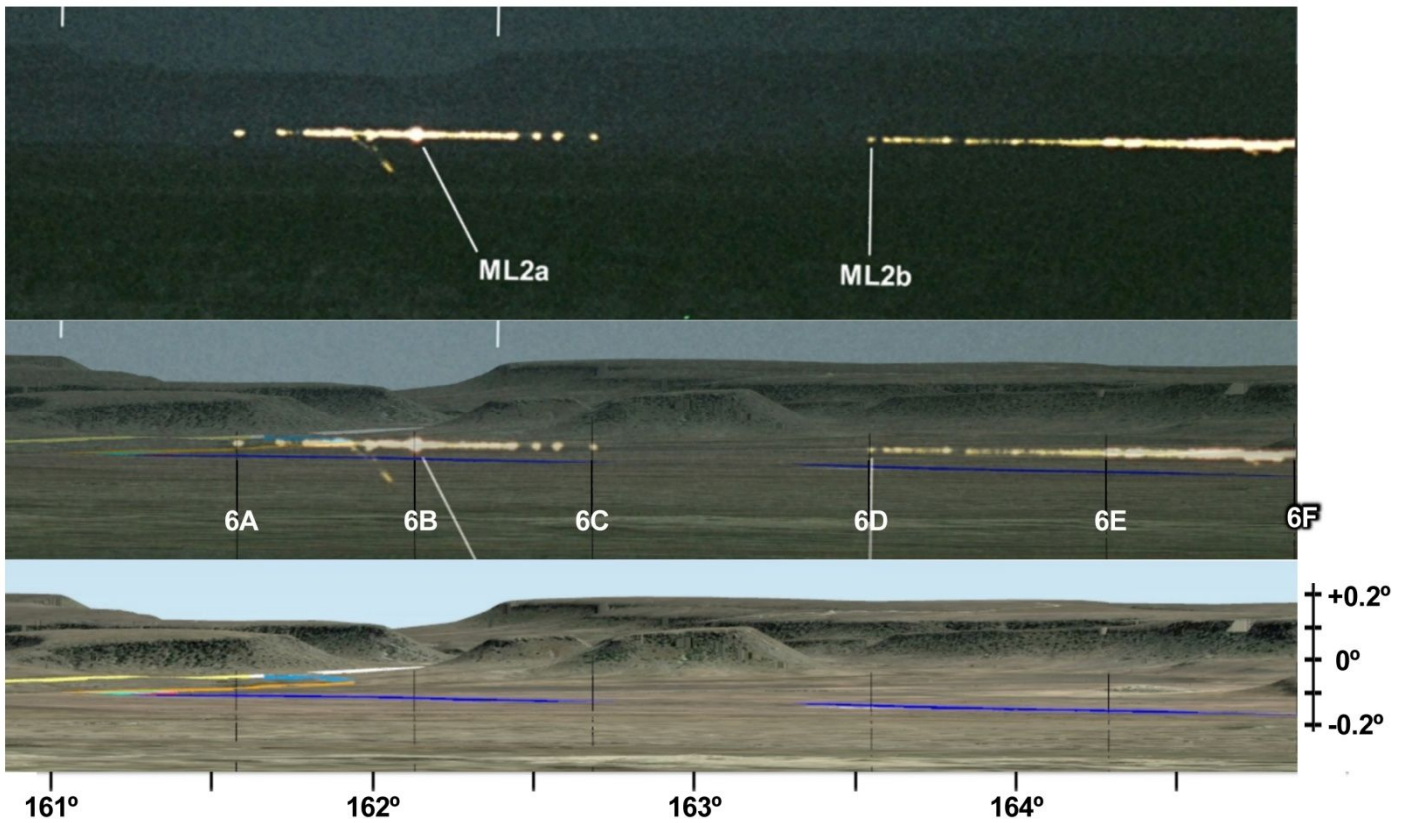


Figure 19. Photo #6 (ML2a/b), May 7, 2003, 10:02pm, Mitchell Flat, Marfa (Texas). Correlation between visible local road and luminous track.
 Top: close-up of Bunnell's photograph.
 Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.)
 Center: combined image, as a comparison. Lines 6A to 6F are directions of special interest in the pictured luminous track (see their true north azimuths below).

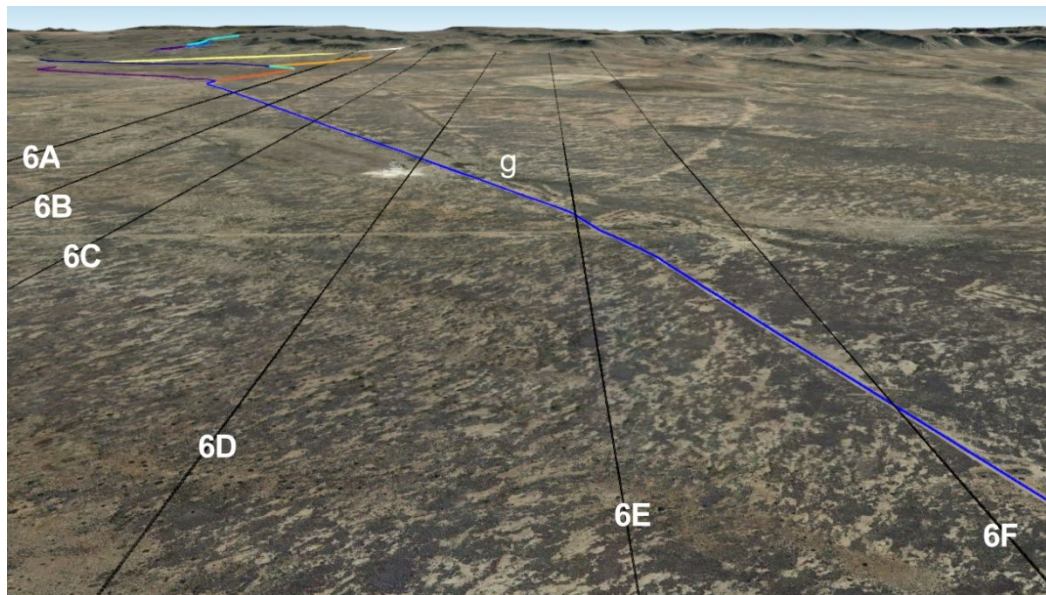


Figure 20. Photo #6 (ML2a/b), May 7, 2003, 10:02pm, Mitchell Flat, Marfa (Texas). Simulated bird's-eye view of the area of interest. (Image: Google, Landsat/Copernicus.)

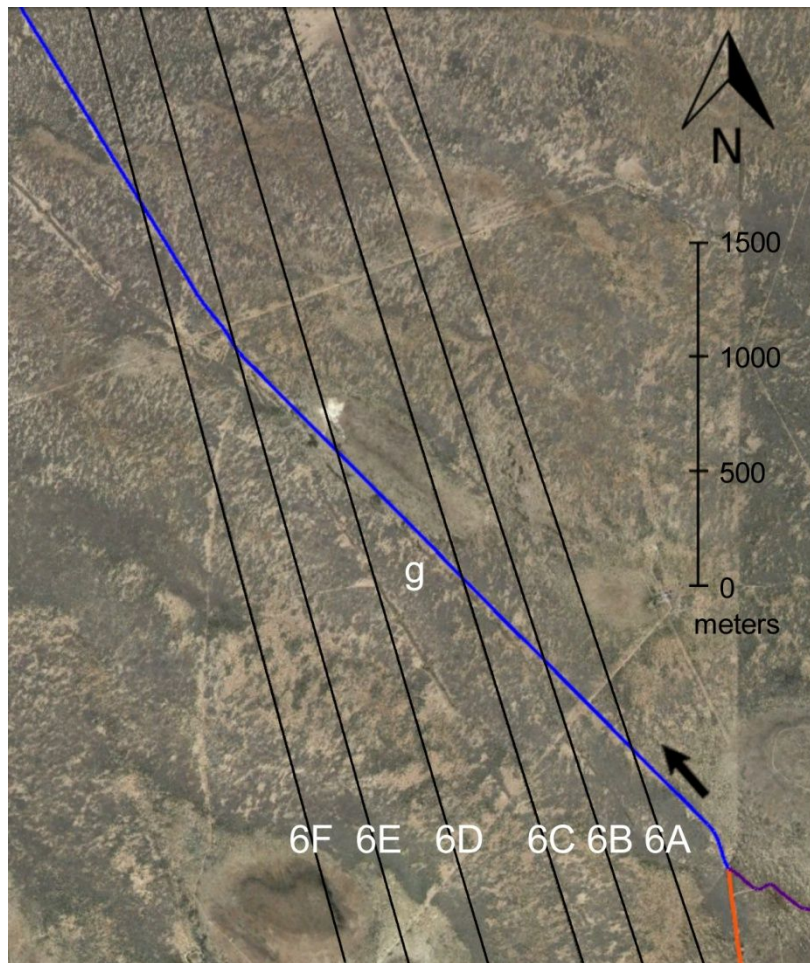


Figure 21. Photo #6 (ML2a/b), May 7, 2003, 10:02pm, Mitchell Flat, Marfa (Texas). Map of the area of interest. (Image: Google, Landsat/Copernicus.)

The interruption of the light track between directions 6C and 6D can be easily explained as caused by terrain features obstructing the view of the road (for more details, see the analysis of photos #10 and #11 below, where we will encounter this same gap).

From direction 6E to the right (toward 6F), the light track becomes brighter coinciding with a change in the road direction, which comes a little closer to the line of sight from the Viewing Center, making the headlights of any approaching vehicle more visible (see **Figure 20** and **Figure 21**).

On the contrary, there is no obvious feature of the terrain or the road that could explain the brighter spot near the center of the ML2a track (at direction 6B). Just to mention one possibility, a short stop of the vehicle at that place, for whatever reason, would lead to this effect.

According to Bunnell, photo #6 includes computed locations, altitudes, and trajectories of expelled elements that are inconsistent with vehicle lights. Actually, it

is the error in the computed locations what would have prevented him from finding the obvious connection of the light track with the road in the first place: we refer the reader to Figure 30 (see further below) to compare his ML2a start location—red star “ML2a”—with the location of the involved stretch of dirt road g near the intersection with line 6A.

Once the car explanation was “ruled out” by Bunnell, speculations took over. He calculated a greater separation from the ground (168feet, or 51m) largely based on a presumption: the oblique luminosity below the first track in photo #6 (see Figure 22) was a fall of fiery material from the plasma ball that he supposes creates the Marfa Lights. However, it is entirely unfounded. If the light traces are but vehicle lights moving on local roads, that curious segment of segregated light must have another nature, a conventional one. Probably optical, just a scanty camera movement. We consulted image analysis expert Andrés Duarte. He was categorical: “I think the oblique trace is due to a shaking of the camera.” There is no spectroscopic or other non-subjective proof that this short-lived effect is due to anything chemical or material.

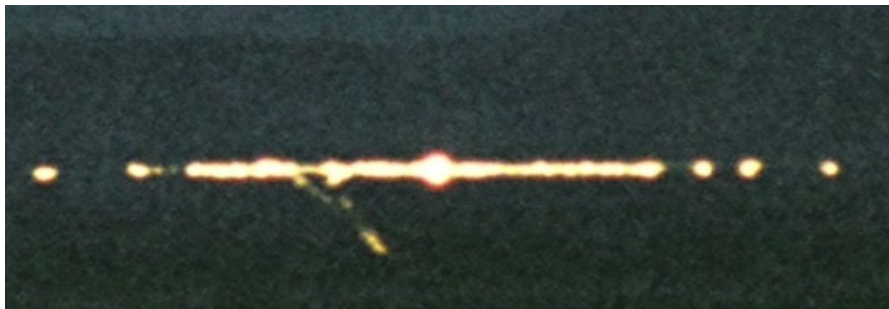


Figure 22. Photo #6 “ejection,” May 7, 2003, 10:02pm, Mitchell Flat, Marfa (Texas). Close-up showing the section of the luminous track where a couple of diverging lines of light appear below it. © James Bunnell.

As for the specific characteristics of this little shaking, we cannot draw any firm conclusions. Unfortunately, the shot did not capture any fixed light (e.g. a ranch light) with its own shake trace, which would have provided additional information. Whether the photo shows two successive shakes or just a single looping shake remains open to discussion. The particular cause of the shaking cannot be ascertained either, with possibilities ranging from an accidental bump to more complex situations. For example, if the shot were a double exposure, shaking could arise from manual intervention and/or the flipping down and up of the mirror inside the reflex camera, coinciding with the beginning and the end of the time-out between exposures. Finally, other unanswered questions concern the existence or not of a “gap” in the track of the headlights. Note that the light track is thinner between the two diverging streaks of light suspected to be shake trails. As we will see later, a similar light track in a picture taken on the next day (photo #10) does not show any anomaly in that stretch of the track. Does this mean that there is a real gap in the main light track in photo #6? Was it caused by a horizontal angular shift of the camera or by a momentary interruption of the exposure? On the other

hand, could the road illuminated by the vehicle's headlights explain the thin luminous trace across the gap (which corresponds to a stretch of Nopal/Escondido Road about 38m long)?

Event dated May 7, 2003, final phase. Photos #7 and #8

At least two less-zoomed pictures were obtained with a second camera. A graph produced to represent the events of May 7 (Map 6 of Bunnell’s book, p. 86) shows that ML1b (regardless of possible initial evolutions, not represented there) kept moving to the northwest, roughly toward the MLVC where the photographer was located. The light lasted 8 minutes, 33 seconds and disappeared at approximately 192° from the MLVC by following “a curving route to the north.” The map of **Figure 23** is Map 6 of Bunnell’s book, modified by us to show only the ML1b event.

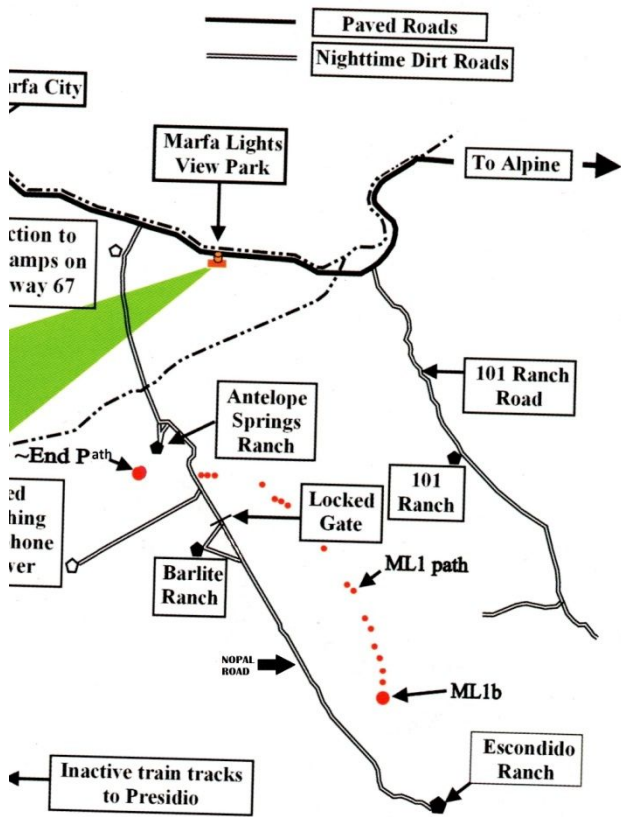


Figure 23. Path of ML1b in the area map, May 7, 2003, 9:59pm, Mitchell Flat, Marfa (Texas), close to Nopal/Escondido Road. © James Bunnell.

We inquired if the light was non-stop during all its movement: “yes and no. I would have to say that the track was continuous although, in typical ML fashion, it did gaps,” Bunnell answered us. Because the light was also recorded from the *Roofus* station, Bunnell calculates the straight-line distance at 18km and an estimated speed of 124km/h.

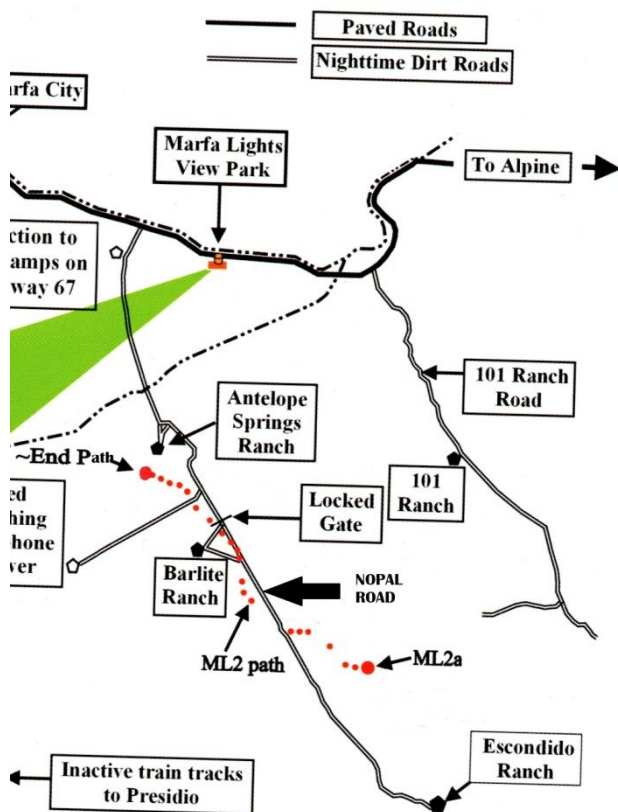


Figure 24. ML2a starting position and path of ML2b in the area map, May 7, 2003, 10:02, Mitchell Flat, Marfa (Texas), close to Nopal/Escondido Road. © James Bunnell.

ML2b followed a similar course. The duration of this sighting was 7 minutes, 57 seconds. By triangulation, a linear distance of 14km was calculated, a roaming distance of 15km, and an average speed of 116km/hr. The map of Figure 24 is Map 6 of Bunnell’s book, modified by us to show only the track of ML2b.

We have already shown that the starting tracks of ML1b and ML2b are probably misplaced due to inaccurate data/calculations and were caused by the lights of a vehicle traveling along the southernmost part of Nopal Road (Escondido Road) and nearby roads, in the Escondido Ranch area. It comes as no surprise, then, that the dotted lines that indicate the subsequent NW course of the alleged strange lights are close (scarcely about 3km west for ML1b) or even extremely close (ML2b) to Nopal Road. They even move over it in certain sections of the road! A small error in the author’s triangulation would suffice to result in wrong positions and altitudes. Remember that, for example, Bunnell’s estimate for the longer light track of ML2b was hardly 6m over the ground.

The number of photographs taken during the final phase of ML1b and ML2b is not known for sure. All we know is that “the original images are locked in a safe.” As for the continuous video achieved that night, it was erased for reutilization. Next, we will check the only two published pictures of the last phase of this photographic session: we will list them as photo #7 and photo #8 (see Figure 25 and Figure 26 below) corresponding to figures 26 and 27 of Bunnell’s book (p. 85).



Figure 25. Photo #7 (ML1b/ML2b), May 7, 2003, after 10:02pm. Mitchell Flat, May 7, 2003. Mitchell Flat, Marfa (Texas), uncropped image. © James Bunnell.



Figure 26. Photo #8, May 7, 2003, after 10:02pm. Mitchell Flat, Marfa (Texas), uncropped image. © James Bunnell.

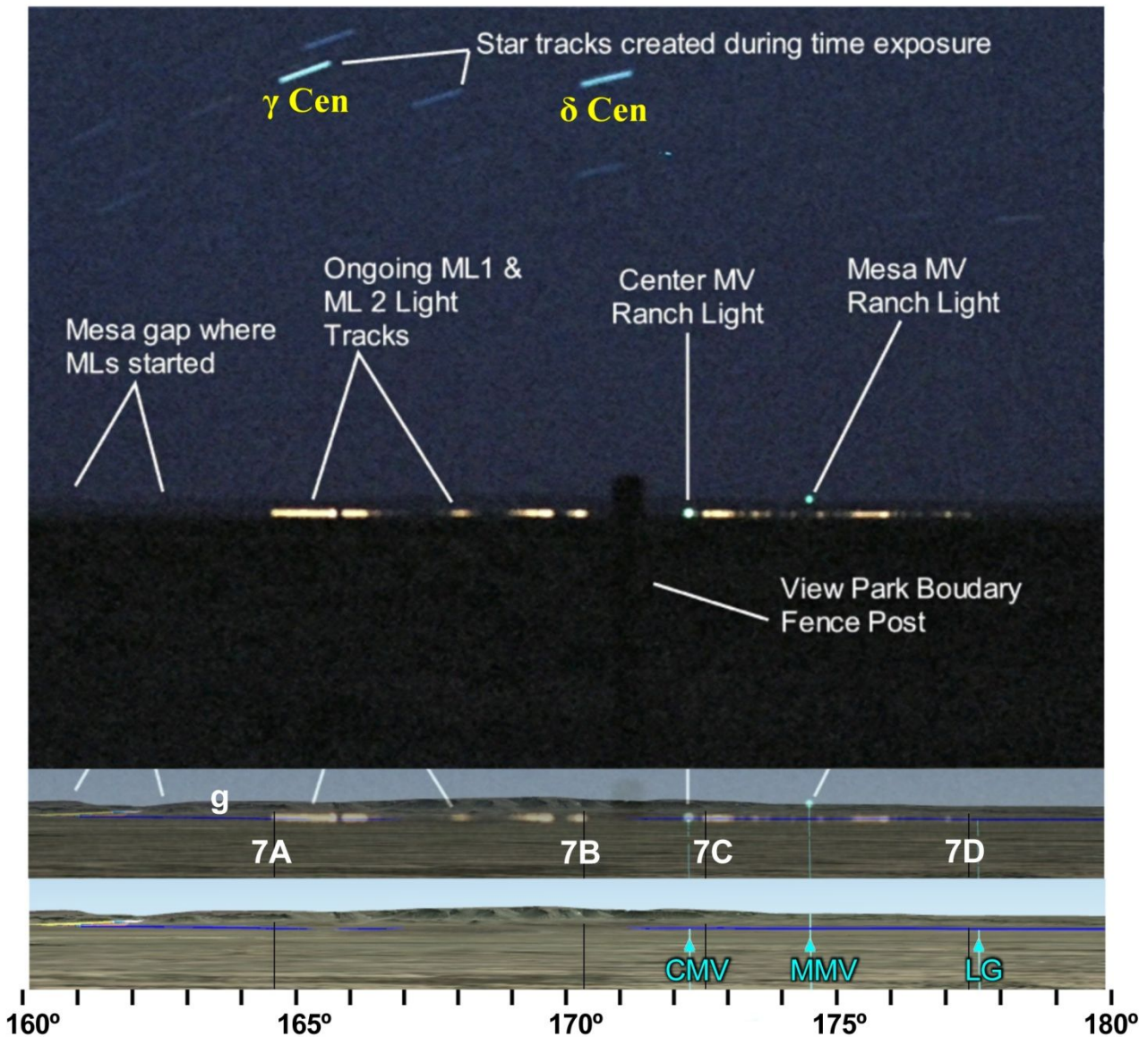


Figure 27. Photo #7 (ML1b/ML2b), May 7, 2003, after 10:02pm, Mitchell Flat, Marfa (Texas). Correlation between visible local road (Nopal/Escondido Road) and luminous tracks. Top: close-up of Bunnell's photograph (text by the author; star labels added by us). Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.) Center: combined image, as a comparison. Lines 7A to 7D are directions of special interest in the pictured luminous tracks (see their true north azimuths below). Also featured in the figure: center mercury vapor ranch light (CMV), mesa mercury vapor ranch light (MMV) and locked gate on Nopal Road (LG).

According to Bunnell, both ongoing light tracks can be seen in photo #7 (see **Figure 27**). Since they moved to the right and ML1b started almost four minutes before ML2b, direction 7D would indicate the farther point reached by the leading light, that is ML1b, during the exposure time. By the same reasoning, line 7A marks the azimuth of ML2b when the shot started (note that ML2b itself started before, at 6D, one degree to the left, as shown in **Figure 19**).

What is uncertain is where in the picture ML1b was when the time exposure began, and which point ML2b reached when the shot ended. We do not even know if both light tracks overlap in the picture. In any case, what matters is that all the light tracks lie on the path of Nopal Road –the most prominent dirt road in the area.

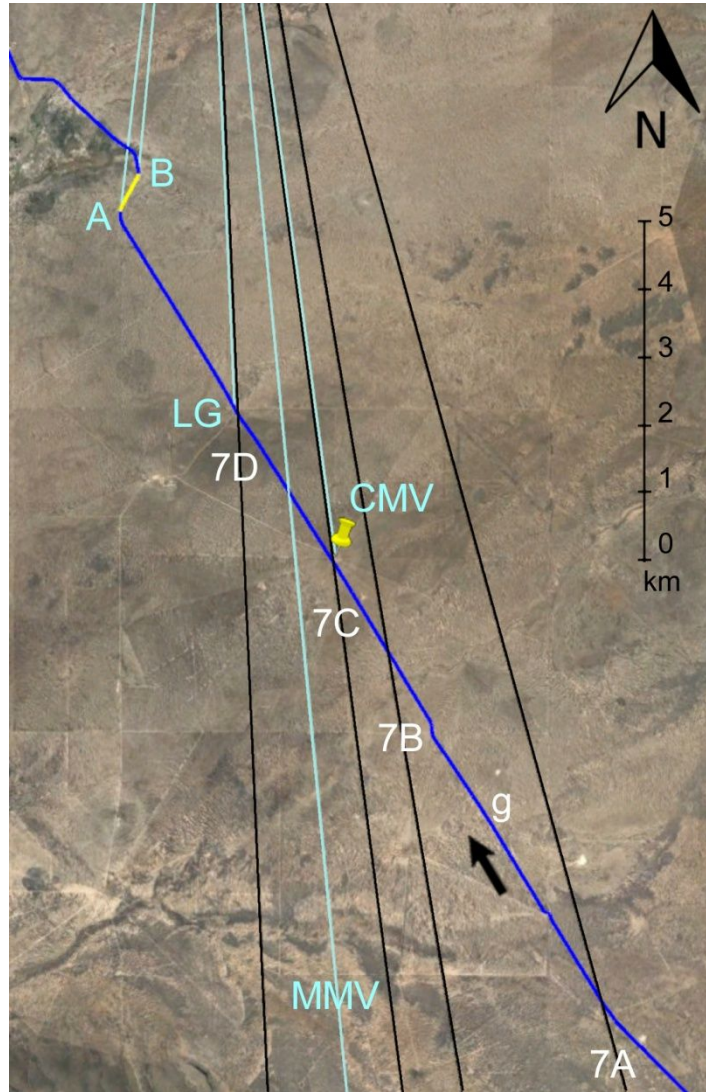


Figure 28. Photos #7 and #8, May 7, 2003, Mitchell Flat, Marfa (Texas). Map of the area of interest. Light tracks captured in photo #7 span from direction 7A to 7D (black lines). Lights appearing in photo #8 are between the directions to LG and A.
 CMV: center mercury vapor ranch light.
 MMV: mesa mercury vapor ranch light.
 LG: locked gate on Nopal Road.
 A, B: turning points in the S-turn of Nopal Road, as seen from the Viewing Center.
 (Image: Google, Landsat/Copernicus.)

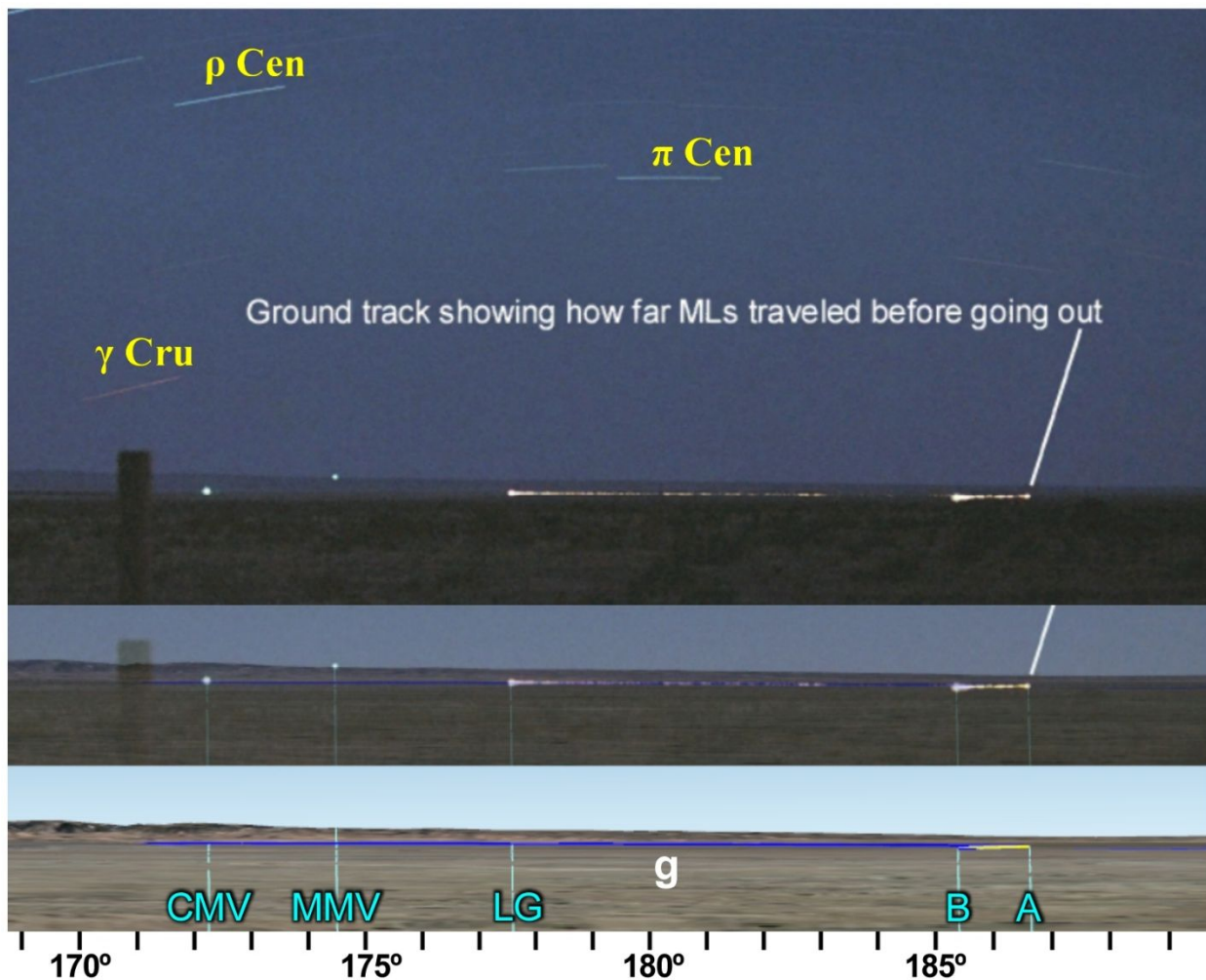


Figure 29. Photo #8 (ML1b and/or ML2b), May 7, 2003, after 10:02pm. Mitchell Flat, Marfa (Texas). Correlation between visible local road (Nopal/Escondido Road) and luminous tracks. Top: close-up of Bunnell's photograph (text by the author; star labels added by us). Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.) Center: combined image, as a comparison (horizontal scale: true north azimuths). CMV: center mercury vapor ranch light. MMV: mesa mercury vapor ranch light. LG: locked gate on Nopal Road. A, B: turning points in the S-turn of Nopal Road, as seen from the Viewing Center.

Light tracks in photo #8 coincide again with the location of Nopal Road. Whether the photograph shows both lights or only one of them (ML1b or ML2b) is not stated by Bunnell. Some features of the pictured lights turn out to be the ultimate evidence in support of the vehicle hypothesis.

A first bright spot can be seen toward Nopal Road's locked gate direction (LG). This is suggestive of a longer exposure of a vehicle's lights due to a temporary stop at this spot. In fact, vehicles passing through the locked gate had to stop twice (to open and close the gate), at least at that time.⁶ Moreover, the two following bright spots coincide with the two turning points (as viewed from the MLVC) in the S-turn of Nopal Road. At these points, a car's headlights beam directly toward the MLVC when the car is traveling northwest (see our map in [Figure 28](#)). In Bunnell's words, this S-turn "results in a very bright flash of head-lights that is unobstructed, unmistakable, and will not be missed if you are ready for it" (p. 58).

The locked gate and the S-turn are precisely the two "filters" highlighted by Bunnell for eliminating vehicles traveling on Nopal Road when observing unknown lights south of the Viewing Center, moving west or northwest (see his book's chapter "The art of rejecting ordinary lights," pages 53-62).

[Figure 30](#) provides an overview of the event, showing how the sequence of shots covered the course of the vehicles traveling on Nopal/Escondido Road from the far area of Escondido Ranch heading for U.S. Highway 90—on which both Marfa and the Viewing Center are located—maybe turning off to Antelope Springs Ranch before reaching the highway. For the sake of comparison, the map includes the MLs starting and end triangulated locations, taken from the Map 6 in Bunnell's book (by the way, these locations slightly differ from the coordinates provided by Bunnell that we have been mentioning in each corresponding section, equally in error).

Note that a vehicle approaching the Viewing Center along Nopal Road reverses its apparent motion on the stretch between A and B (S-turn), highlighted in yellow in [Figure 30](#). This could explain why Bunnell stated in his earlier book *Hunting Marfa Lights* that the MLs in Photo #8 "reversed direction and headed in the direction of the two MV [ranch] lights they had passed, only to extinguish before reaching them" (see [Figure 29](#)).

(6) In 2003, the gate was padlocked and could not be opened remotely. Passage through the gate required two consecutive stops to carry out its opening and closing. Nevertheless, the stop places being only meters apart and at 13km from the camera, the two light blobs would appear merged as one in the picture.

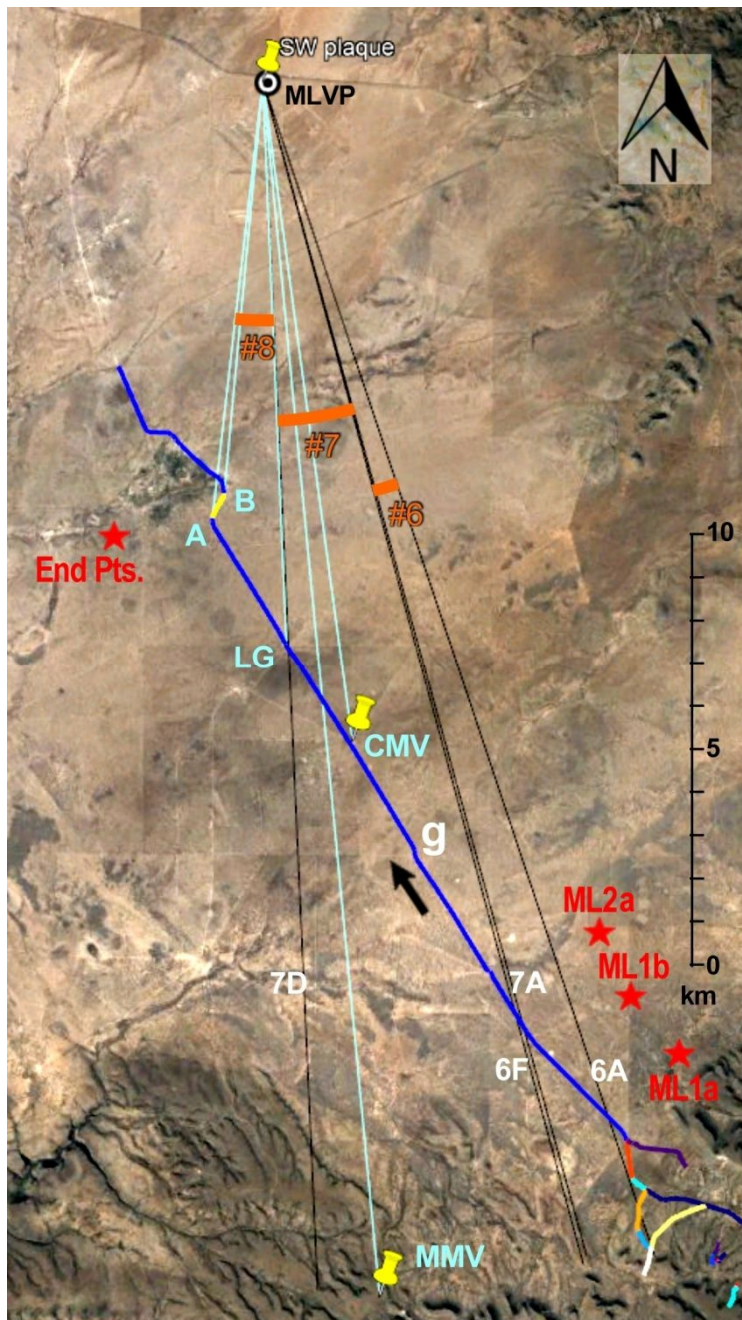


Figure 30. Events of May 7, 2003, Mitchell Flat, Marfa (Texas). Map of the area. (Image: Google, Landsat/Copernicus.)

Angles highlighted in orange show the viewing direction and angular span of the luminous tracks in photos #6, #7 and #8 (ML1b and ML2a/b). All the evidence points to a couple of vehicles traveling on Nopal/Escondido Road (**g**) across Mitchell Flat. The red stars indicate the starting points of ML1a (photo #4), ML1b (photo #5) and ML2a (photo #6), as well as the end points of ML1b/ML2b, according to Map 6 in Bunnell's book. All these estimated locations would be misplaced.

MLVP: Marfa Lights Viewing Center (all the photographs were taken from the SW plaque, to be precise)

CMV: center mercury vapor ranch light. MMV: mesa mercury vapor ranch light.

LG: locked gate on Nopal Road.

A, B: turning points in the S-turn of Nopal Road, as seen from the Viewing Center.

Finally, we will address the major objection raised by Bunnell: the light patterns could not be made by vehicles traveling on Nopal Road because calculated speeds are too great for prevailing road conditions. Besides, the transit time of such a nighttime trip on a “pothole filled dirt ranch road” (p. 89) would stretch even farther due to the required two stops at the locked gate.

Let us recall that the average speeds estimated by Bunnell for ML1b and ML2b were 124km/h and 116km/h, respectively.

The presence of stars in photos #7 and #8 allows us to do some basic checks. The position of the stars in the sky reveals the exact time when the pictures were shot, and the length of their luminous tracks allows to deduce the exposure time of every picture. The times we have calculated are shown in **Figure 31** as rectangles, together with the ML1b and ML2 timing indicated by Bunnell (straight lines).

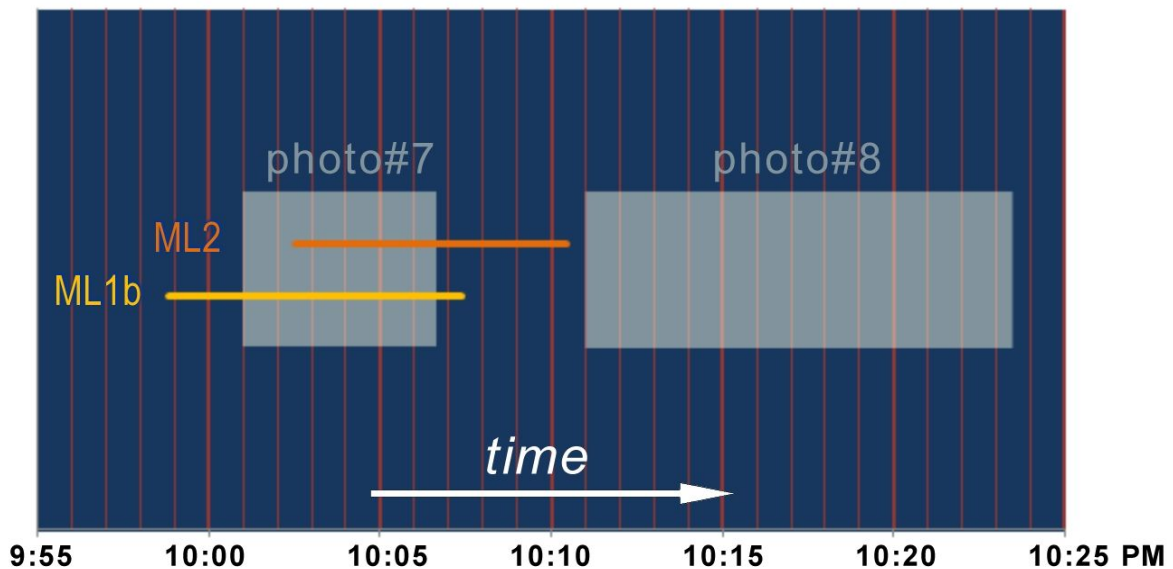


Figure 31. Bunnell's timing of ML1b and ML2 vs. timing of the time-exposure photos #7 and #8 estimated from the position of stars appearing in the pictures.

(The orange line should move to the right an indeterminate small amount of time, considering that the actual start time of ML2b with regard to the apparition of ML2 is unknown. As for the length of that line, it rightly depicts the travel time of ML2b, as estimated by Bunnell.)

Two details draw our attention. According to **Figure 31**, photo #7 should have captured the commencement of ML2 (the initial left side of the orange line). However, we know it did not happen that way (the reader just must compare **Figure 19** and **Figure 27**). Therefore, the starting time of ML2 would be wrong (ML2b's start time is unknown): it must have started earlier than indicated in Bunnell's book. It is also striking that, according to **Figure 31**, photo # 8 should not have captured any of the lights. It clearly suggests that the durations indicated by Bunnell are underestimated. This serious mistake would distort upwards any speed estimates.

Thus, according to our estimates (see details below), as ML2b started before photo #7 was shot, and, most probably, it was also recorded by photo #8, its lifetime had to exceed 10 minutes (in lieu of the 7 minutes, 57 seconds indicated by Bunnell). Assuming the lights were from vehicles circulating on Nopal Road⁷ and strictly following verified data contained in each of these two pictures, the following speed estimates can be derived:

- Photo #7: For several reasons we can safely assume that the lights did not go out of frame during this exposure. Travel time would then coincide with exposure time (~5.6 minutes). The recorded light tracks span from direction 7A to 7D (see [Figure 27](#)), which translates into 10.3km on Nopal Road. If there had been only one light, its average speed would have been 110km/h. But knowing that there were two lights, their average speed would have been around 55km/h.

- Photo #7 plus the interval between shots (i.e., immediately before photo #8). We are assuming, as Bunnell does, that photo #7 shows two different lights: ML1b, followed by ML2b. In the picture, the leading light ML1b reaches 7D, practically at the locked gate location. Therefore, the light pictured minutes later in photo #8 at the locked gate direction must have been the light following behind, ML2b (see [Figure 27](#) and [Figure 29](#)). Considering a distance on Nopal Road of 10.3km (7A-LG) and an interval of ~10 minutes (photo #7 exposure time of ~5.6 minutes plus the time elapsed between the end of photo #7 and the start of photo #8, that is, ~4.4 minutes) we have a minimum average ML2b speed of 61.8km/h. The real average speed could be greater depending on the time that the vehicle remained stopped at the locked gate before the start of photo #8.

- Photo #8: The visible tracks cover about 4.5km on Nopal Road (from the locked gate to the exit of the S-turn). The exposure time was ~12.5 minutes. Therefore, the average speed assuming a single light (only ML2b?) is 21.6km/h. We suspect that this is an underestimate, even allowing for a significant stop interval at the locked gate that would have lowered the estimated average speed. The real speed would be higher if the lights went out of frame before the end of the exposure. This could be the case if the rightmost stretch of Nopal Road in the picture (past direction A in [Figure 29](#)) was not visible.

All in all, it is to be highlighted that the speed estimates we have obtained do not exceed 70km/h, that is, a reasonable speed for a vehicle traveling along Nopal Road.

(7) For simplicity's sake, we are using "Nopal Road" loosely to refer to the entire road, including the southernmost section whose proper name is Escondido (Ranch) Road.

Event dated May 8, 2003, 22:15:55 hours (CDT). Photo #9

Starting at 149.2°, ending at 151.1° and distant 15 miles (24km) from the MLVC, a light was seen (and photographed) “following an ascending trajectory with a prominent gap” (p. 91) to finally extinguish after a single 42-second time exposure in what the writer describes as an explosive end with burning material descending toward the ground on a slanted trajectory (see **Figure 32**). “This explosive event—Bunnell affirms—eliminates both car lights and mirage conditions as valid explanations.” (p. 90) Total duration of the light (photo #9), as recorded by *Roofus*, was 2 minutes, 20 seconds (apparently it first came on but went out before it could be snapped; then, it reappeared, and the photograph was achieved). At the “explosion” [*sic*] point, the object’s altitude was computed as 270 feet (82m). For Bunnell, the “clear evidence of expelled elements” shows that the lights were in the air, not on the ground. Estimated site coordinates at the start: 30.1024° N, 103.7957° W.



Figure 32. Photo #9, May 8, 2003, 10:16pm, Mitchell Flat, Marfa (Texas), uncropped image. © James Bunnell.

Again, in order to ascertain the nature of the linear light track photographed, we drew upon Google Earth and placed the smearing light in the simulated spot (see **Figure 33**). Our first observation has to do with the systematic deviation (see **Figure**

3 and Figure 4) between true north azimuths derived from measurements by Bunnell's compass and those determined from Google Earth, 3.9° at the starting point (at 24km, this implies an error over 1,600m). The same discrepancy should appear in the azimuth derived from the estimated coordinates but—as in other cases—we found a different deviation, 4.3° , and even a different distance, 21km (leading to a location error over 1,500m).

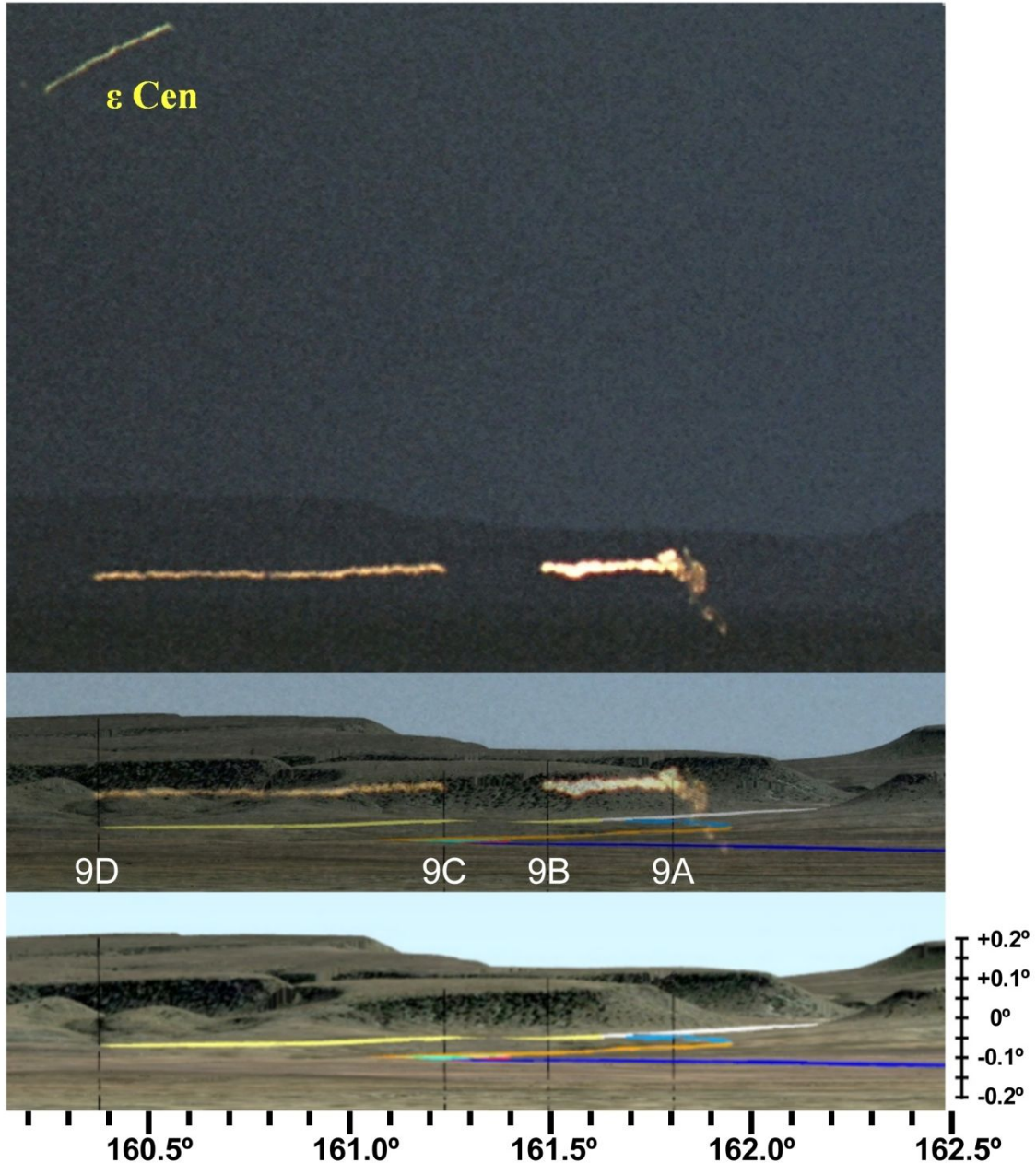


Figure 33. Photo #9, May 8, 2003, 10:16pm, Mitchell Flat, Marfa (Texas). Correlation between visible local roads and luminous tracks.
 Top: close-up of Bunnell's photograph (star label added by us).
 Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.)
 Center: combined image, as a comparison. Lines 9A to 9D mark the endpoints of each light track (see their true north azimuths below).

As in previous cases, the light track does not seem to perfectly match any road. It just looks like it was displaced upward, presumably due to a refraction phenomenon (looming).

In principle, there are several stretches of dirt roads that could be related to this partitioned light track (see [Figure 34](#)). The fact that both luminous segments appear aligned as if they belong to a single light track with a central gap will help us to guide the search, as we will see below.

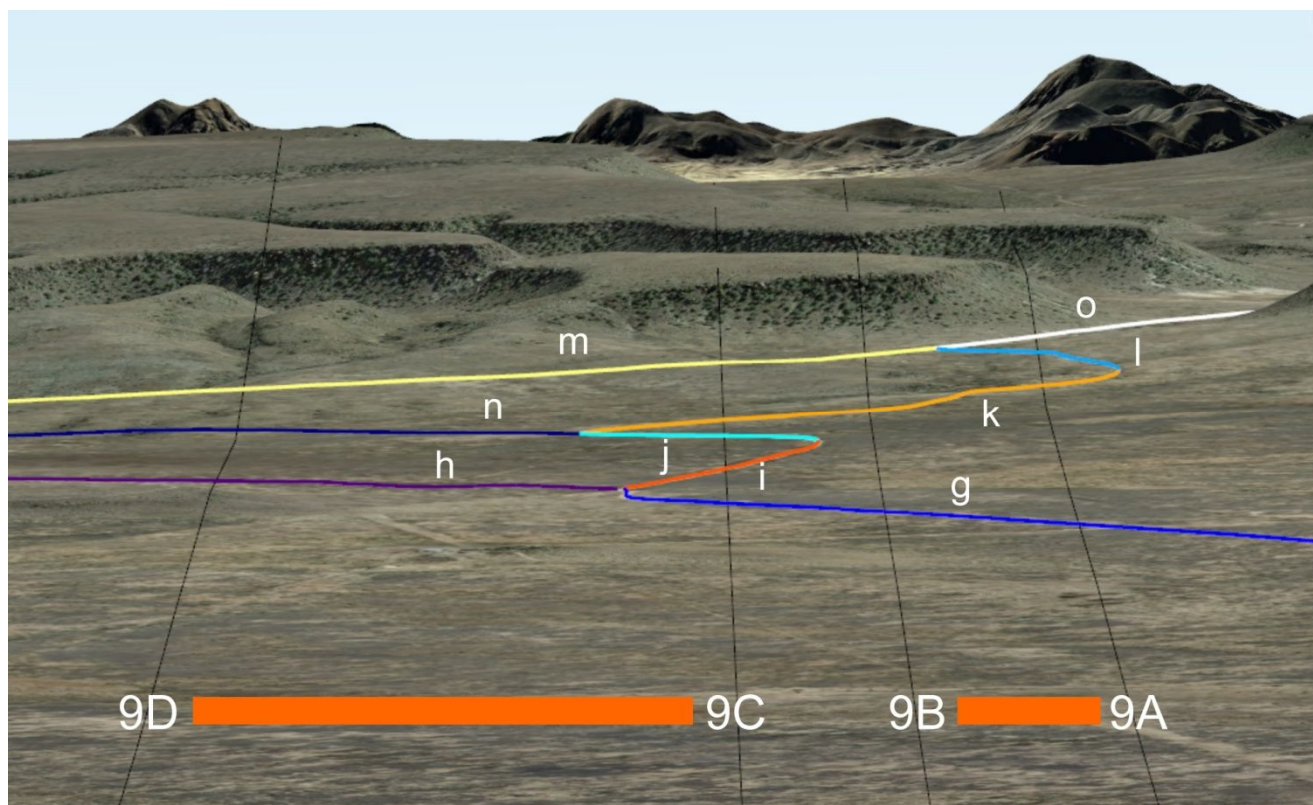


Figure 34. Photo #9, May 8, 2003, 10:16pm, Mitchell Flat, Marfa (Texas). Simulated bird's eye view of the area of interest. (Image: Google, Landsat/Copernicus.) The photographed light trail has two segments: one between directions 9A and 9B, and another between directions 9C and 9D, with a gap between 9B and 9C. The different stretches of road in the area are labeled with lowercase letters. Note that the headlights of an approaching vehicle would move to the right in the blue and violet stretches, and to the left in the others.

The set formed by road sections **o** & **m** would be the most obvious candidate. But the **n** & **k** and **h** & **g** pairs should also be considered. Let us check the three options.

The pair **n** & **k** should be discarded because in these road sections the headlights of the vehicles would be displaced in opposite directions. That is, one vehicle would be circulating through **n** from left to right while another vehicle would travel right to left along the **k** path. Moreover, the first vehicle would also travel through a part of **j** (so that the light track segment on the left would reach direction C).

Regarding the **h & g** option, it shows some drawbacks also. We refer now to **Figure 35**, where it is observed that the initial stretch of the **g** path is practically aligned with the Viewing Center. The photograph should show a remarkable increase in brightness at that point, which does not happen. As we will also find later, the **g** path is related to some light strokes appearing in the following picture (photo #10), but these strokes are less elevated than in the photo we are currently analyzing.

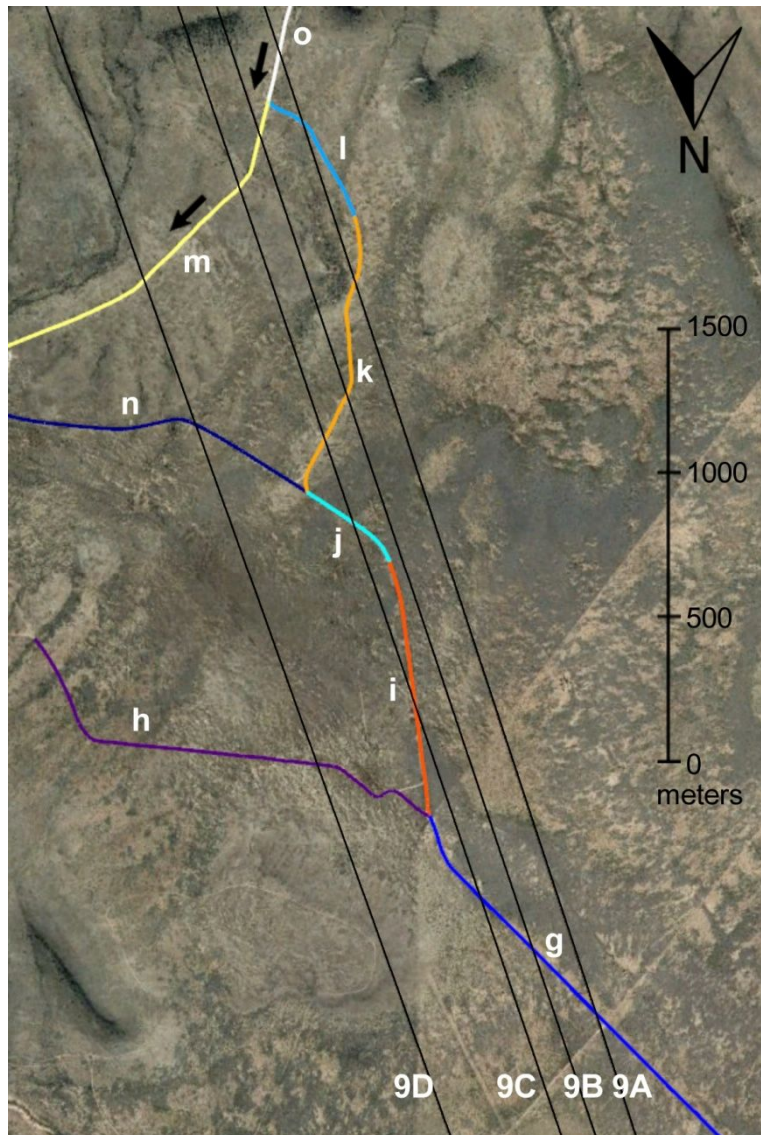


Figure 35. Photo #9, May 8, 2003, 10:16pm, Mitchell Flat, Marfa (Texas). Map of the area of interest. Arrows show the travel direction of culprit vehicle. (Image: Google, Landsat/Copernicus.)

Therefore, everything seems to indicate that the light track of photo #9 is related to the **o & m** paths. These are part of the same dirt road that, coming from the mesas, goes toward Escondido Ranch, running roughly in a NE direction. This track runs perfectly parallel to the luminous trace (located almost 0.1° above it), and adequately explains these two special features of photo #9:

1) The difference in luminous intensity of the two segments of the light track. It is evident in **Figure 35** that the path between 9A and 9B (**o-m**) points more directly toward the camera than the path between 9C and 9D, therefore any luminous track due to vehicle's lights photographed from the Viewing Center would appear brighter if traveling along the first path.

2) The very existence of the central gap. As the elevation profiles of **Figure 36** show, in the area between 9B and 9C (that is, the directions encompassing the gap in the light track) there are some shoulder slopes in the terrain that obstruct the vision of some stretches of dirt road **m** for an observer located in the Viewing Center. The lights of a vehicle traveling along road section **m** would necessarily disappear in certain stretches, thus causing a gap in the luminous trail on the photograph.⁸

(8) Because the difference in altitude is only a few meters, it is possible that this variation does not appear in most of the existing contour maps of the area.

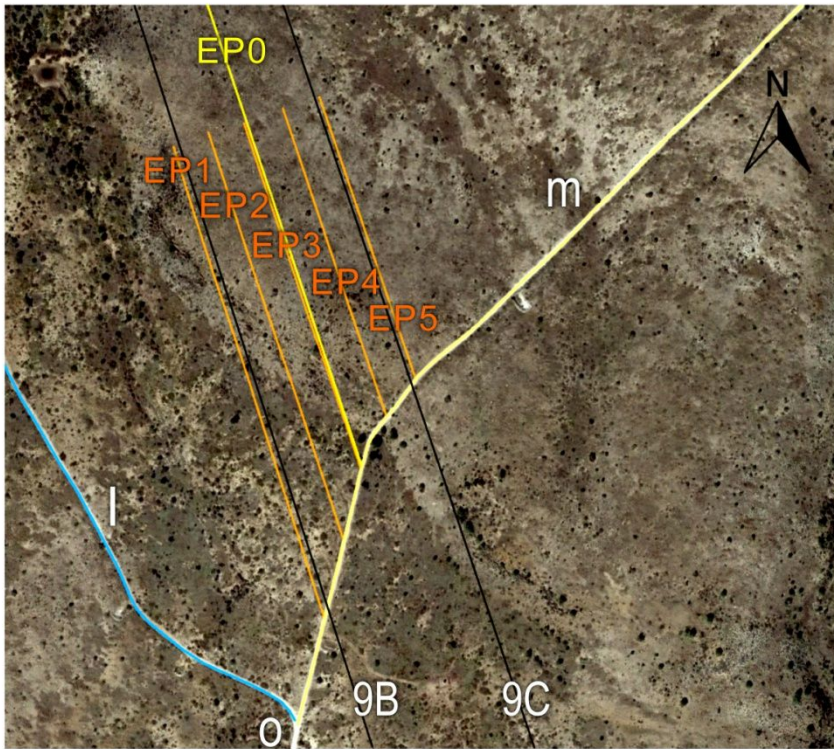


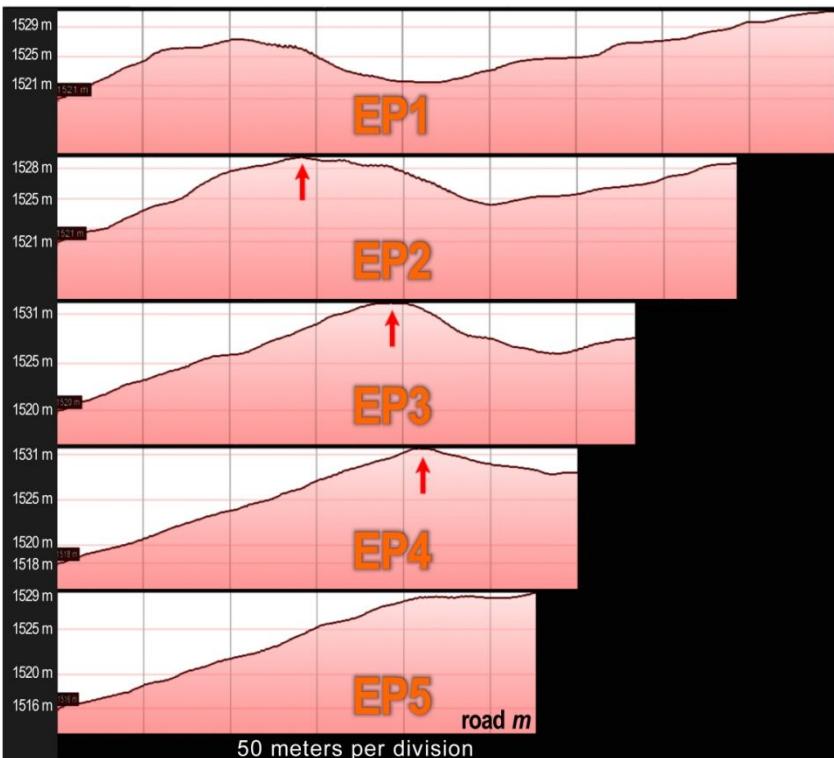
Figure 36. Photo #9, May 8, 2003, 10:16pm, Mitchell Flat, Marfa (Texas).

Top: Map of the area close to the stretch of road **m** around the direction of the light-track gap (spanning from 9C to 9B, as seen from the Viewing Center). (Image: Google, Landsat/Copernicus.)

Center: Google Earth elevation profile along line EP0, across Mitchell Flat, from the Viewing Center (marked “MLVP” on the left) to the intersection with stretch of road **m** (right).

Bottom: Google Earth elevation profiles along lines EP1-EP5, close to the stretch of road **m** and finishing at the intersection with it (right end of every graph). Arrows mark the obstacles that would hide the road for an observer at the Viewing Center. They are found “inside” the gap only (lines EP2, EP3 and EP4).

Note: the vertical scale is exaggerated in all the profiles to emphasize vertical features (slopes appear steeper than they are).



The apparent “explosive” effect seems to be rather an optical effect due to the accidental movement of the camera. In fact, in a separate reference (Note 49), Bunnell includes a picture of an alleged ML and writes: “in my haste, I accidentally bumped the camera and created two slopping [sic] artifacts seen on the right.” These two artifacts very much resemble the so-called “explosive” end of the photograph under examination, as this can be observed in Figure 37, a composite picture we have created with that “real” motion blur (large picture) and the enlargement of photo #9 (insert).



Figure 37. Comparison of confirmed motion blur and photo #9. Photos: © James Bunnell.

A similar motion artifact also appears in a picture published by Bunnell in his book *Night Orbs* showing the lights of the town of Marfa (see Figure 38). Interestingly, in this case we can determine when the effect took place: right at the start of the exposure—just like in the case of photo #9 if our proposed explanation is correct.

We have consulted photo analysis expert Andrés Duarte on the “explosive” phase of photo #9. His diagnosis was forthright: “This is due to camera shake.”⁹ Duarte also advised on another serious inconsistency in the photo. The star trace is apparently longer than could be expected if the exposure were 42 seconds, as indicated by the author. This finding implies that the object’s speed is lower than could be estimated and, therefore, probably compatible with that of an automobile.

Examining the position and length of the trace of the star (ϵ Cen) with the help of planetarium software (Stellarium) and taking as a reference the azimuth scale derived from identified landscape features in the picture, we have found that the

(9) Although the track of the star visible in photo #9 should show a similar effect if there was a movement of the camera, the light of the star could have been too faint to leave a noticeable shake track.

shutter-release button was pressed at ~22:11 hours, some five minutes before that indicated in Bunnell's book, and the exposure time was definitely longer than 42 seconds (~2 minutes, 17 seconds, actually).

Our exposure time estimate is very close to the total duration of the light as recorded by *Roofus* (2 minutes, 20 seconds). The light track (gap included) covers about 1km on dirt road **o-m**, between 9A and 9D. Therefore, the average speed would be 26.3km/h (provided that the light was not momentarily hidden from view at the start and/or end of its course during the exposure time). (In recent personal correspondence, Bunnell has admitted he had been "dead wrong" regarding the timing of this photo.)

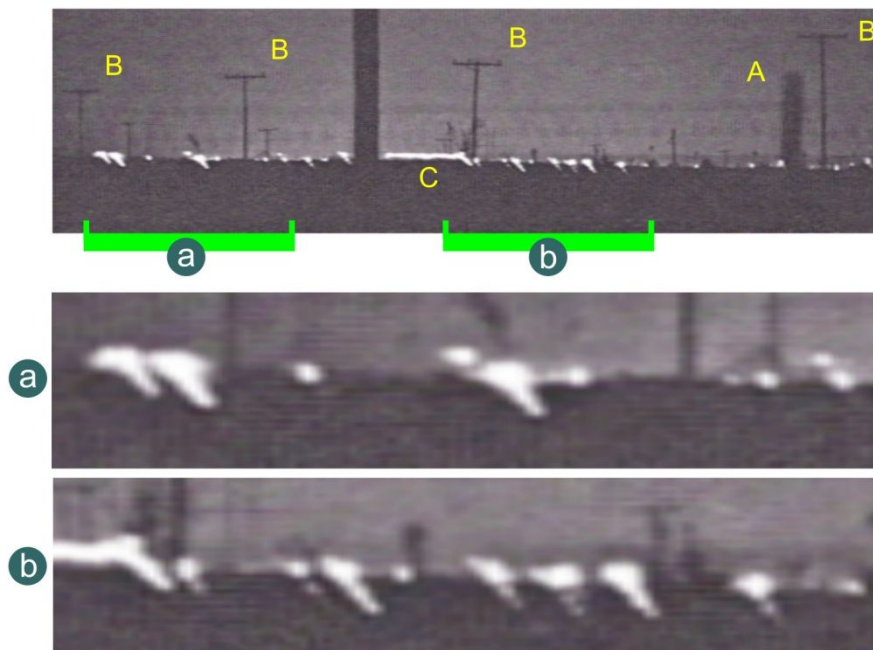


Figure 38. Another example of artifacts due to camera motion. Top: partial view of a photograph of Marfa's city lights published in Bunnell's book *Night Orbs* (<http://web.archive.org/web/20070223150007/http://www.nightorbs.net/book1.htm>).

Bottom (a & b): enlargement of some of the lights. © James Bunnell.

The published picture has a height demonstrably double than it should be. The images presented here have been resized to the right proportions.

Although this photo was accompanied with the caption "Marfa City lights with mirage conditions down and to the right", it does not show a mirage (such a widespread bending of the light rays on a non-vertical plane would require miraculous conditions!) but an artifact caused by camera motion.

The artifact is very similar to what we see in **Figure 37**.

An analysis of the scene allows to ascertain that the "shake" came about at the beginning of the exposure. The picture was shot from the MLVC, hence the nearby fence **A** and the row of poles **B** along the southern side of Highway 67/90. It should be noted that Marfa is mostly below the physical horizon for an observer at the MLVC, but some lights from the western outskirts of the town can be seen occasionally under certain atmospheric "looming" conditions. The streak of light visible at the center **C**, slightly over the fixed city lights, was caused by a moving light. It can be identified as the headlights of a vehicle approaching Marfa from the west on Highway 90. Observed from the MLVC, the apparent motion had to be from right to left and, therefore, the artifact appearing on the right end of the light streak occurred when the shutter was opened.

In the previous lines we have proposed an ordinary and reasonable explanation capable of accounting for all the anomalous-looking features presented by the light track captured in photo #9. The explanation has, nevertheless, its Achilles' heel in the only characteristic that cannot be deduced from the photo: the direction in which the light moved. Although our proposal refers to the lights of a vehicle moving from right to left (to the east) and a small shock of the camera at the beginning of the exposure, Bunnell describes a light moving from left to right (to the west) as it ascended slightly, disappearing at its end with an "explosion."

This contradiction and the nature of the key information led us to ask two major questions that were directly posed to Bunnell. What did he visually observe in reality? Does the *Roofus* recordings support his assertions? Our queries, his responses, and our analysis follow.

An important point regarding the first question is: did Bunnell really see the final "explosion," just before the light went off? Note that we could think of a mistake made when judging the motion direction of a tiny light slowly traveling a continuous path of less than one degree long in a dark setting. Nevertheless, it would be more difficult to understand an error about whether the "explosion" took place at the start or at the end of the sighting. Note also that this timing detail along with what the picture shows would suffice to settle the question of the motion direction.

Of course, in case that Bunnell did not observe the "explosion" and *Roofus* did not record it, we should wonder if he just derived the information from his own interpretation of the picture once it was taken.

Questioned about these matters, Bunnell, always willing to clarify any issue related to his investigation, informed us that he could not remember having seen the "explosion," probably due to being busy monitoring a lightning strike alert device from time to time. On the other hand, no "explosion" nor gap is mentioned in his notes on the *Roofus* recording of the beginning of the event (the footage was not kept), although there is an entry about a final "huge expansion" (0.3 inch on a 12-inch TV) taking place 17 minutes later, just at the end of what would be the "ML2" phase of the event, as named in Bunnell's book.

According to Bunnell's notes on the footage, the first evidence of a suspect light was recorded at 22:15:55. Ten minutes later the light disappeared for 1 minute, 16 seconds, but there was no gap in the early part of the footage, where we would expect to find the gap that appears in photo #9. Note also that, even assuming that *Roofus* clock was slow and all the videoed events happened earlier, the gap (appearing at 22:25:59, as per the *Roofus* diary) and the "explosion" actually recorded (at 22:33:02) are seven minutes apart and could not have appeared in the same picture if the exposure time of photo #9 was in an interval slightly over 2 minutes. Bunnell has been advised of this discrepancy and has admitted his own faults in reporting both exposure time and travel time in his book. His answer "The correct travel time was 17min, 8s," is, in our opinion, an attempt to

reconcile *Roofus* data with the photograph. But it is a futile one, figures do not match.

In short, in which direction did ML1 (the light captured in photo #9) move? Since the known information about the *Roofus* recordings does not clarify the issue,¹⁰ we are left only with the observer's account, which could be wrong on this specific point, as we suspect. The analysis of photo #9, considering the local tissue of dirt roads strongly supports that suspicion. Moreover, there even exists a Bunnell's picture showing photographic artifacts appearing *at the start* of the exposure which are strikingly similar to the alleged final explosive feature in photo #9.

Event dated May 8, 2003, 3 minutes, 43 seconds later. Photos #10, #11, #12 and #13

Located 13 miles (20.9km) away from the MLVC, another light appeared (ML2), east of the vanishing point of the light in photo #9 and followed a horizontal path toward the northwest. Event located at 30.0879° N, 103.7927° W, always according to Bunnell. It is our photo #10 (**Figure 39**): the light "continued across Nopal Road and traveled ~12 miles [19km] before going out near the inactive Presidio railroad track" (p. 90), from 150.2° to 208.8°. This should have rung a bell. A UFO or a geophysical plasma traversing the route of a known road! The event was a light moving on a straight line at ground level ("a low flier," Bunnell says) for almost 14 minutes, documented with (at least) four pictures. Bunnell's book only reproduces one of them (photo #11), printed here as **Figure 45**, with 7 minutes, 6 seconds time exposure. Bunnell estimated that the light flew at a speed from 84 to 90km/h.

The starting magnetic azimuth of ML2 given by Bunnell (150.2°) would equate to a true north azimuth of 157.5°. However, as in others of his measurements, the value of the calculated azimuth is wrong because the original compass readings were erroneous. In the present case, it deviates 3.7° from what we found through Google Earth (161.2°), causing the position estimates to be in error by more than 1,350m (or 1,650m if we consider both the deviation and the distance—4.2° and 22.5km—deduced from the coordinates provided by Bunnell.)

We cannot assess the reliability of the ending azimuth (208.8° mag., that is, 216.1° true north), since the pictures made available do not show azimuths greater than 202° (see **Figure 51** and **Figure 52** below).

(10) In fact, as we will see below, further analysis suggests that the provided *Roofus* data pertain to a later time interval, when photo #9 exposure was already completed.



Figure 39. Photo #10, May 8, 2003, 10:20pm, Mitchell Flat, Marfa (Texas). Uncropped picture. Photograph not included in Bunnell's book. Upper track is a star, smeared by time exposure.
© James Bunnell.

During our correspondence, Bunnell contributed this statement from his talks with Kerr Mitchell, owner of a ranch¹¹ located at the west end of Mitchell Flat (the flat is named after his grandfather):

His view east is masked to some extent by terrain near his ranch. Because of this terrain masking, vehicle traffic on Nopal Road (and most roads in Mitchell Flat) is below his horizon (including most of Nopal Road even when viewed from his roof top). He has been a resident of Mitchell Flat all his life and is well aware of MLs. On the night of May 8, 2003, he was outside and noticed the ML that was clearly visible and headed in his direction. He stood and watched it until it went out about 3.5 miles from his location. He commented that that ML was the biggest he had ever witnessed. That he could even see it established the fact that it was definitely flying in the air [our emphasis] and was, in his opinion, a typical ML, albeit bigger than usual (probably because it came closer to his location than others he had witnessed over the years).

So, was the source of the moving light on the ground or above it? Searching for a correlation between roads and light tracks, we find that the latter appear to relate to a given stretch of road, the southernmost part of Nopal/Escondido Road (see **Figure 40**). Nevertheless, we also find, once again, that the light strokes remain a certain angular distance above the road, not exceeding $\sim 0.1^\circ$.

(11) Roofus camera was installed on the roof of Kerr Mitchell's ranch house.

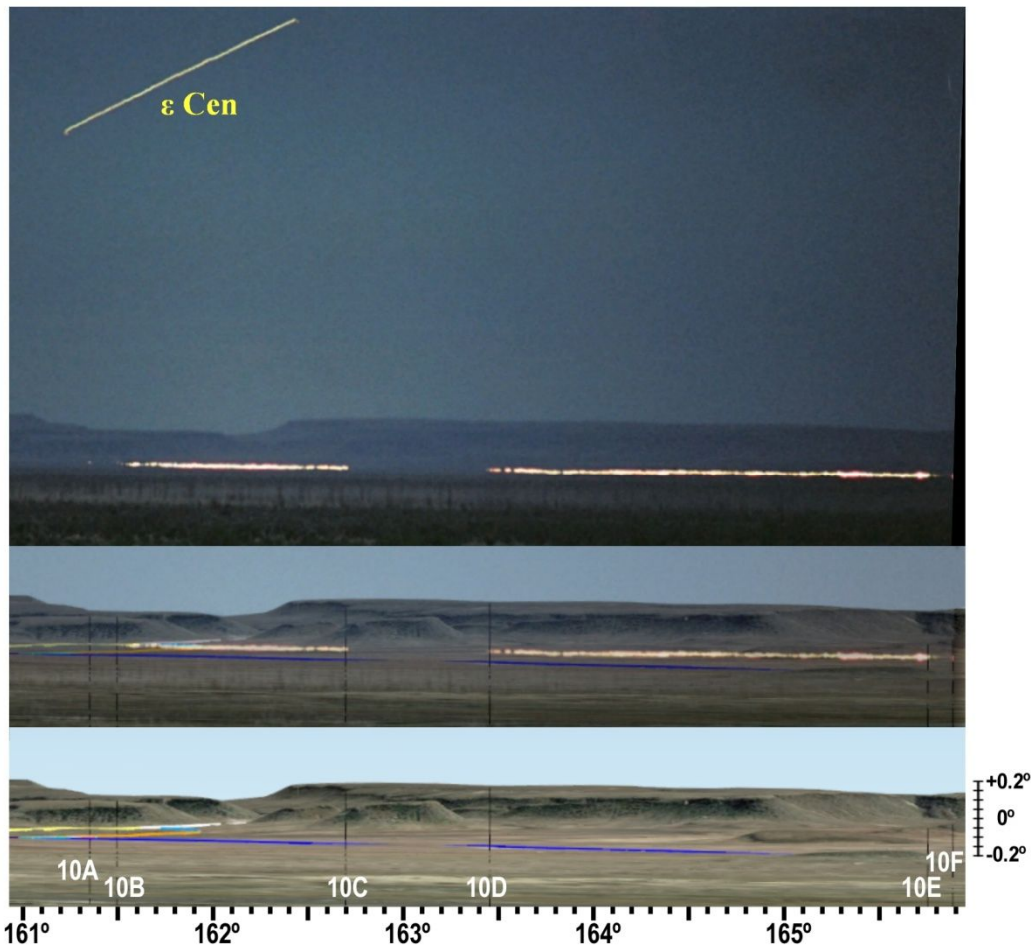


Figure 40. Photo #10, May 8, 2003, 10:20pm, Mitchell Flat, Marfa (Texas). Correlation between visible local roads and luminous tracks (ML2). Top: close-up of Bunnell's photograph (star label added by us). Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.) Center: combined image, as a comparison. Lines 10A to 10F are directions of special interest in the pictured luminous tracks (see their true north azimuths below).

So far, every time that we have encountered this peculiar detail, we have suggested that it was an optical effect (looming, specifically) due to abnormal atmospheric refraction. Now, photo #10 allows to safely conclude that there were indeed abnormal refraction conditions on the night of May 8th, 2003.

At that precise time (10:20pm), local conditions allowed mirages to be generated, as the one we can observe in the enlargement of a far section of photo #10, shown in **Figure 41**: below the straight light rod, a series of vertical poles appear, but these are nothing but a type of optical warp of distant elements of the landscape. It is a typical superior mirage effect, to be specific. It explains the small spatial discrepancy between lights rods and roads in the Google Earth simulation. Note that a combination of different refraction phenomena may occur together. Just above the mirage area that we have described, looming affects the light track (which is to say, the landscape strip containing the road), increasing its apparent elevation without noticeably changing its apparent shape. Strictly speaking, although caused by refraction anomalies too, looming is not considered a mirage since it does not involve inverted or multiple images.

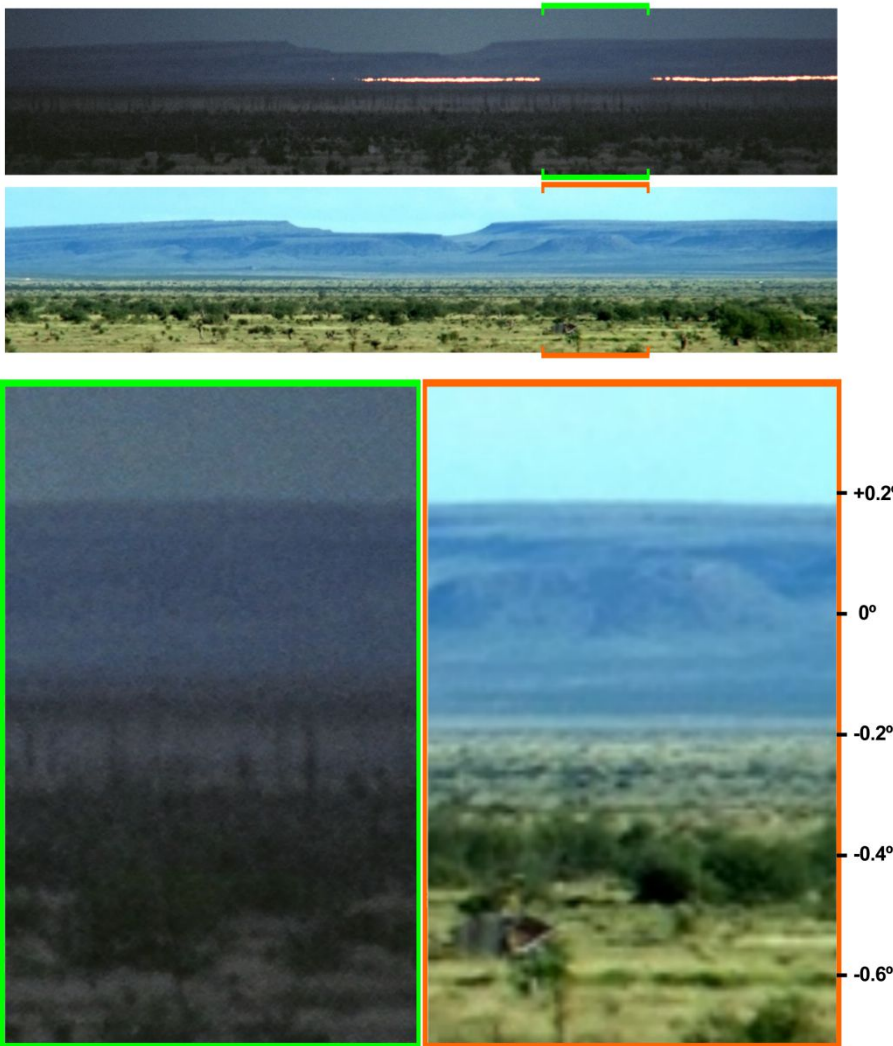


Figure 41.

Top: superior mirage in the photo #10 landscape (central horizontal strip right under the light tracks).

Center: daylight view of the same area without any mirage. Compare with the above view. (Note 50).

Bottom: side-by-side comparison of the same portion of the landscape with and without the superior mirage (enlarged view from the pictures above). The abnormal refraction is responsible for the vertical pattern visible in the scene on the left, where only horizontal features should appear, as shown on the right. Vertical scale is only indicative.

Photos: © James Bunnell.

We must stress that looming sometimes allows an observer to see objects that are located below the horizon under normal conditions, because their apparent elevation is increased. Therefore, there is a possibility that Kerr Mitchell saw the lights of vehicles on Nopal Road from his ranch that night, even if “because of [...] terrain masking, vehicle traffic on Nopal Road [...] is below his horizon.”

It is beyond the scope of this investigation to look in detail at the atmospheric conditions prevailing in Mitchell Flat and the intricacies of the abnormal refraction phenomena (Note 51). We just limit ourselves to notice the ones at the time and place when pictures were taken. Nevertheless, to give the reader a quick overview of the type of optical effects encountered under thermal inversion conditions, we have gathered in Figure 42 a series of selected frames from a full day time-lapse video showing the development of superior mirages seen across Puget Sound (U.S. state of Washington) (Note 52). In this particular example, the region said to have an “inverted” temperature gradient (warmer air lying above colder air) is over water instead of land. This fact prevents direct comparison with the environmental conditions in Mitchell Flat.

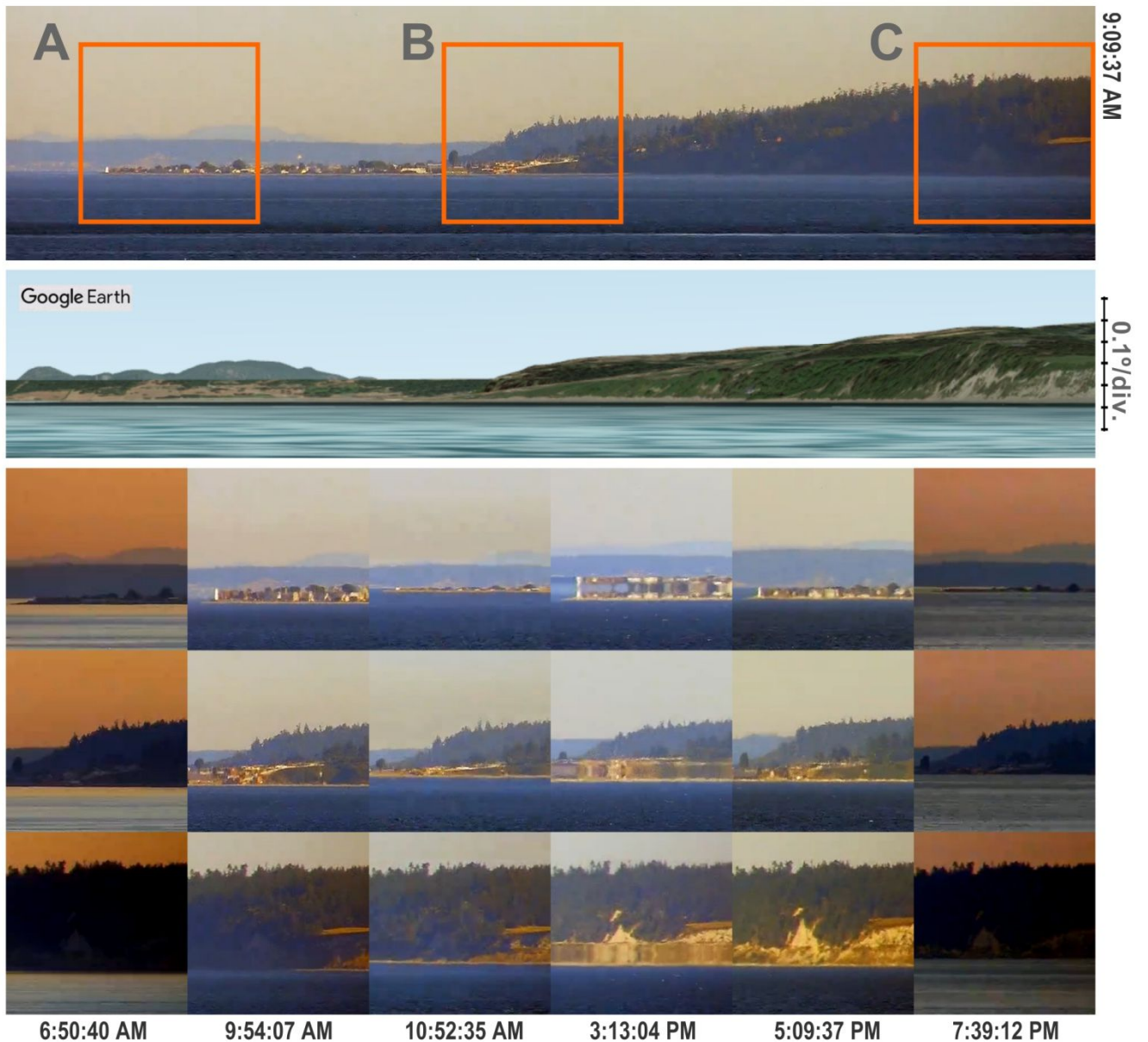


Figure 42. Superior mirages and related phenomena in a full day time-lapse video recorded from Skunk Bay (Washington) on Sep. 7, 2012 (Note 52).

Top: landscape view from one of the frames of the video. The camera was pointed north in the direction of the Bush Point Lighthouse (on the left), located at 12.5km across the Puget Sound.

Center: landscape image created from Google Earth to be compared with the view above. (Image: Landsat / Copernicus. Data: SIO, NOAA, U.S. Navy, NGA, GEBCO.)

Bottom: changing appearance throughout the day of three representative places in the scene (the three boxed areas labeled “A”, “B” and “C” in the image on top of the figure). Each row shows views of one of the places, extracted from selected frames of the video. Time is specified at the foot of each column.

Elements at different distances and altitudes are affected differently by the refraction phenomena, which change over time. Some towering can be seen in the second column. Looming affects the view of background mountains to varying degrees in many of the images. Superior mirages are clearly recognizable in the fourth column. (Video images: © Greg Johnson / Skunk Bay Weather Blog.)

Back to photo #10, attention must be drawn to the gap in the light track (between directions 10C and 10D). It is exactly the same gap that we have seen in photo #6, shot the previous day, as Figure 43 shows. It also appears in photo #11 (gap from 11C to 11D in Figure 46 and Figure 47), which overlaps with photo #10 (see Figure 52 below), each one taken about the same time with a different camera.

This gap can be explained as a visibility issue due to obstruction by terrain features close to Nopal/Escondido Road (Figure 44). All of this reinforces even more our hypothesis that vehicle lights caused the pictured luminous tracks.

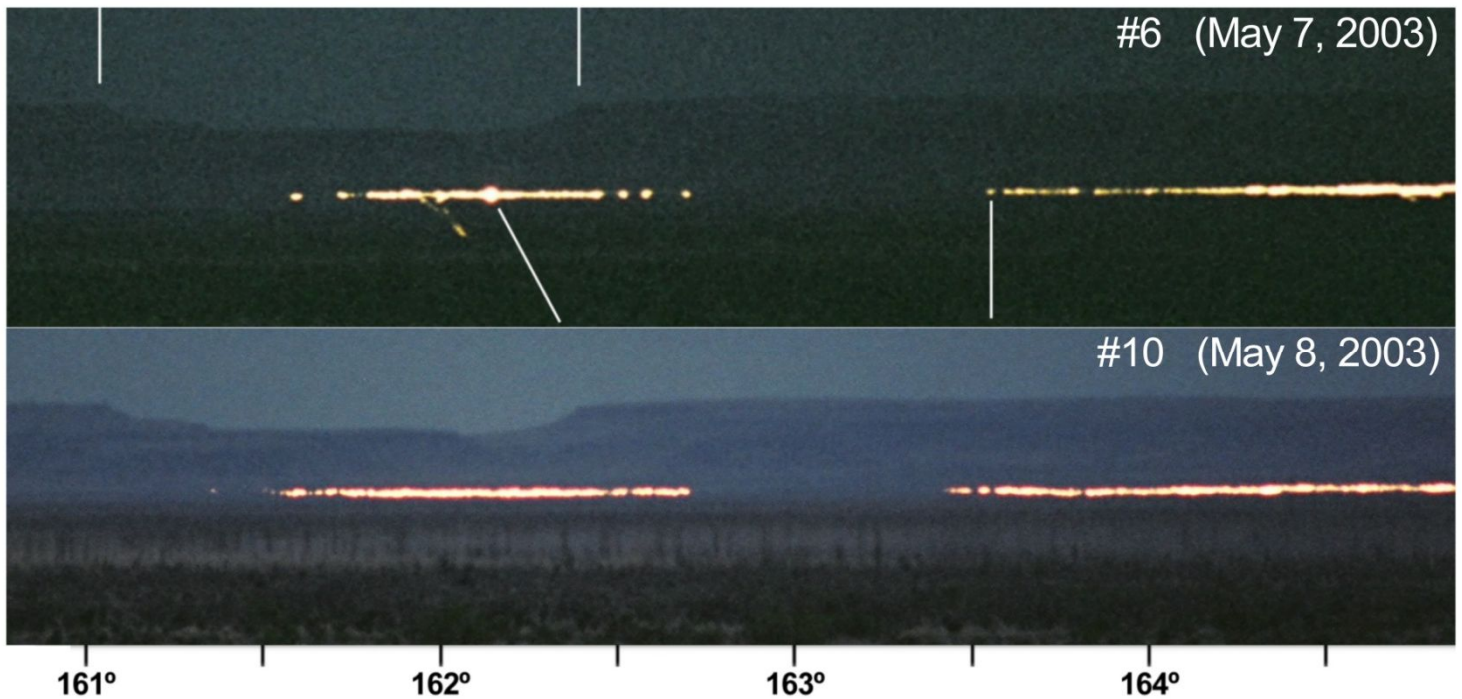


Figure 43. Comparison of the gap in the light track in photos #6 and #10. Both views are reproduced at the same scale (true north azimuths indicated at the bottom).

Incidentally, note that light traces in photos #10 and #11 are linearly more complete if compared to those in photo #6. This suggests that, around 10:00pm, light ray bending due to refraction was greater on May 8 than on May 7 (provided that camera height did not vary, and car's headlights height was quite the same in both instances), thus allowing the light to go up and over the vegetation on the plain.

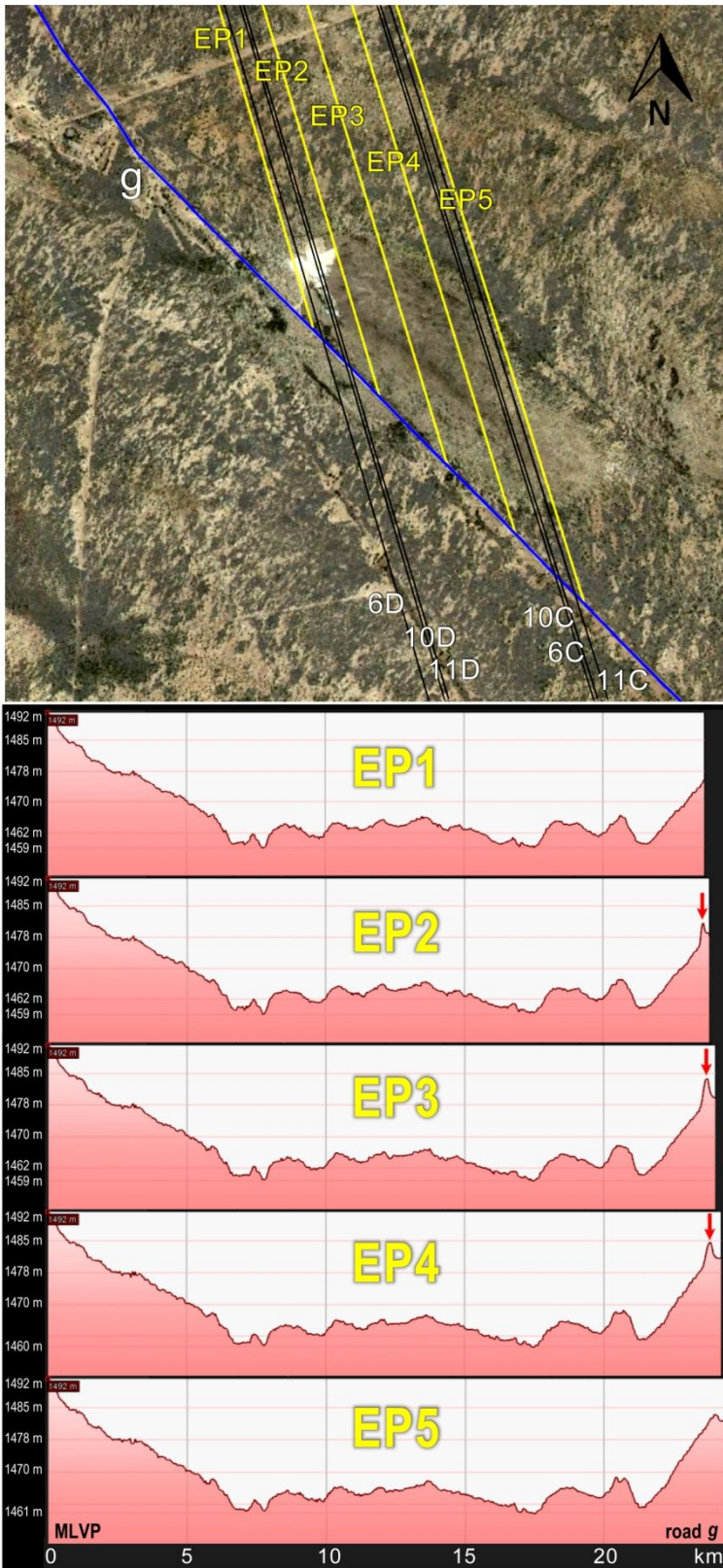


Figure 44. Geography of photos #6, #10 and #11, May 7 and 8, 2003.

Top: Map of the area close to a southern stretch of Nopal/Escondido Road (g), around the direction of the light-track gap (spanning from 6C to 6D, 10C to 10D, or 11C to 11D - depending on the picture-, as seen from the Viewing Center. (Image: Google, Landsat/Copernicus.)

Bottom: Google Earth elevation profiles along lines EP1-EP5, across Mitchell Flat, from the Viewing Center (marked "MLVP" on the left) to the intersection with Nopal Road (right end of each graph). Arrows mark the obstacle that would hide the road for an observer at the Viewing Center. The obstacle is found "inside" the gap only (lines EP2, EP3 and EP4).

Note: the vertical scale is exaggerated in all the profiles to emphasize vertical features (slopes appear steeper than they are).

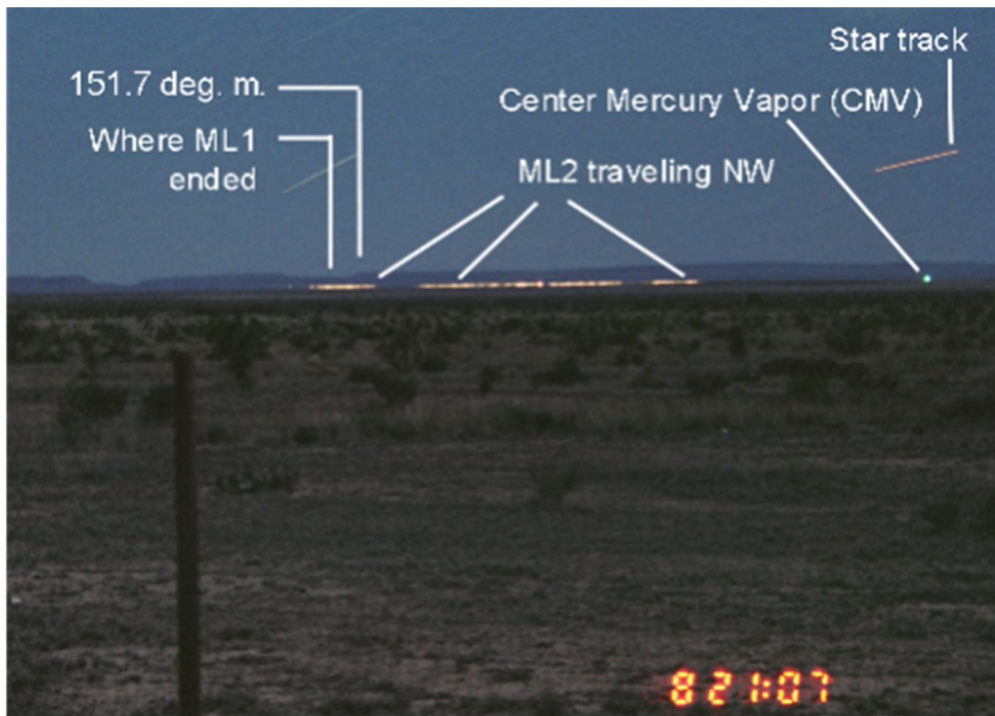


Figure 45. Photo #11 (ML2), May 8, 2003, 10:20pm, Mitchell Flat, Marfa (Texas). © James Bunnell.

The light tracks in photo #11 (Figure 45—the only picture of ML2 included in Bunnell’s book) as well as in photo #12 (Figure 48) and photo #13 (Figure 50) are compatible with the luminous trail of the headlights of a vehicle traveling northwest on Nopal/Escondido Road. Besides the fact that the light tracks match the path of the road in the landscape simulations from Google Earth (see Figure 46, Figure 49, and Figure 51 below), there is additional evidence in every picture, like the gap in photo #11, examined above.

No doubt it is purely by chance that the light track in photo #12 appears to start “near” the mesa mercury vapor ranch light, which is actually over 13km off the road at that point (Figure 49). However, it is significant that the brighter spot in this light track is located right where the locked gate is placed.

Regarding photo #13, it is no less significant that the brighter spot in this case is located just at one of the turning points in the S-turn of Nopal Road (point B in Figure 51 below), where a vehicle’s headlights would appear to flash when observed from the MLVC.

See the map in Figure 52 below to get an overall view of the event and what the different pictures captured.

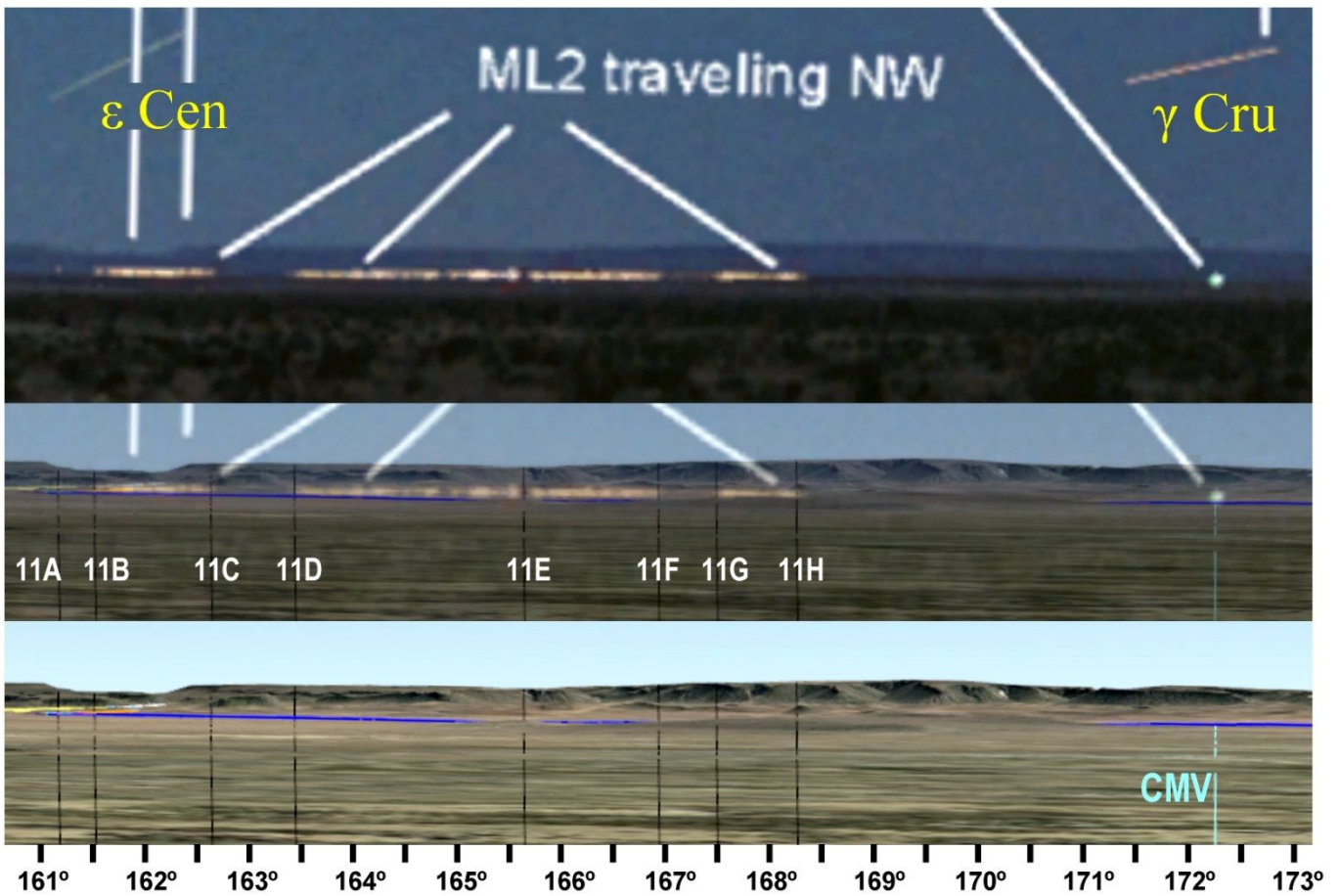


Figure 46. Photo #11 (ML2), May 8, 2003, 10:20pm. Mitchell Flat, Marfa (Texas). Correlation between local road (Nopal/Escondido Road) and luminous tracks.
 Top: close-up of Bunnell's photograph (text by the author; star labels added by us).
 Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.)
 Center: combined image, as a comparison. Lines 11A-11H point to directions of special interest in the pictured luminous tracks (see their True North azimuths below).

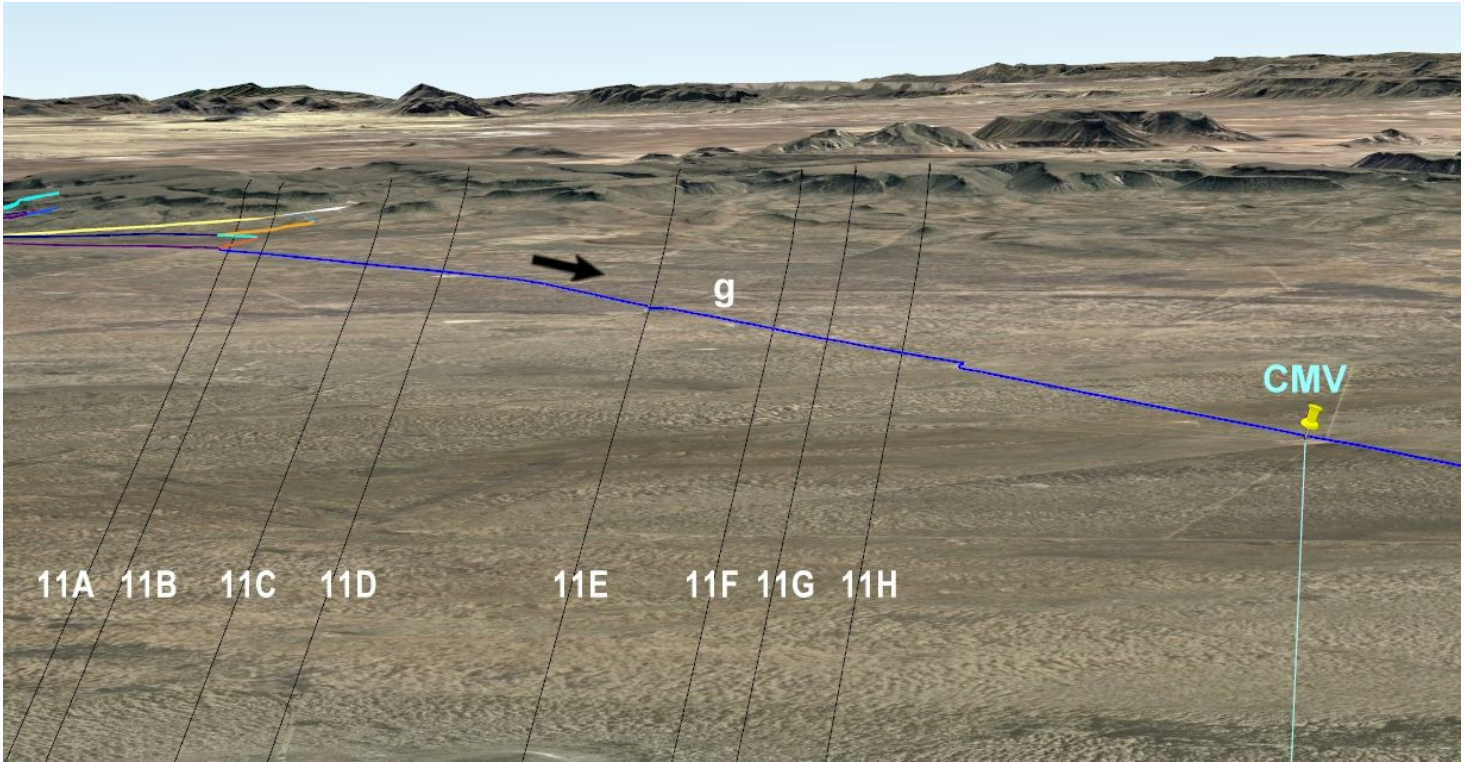


Figure 47. Photo #11 (ML2), May 8, 2003, 10:20pm, Mitchell Flat, Marfa (Texas). Simulated bird's-eye view of the area of interest, crossed by Nopal/Escondido Road (**g**). The light track spans from direction 11A to 11H, with a major gap between 11C and 11D. CMV: center mercury vapor ranch light. (Image: Google, Landsat/Copernicus.)



Figure 48. Photo #12, May 8, 2003, after 10:20pm, Mitchell Flat, Marfa (Texas). Photograph not included in Bunnell's book. Uncropped picture. © James Bunnell.

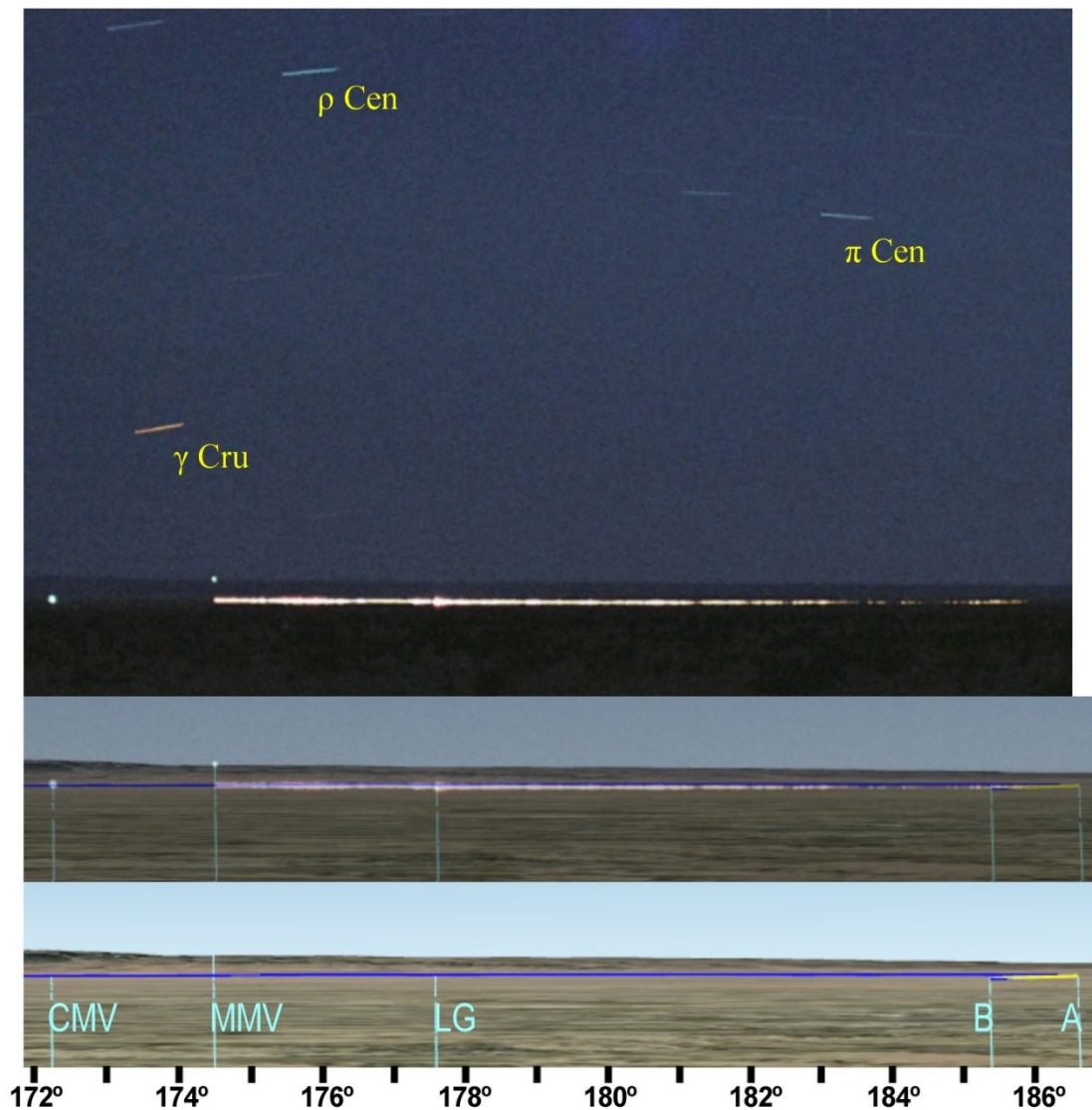


Figure 49. Photo #12, May 8, 2003, after 10:20pm, Mitchell Flat, Marfa (Texas). Correlation between visible local road (Nopal/Escondido Road) and luminous track.

Top: close-up of Bunnell's photograph (star labels added by us).

Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.)

Center: combined image, as a comparison.

Horizontal scale at the bottom of the figure: true north azimuths.

CMV: center mercury vapor ranch light.

MMV: mesa mercury vapor ranch light.

LG: locked gate on Nopal Road.

A, B: turning points in the S-turn of Nopal Road, as seen from the Viewing Center.



Figure 50. Photo #13, May 8, 2003, after 10:20pm, Mitchell Flat, Marfa (Texas). Photograph not included in Bunnell's book. Uncropped picture. © James Bunnell.

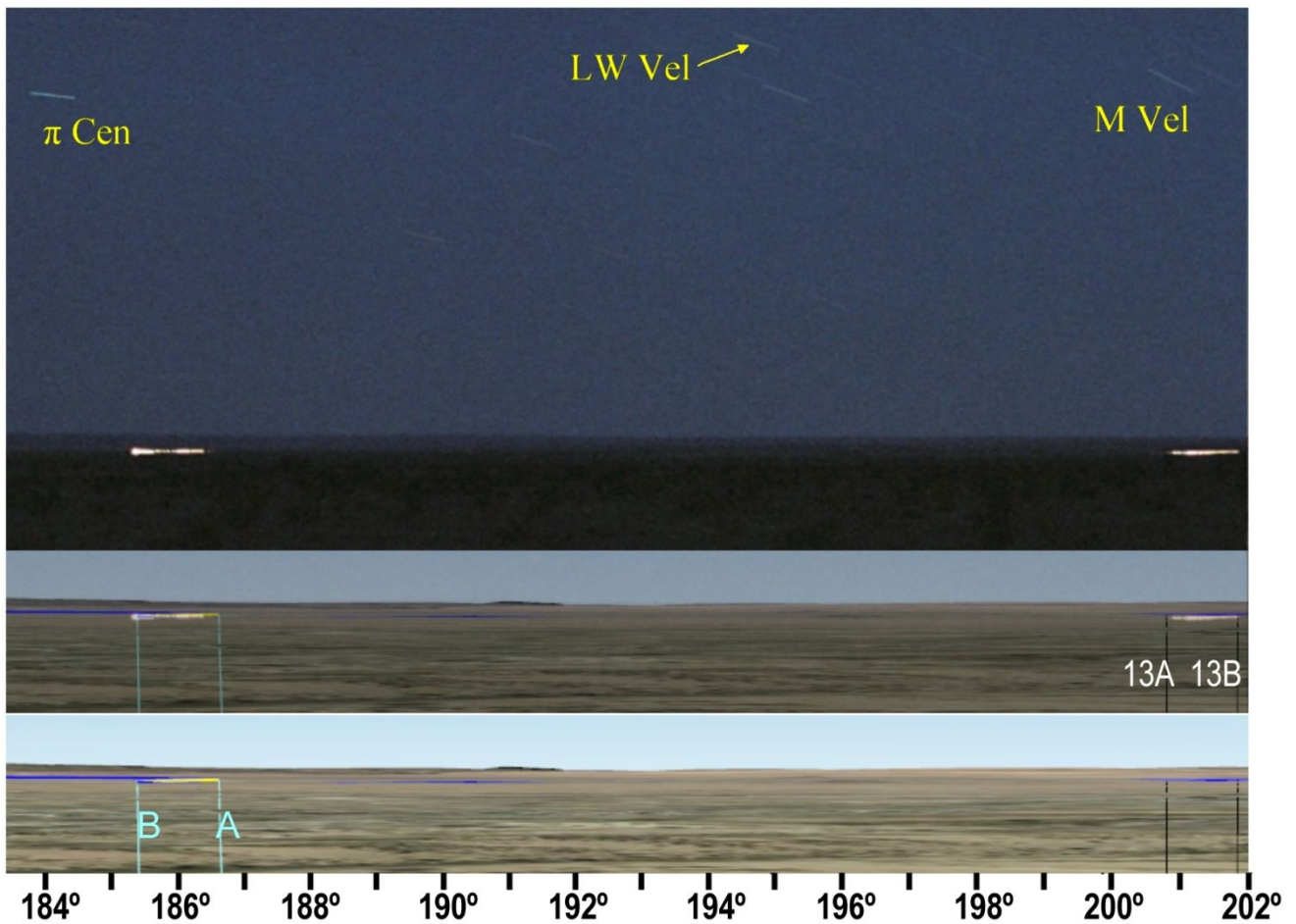


Figure 51. Photo #13, May 8, 2003, after 10:20pm, Mitchell Flat, Marfa (Texas). Correlation between visible local road (Nopal/Escondido Road) and luminous tracks.
 Top: close-up of Bunnell's photograph (star labels added by us).
 Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.)
 Center: combined image, as a comparison. The light track on the left is visible between directions A and B, which indicate the turning points in the S-turn of Nopal Road, as seen from the Viewing Center. Lines 13A and 13B mark the end points of the light track on the right (see their true north azimuths below).

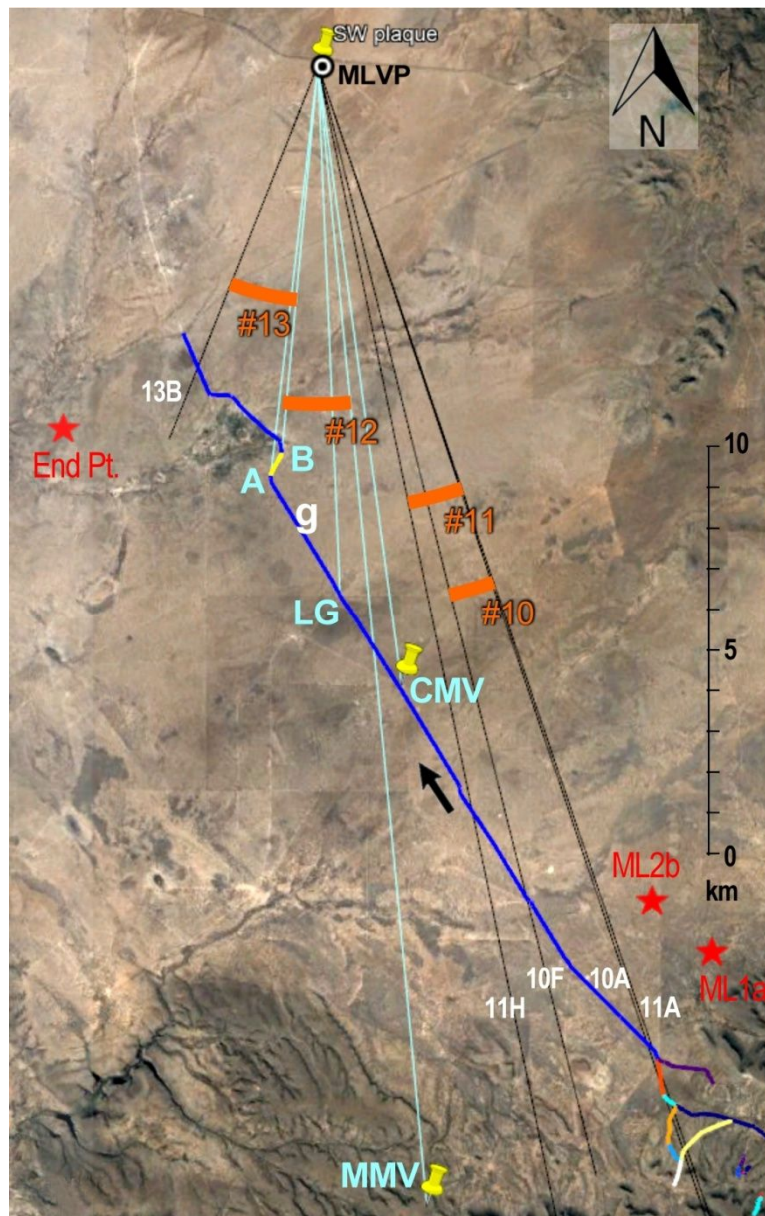


Figure 52. Events of May 8, 2003, Mitchell Flat, Marfa (Texas). Map of the area. (Image: Google, Landsat/Copernicus.)

Angles highlighted in orange show the viewing direction and angular span of the luminous tracks (ML2) in photos #10, #11, #12 and #13. All the evidence points to a vehicle traveling on Nopal/Escondido Road (g) across Mitchell Flat. The red stars indicate the start points of ML1 (photo #9) and ML2, as well as the end of the latter, according to Map 7 in Bunnell's book. All these estimated locations would be misplaced.

MLVP: Marfa Lights Viewing Center (all the photographs were taken from the SW plaque, to be precise)

CMV: center mercury vapor ranch light.

MMV: mesa mercury vapor ranch light.

LG: locked gate on Nopal Road.

A, B: turning points in the S-turn of Nopal Road, as seen from the Viewing Center.

In the following table, we present the approximate start time and exposure time data that can be deduced from the position of the stars that appear in photos #10 to #13. The resulting estimated speeds are also indicated, under the assumption that the luminous trace that appears in the images (ML2) was caused by the lights of a vehicle traveling on Nopal Road.

ML2 May 8, 2003						
Photo #	Time stamp	Start time (CDT)	Exposure time (minutes)	Distance on Nopal Road (km)	Stretch of road	Minimum average speed (km/h)
10	-	22:18	8.9	4.69	10A - 10F (Figs. 34 & 46)	31.7
11	21:07	22:18	10.2	7.43	11A - 11H (Figs. 40 & 46)	43.8
12	21:22	22:32	4.6	4.65	MMV - before curve A (Figs. 43 & 46)	60.4
13	21:27	22:36	4.5	3.82	Curve A - 13B (Figs. 45 & 46)	50.5
Full set	-	22:18	22.2	20.94	11A - 13B (Figs. 40, 45 & 46)	56.6

The obtained estimated speeds are within reasonable ranges for a vehicle traveling in the area. However, it should be stressed that this type of estimate provides *minimum* average speeds, since the reference we are taking is the photograph's total exposure time, while the light may have taken less time to leave the visible trace in the image or could stop for a few moments (as probably happened in photo #12, which would show the passage of the vehicle through the road's locked gate).

Three of the pictures (photos #11 to #13) include a printed time stamp showing the actual time these were taken, noted as hour and minute. In principle, it only implies a maximum error of one minute. That is, a time stamp of "21:07" would indicate the span between 21:07:00 and 21:07:59. However, and this is quite important, apparently the camera was not switched to daylight saving/summertime (CDT) and was using Central Standard Time (CST). Therefore, any calculation performed requires that one hour is added to the times given in the Time stamp column shown in the above table. The diagram of [Figure 53](#) shows the corrected data. On top of that, we have discovered that the camera clock had a delay of ~9-10 additional minutes, comparing the displayed time stamps with the real times the photos were shot, according to objective astronomical data.

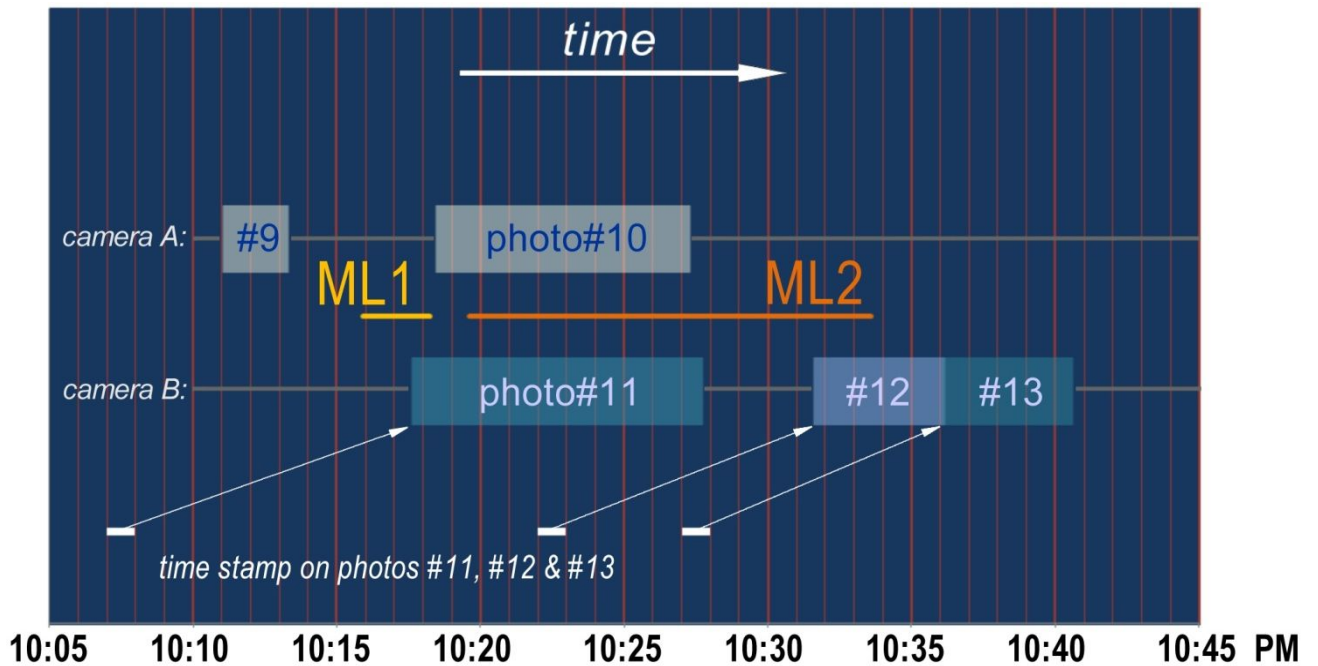


Figure 53. Bunnell's timing of ML1 and ML2 vs. timing of the time-exposure photos #9 to #13 estimated from the position of stars appearing in the pictures. Time stamps on photos #11, #12 and #13 are also indicated (with a correction of 1 hour to have them in CDT).

The time overview depicted in Figure 53 shows a series of consecutive photos (#11, #12 and #13) with an intermediate gap (between #11 and #12), plus two other photos (#9 and #10) made with another camera. Of these last pictures, photo #10 practically overlaps in time with photo #11, which has a slightly longer exposure time. All this is consistent with the angular information we summarized earlier in Figure 52.

Figure 53 also shows the time data provided by Bunnell. Previously we already mentioned that there exists a serious discrepancy between Bunnell's estimate and our own estimate, concerning photo #9's exposure time. The same goes for photo #11's exposure time (7 minutes, 6 seconds, according to Bunnell's book, p. 92): that would have been almost three minutes longer, following an astronomically-derived estimate.

Paradoxically, time data provided by Bunnell should be delayed so that ML1 was visible during photo #9's exposure, but, similarly, his time data should be advanced to match ML2 with photo #13's exposure.

Bunnell's time data come from video recordings shot by *Roofus* camera (see Figure 54). By then (2003) some recordings were saved on tape. Recently, we have asked Bunnell if those tapes were still available, so that they can be transferred into digital form for study. "Unfortunately—he replied—the tapes are completely unusable. It has been 15 years and maybe they got too hot in storage. Made a valiant effort to salvage them but it was hopeless."



Figure 54. Roofus station. © James Bunnell.

Although it is not possible to examine the original footage, at least we have a listing of the data that were duly extracted from the video. We have represented them in Figure 55. Time and magnetic azimuth are Bunnell's reported data. The rest is added by us.

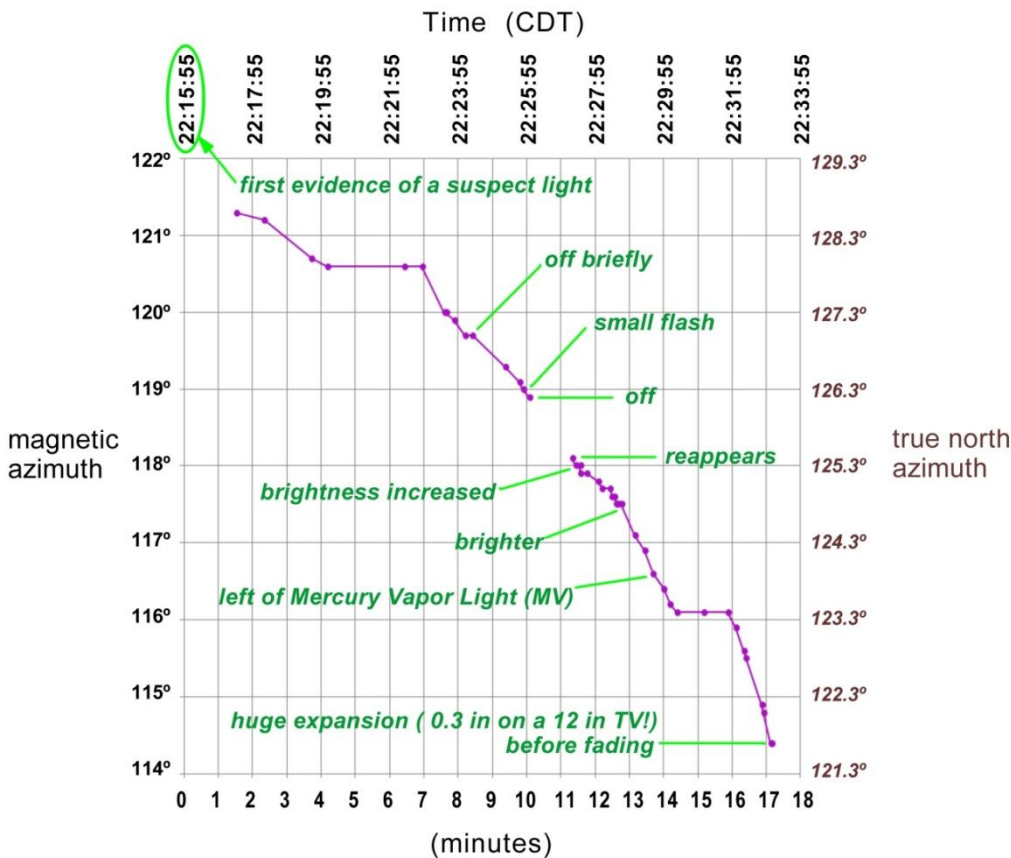


Figure 55. Azimuth vs. time plot on May 8, 2003, displaying the Marfa light recorded from Roofus station. The vertical scale on the right has been included to allow a true-north reading of the original magnetic azimuths (7.3° difference). The lower time scale shows the time elapsed since the first Roofus recorded evidence of a suspect light. Text in green: original notes by James Bunnell.

Bunnell triangulated the position of the lights by combining the information obtained from the *Roofus* footage with that of the photos taken from the Viewing Center. **Figure 56** shows, in red, the approximate trajectory of ML2 thus obtained (according to Map 7 on p. 93 of his book). It also shows the initial and final azimuths of the light filmed with the *Roofus* camera (orange lines), as per the listing provided by Bunnell and graphically represented here in **Figure 55**. Finally, **Figure 56** also indicates the initial and final azimuths of ML1 and ML2 (black lines), as we have deduced independently from photographs #9 to #13.

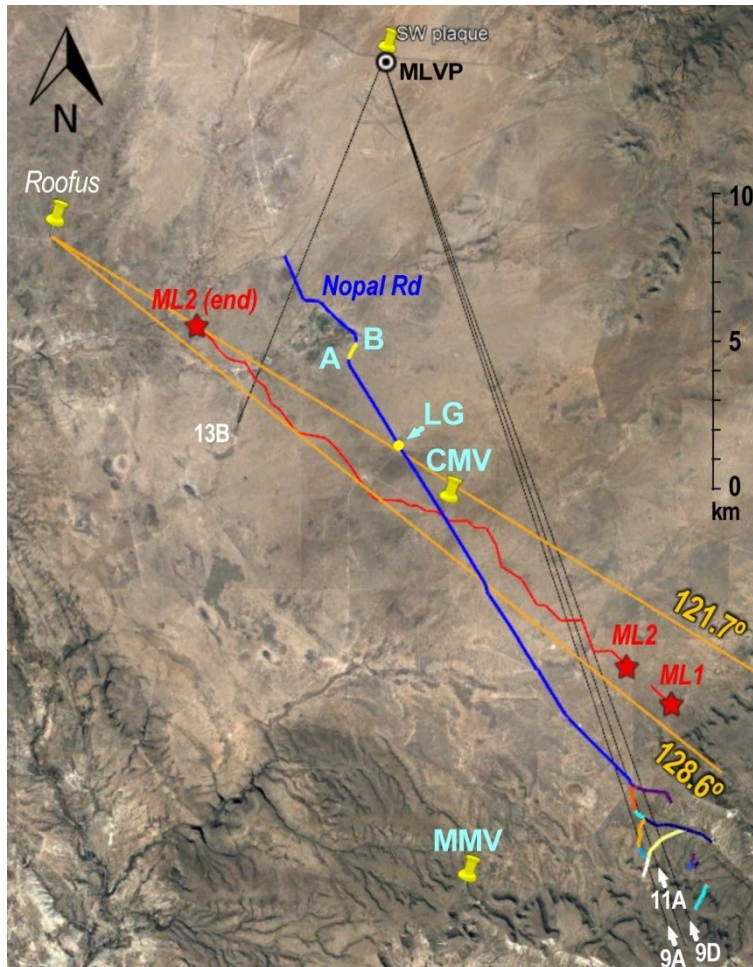


Figure 56. Events of May 8, 2003, Mitchell Flat, Marfa (Texas).
 Red line: approximate trajectories of ML1 and ML2, according to Bunnell (as per Map 7 in his book).
 Orange lines: initial azimuth (128.6°) and final azimuth (121.7°) of the light recorded by *Roofus* station.
 Black lines: initial and final azimuths of ML1 (9A & 9D) and ML2 (11A & 13B), from the photographs.
 (Image: Google, Landsat/Copernicus.)
 MLVP: Marfa Lights Viewing Center.
 CMV: center mercury vapor ranch light.
 MMV: mesa mercury vapor ranch light.
 LG: locked gate on Nopal Road.
 A, B: turning points in the S-turn of Nopal Road, as seen from the Viewing Center.

We must highlight that the above reconstruction of the ML trajectories is problematic for three reasons:

1) As we have repeatedly warned, some of the magnetic azimuths from the Viewing Center handled by Bunnell are erroneous. From [Figure 56](#) it is evident that any point triangulated from photos #9 to #13 should be located within the area delimited by the outermost black lines (i.e., directions 9D and 13B). It can be observed, nevertheless, that both ML1 and the start and end of ML2 are outside that range of azimuth. It allows us to affirm that their positions are wrong.

2) If we look at [Figure 55](#), we find that the azimuth of the light recorded by *Roofus* did not increase *at any time*. Therefore, the trajectory shown in [Figure 56](#), with its sharp ups and downs of azimuth from *Roofus* position, is incompatible with the data on which it is supposedly based.

3) In an Appendix to his book, Bunnell correctly indicates that triangulation of a moving target requires an accurate time match of the azimuths, to obtain a valid result. It is rather obvious that the necessary conditions were not met here, since *Roofus* had an uncontrolled clock that was prone to drift (the problem was solved in late 2005 by extracting time from GPS satellites) and, as we showed before, the information from the time stamps on the photographs was not reliable either.

Moreover, we strongly suspect that there is even a greater problem in the data obtained from the *Roofus* video. If our hypothesis is correct and the observed, photographed, and videoed lights were a vehicle's headlights, then they should have been recorded over a wider range of azimuth angles from the *Roofus* station. In other words, the azimuth listing plotted in [Figure 55](#) would be wrong. We could not state that, because of features of the terrain, car lights on Nopal Road must have been invisible from the *Roofus* station outside the small interval of azimuths from 128.6° to 121.7°. As we can see in [Figure 56](#), this interval delimits a 5km long stretch of Nopal Road, which implies a speed of only 19km/h since the *Roofus* camera recorded the light for 15.5 minutes. This low speed is not compatible with our previous minimum speed estimates. Therefore, if we were to assume that the lights belonged to a vehicle traveling on Nopal Road (ML2), the provided azimuths from the *Roofus* location would be necessarily wrong.

For a better understanding of this possible error, we must first know how the azimuth data were derived from the images of the *Roofus* video. Bunnell remarks that the quality of the video footage was “pretty terrible in 2003 & 2004,” since the security-type, black-and-white cameras used were set to a low resolution to avoid filling the hard drives too quickly. “Even so—he clarifies—the lights that *Roofus* recorded were good enough to track light directions and elevations over time.”

There are no images available of any 2003 *Roofus* video frames to ascertain the camera direction and the field of view at the time. All we know is that, in later years, the camera was pointed close to the center mercury vapor ranch light, and this is likely to have been no different in 2003 too since “general direction of the camera

was mostly, but not completely, consistent over the years.” Concerning the field of view, an angular frame width of about 30°—as in subsequent years—also seems probable, although Bunnell states that in 2003 he was “trying different cameras and different lenses resulting in different fields of view.”

The method Bunnell followed to obtain the directional information was measuring light movements relative to the center mercury vapor ranch light. The azimuth of this reference light from the *Roofus* station was 125.02°. The azimuth of any unknown light appearing in the video was deduced from its horizontal distance to the reference light, measured on a 12-inch screen. Under certain conditions (small angular distance between the direction of the unknown light and the direction of the camera, camera pointing to the horizon or near it, and little or no tilt of the image), the calculation can be approximated as a simple addition or subtraction to the reference azimuth of an amount of degrees directly proportional to the horizontal distance, as shown in **Figure 57**. If there was an error in calculating the azimuths, probably it would be related to the use of a wrong coefficient of proportionality (k). Is there any indication of such an error?

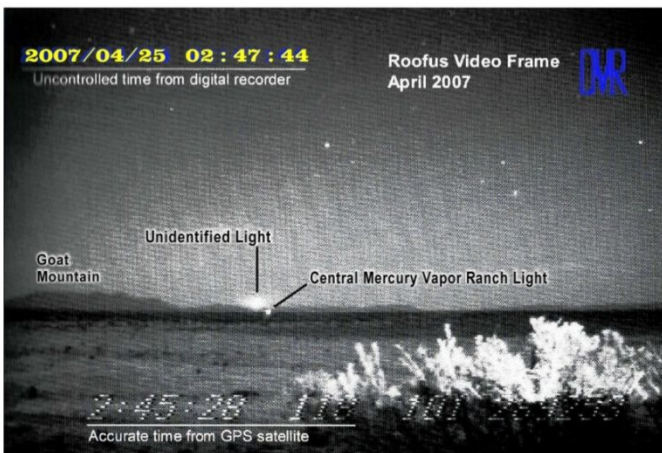
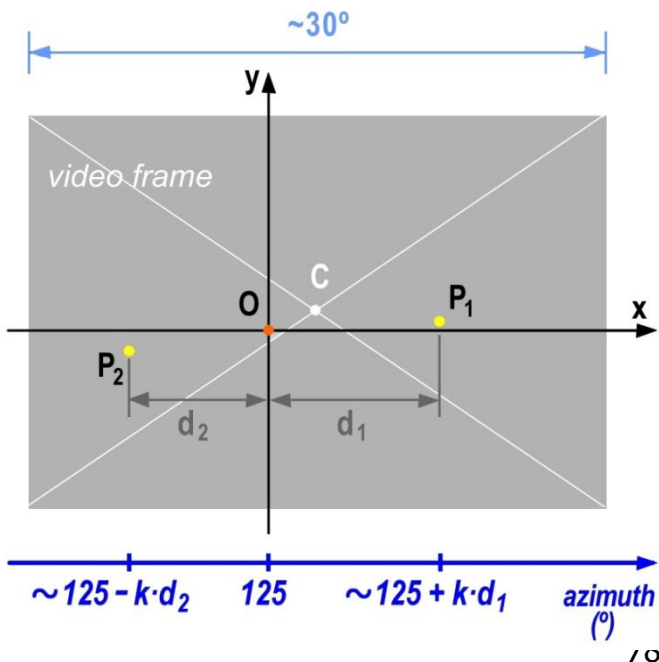


Figure 57. Top: *Roofus* video frame from 2007 reproduced in Bunnell's book (as a negative, in p. 167). Both camera's direction and field of view could differ somewhat from those in May 2003. Accurate time pulled from GPS satellites was not used in 2003. © James Bunnell.

Bottom: diagram relating distances measured on a video frame to azimuths from the camera location (blue axis at the bottom). In May 2003, the camera was most probably pointed almost directly at the central mercury vapor ranch light, with the latter used as point of reference **O**. It would appear at or near the optical center **C**. The angular width of the video frames was likely about 30°.



The diagram shows two hypothetical example lights, P_1 and P_2 , and the horizontal distances to the reference light O , denoted by d_1 and d_2 . The corresponding azimuths are expressed at the bottom in simplified form, making use of the small-angle approximation of the tangent function (results are pretty accurate for locations P , not more than 10° apart from the optical center C). 125° is the azimuth of the mercury vapor light O from *Roofus* station and k is a constant that depends on the field of view of the video frame and the width of the frame expressed in the same units in which d is measured.

Under the hypothesis that what *Roofus* filmed were the headlights of a vehicle traveling on Nopal/Escondido Road, we would see in the video a moving light apparently making two stops (see [Figure 58](#)). This is precisely what we find in the *Roofus* data, although with a disagreement in azimuth. Coincidence or not, the rescaling of the azimuth needed for a good match leaves the azimuth of 124.78° unchanged, which is very close to the azimuth of the reference light (125.02°), as we could expect if a wrong coefficient of proportionality were used. Apparently, the coefficient k should have been increased by a factor of 2.65.

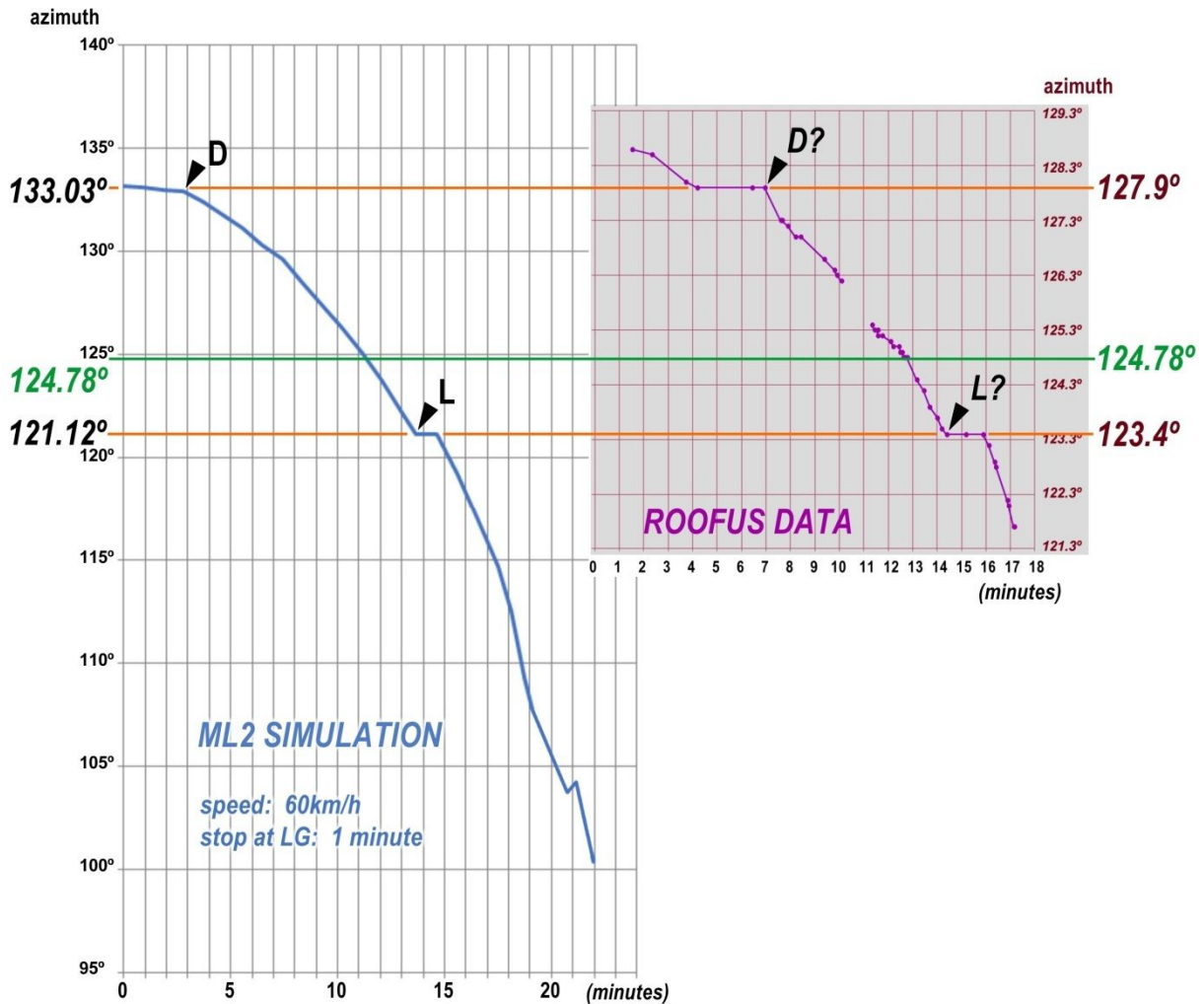
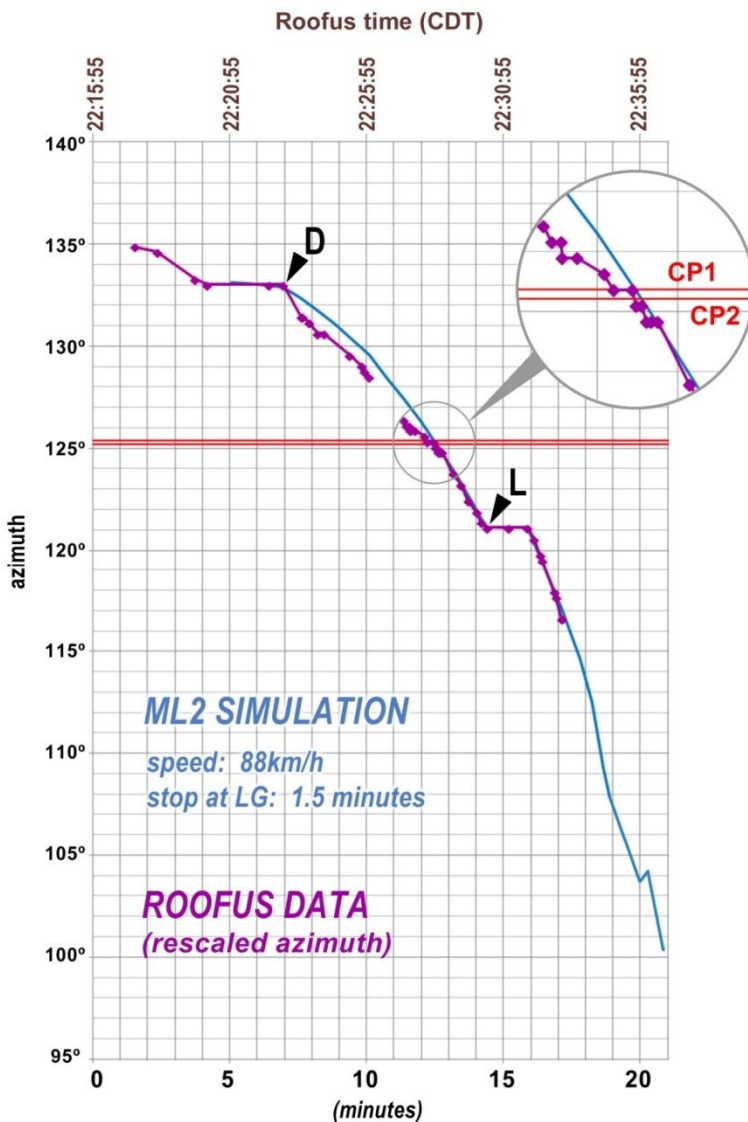


Figure 58. Left: simulated azimuth from *Roofus* station over time of ML2 (light appearing in photos #10 to #13) assumed to be the headlights of a vehicle traveling Nopal Road northwesterly at a constant speed of 60km/h and stopping at the locked gate for 1 minute (plausible initial guesses). Any possible gaps due to visibility issues from *Roofus* location are not considered. The curve turns out to be flat, showing little or no change in azimuth, at two intervals corresponding to the initial stretch of road (prior to point **D**) and the stop at the locked gate (starting at point **L**). Right: azimuth from *Roofus* station over time of the light recorded by the video camera on May 8, 2003. If the flat parts in this graph were related to the aforementioned **D** and **L** points (as the similarity of both plots suggests) the azimuths derived from the *Roofus* video would be wrong: azimuths 123.4° and 127.9° should read 121.12° and 133.03°, respectively. Rescaling the azimuth axis accordingly would affect all the azimuth values but one, 124.78°, which is very close to the azimuth of the reference light (125.02°).

While times derived from the *Roofus* clock might not be reliable, the time *intervals* during the span of the observation are surely accurate enough. Under Nopal Road traffic assumption, we can infer a vehicle's average speed of 88km/h (a rather high velocity) and a stop time interval of 1.5 minutes at the locked gate (see [Figure 59](#)).



Roofus at (rescaled) azimuths below 116.6°, despite the light still being photographed from the Viewing Center for a few minutes. Also note the gap in the *Roofus* data curve around a (rescaled) azimuth of 127.5°.

Finally, in [Figure 60](#) we have contrasted the data from *Roofus* (with the appropriate corrections in azimuth) with the information of times and azimuths extracted from photos #10 to #13. Both sets of data are compatible. This is a new indication in support of the Nopal Road hypothesis, although the final demonstration would only be obtained by examining the video, which is no longer available.

Figure 59. Blue curve: Simulated azimuth from *Roofus* station over time of ML2 (light appearing in photos #10 to #13) assumed to be the headlights of a vehicle traveling northwest on Nopal Road. In order to fit the timing from the *Roofus* data, a constant speed of 88km/h and a stop at the locked gate 1.5 minutes long have been considered, as well as a start delay time of 5 minutes 3 seconds relative to the start of the *Roofus* data at “22:15:55” (when a “first evidence of a suspect light” was noticed in the video).

Purple curve: plot of the azimuth from *Roofus* station over time of the light recorded by the video camera on May 8, 2003, vertically rescaled taking points **D** and **L** as references (see [Figure 58](#)).

Both curves are in good overall agreement. Nevertheless, while the simulation plotted in blue assumes constant speed, for sake of simplicity, the *Roofus* data plot shows what appears to be a transient increase in speed (steeper slope of the curve) right after point **D** and an equally transient reduction in speed (shallower slope) when approaching the fenced cow pen where the reference mercury vapor light resides (**CP1** & **CP2**: azimuths of the entry/exit gates of the cow pen on Nopal Road –see images 9 and 10 in [Figure 63](#) below).

The simulation plotted in blue does not consider any visibility issues from the *Roofus* station either. Note that the rescaled *Roofus* data plot starts before ML2 was photographed for the first time from the Viewing Center whereas, at the end, nothing would have been recorded by

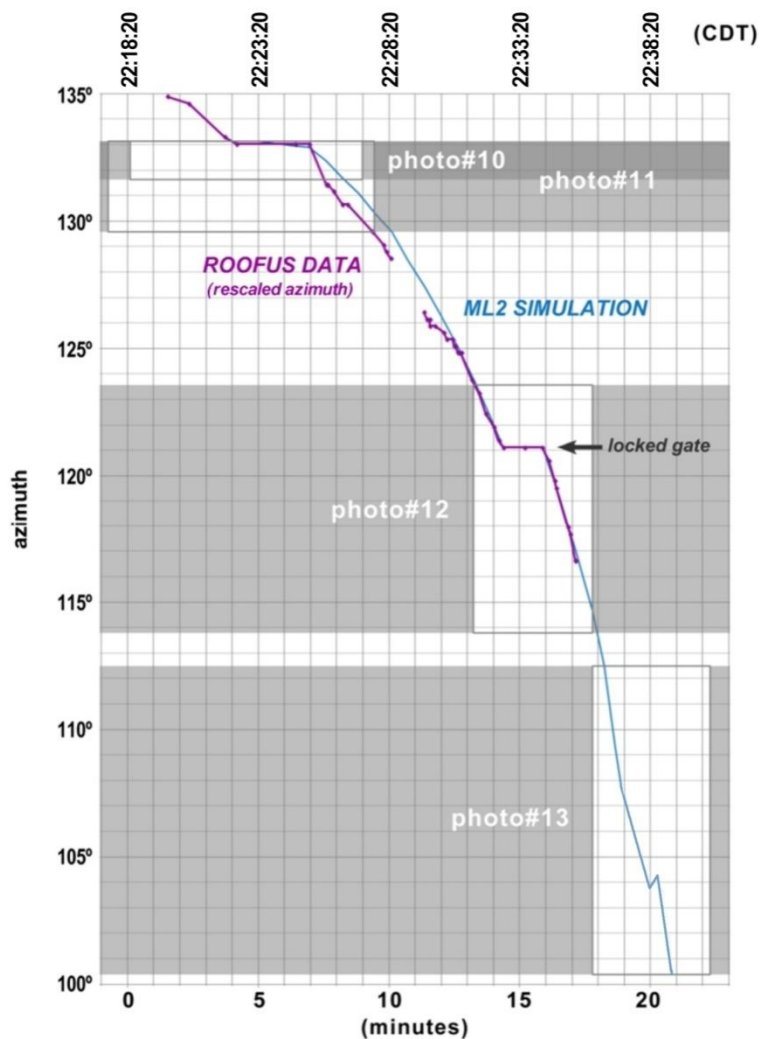


Figure 60. The previously rescaled azimuth from *Roofus* station over time of the light recorded by the video camera on May 8, 2003 has been plotted along with the prohibited areas (in gray) determined from photos #10 to #13 under the assumption of lights traveling Nopal Road. The rescaled *Roofus* data (purple curve) fit perfectly in the template thus created. Times on top of the graph, derived from astronomical data in the photos, would imply that *Roofus* clock was about 2' 25" slow. Simulated azimuth from *Roofus* station over time of ML2, under the Nopal Road assumption (refer to **Figure 59** for more details), has been also plotted (blue curve) to illustrate hypothetically the last part of the event, captured in the two last photos.

The so-called prohibited area of each photo is the area within the azimuth span of the light track visible in the photo which is outside of the exposure time interval. For example, photo #11 determines two vertical limits at 22:17:35 and 22:27:46 (CDT), the approximate start and end times of the exposure as deduced from the position of stars in the picture. The two horizontal limits are given by extreme directions 11A and 11H from the Viewing Center (see **Figure 46**): we consider the azimuth from *Roofus* station of the points at which 11A and 11H cross Nopal Road ($133,13^\circ$ and $129,57^\circ$, respectively).

Bearing this in mind, it can be observed that ML2 must have been captured at both the start and the end of the photo #12 exposure, but it was out of view of the camera when the exposure of photos #10 and #11 started, and when the photo #13 exposure ended.

From the comparison made in [Figure 60](#), always under the assumption of a vehicle traveling along Nopal Road, it follows that:

- The *Roofus* clock would be delayed 2 minutes 25 seconds, approximately.
- ML1 (the light captured in photo #9, see timing in [Figure 53](#)) does not appear in the video whose data have been examined here, since the first lights on the footage appear some minutes later, around 22:18:20.
- When the exposure of photos #10 and #11 started, ML2 still could not be seen from the Viewing Center, but it was already being filmed from *Roofus* station (see map of [Figure 61](#) to get an idea of the situation).
- On the contrary, when at last ML2 stopped being seen from the *Roofus* position (shortly before finishing the exposure of photo #12), it continued to be photographed from the Viewing Center in photo #13 (see map of [Figure 61](#)).
- ML2 finally ended up coming out of the frame of photo #13 before exposure time ended.
- Contrary to what happens in the photos #10, #11 and #13, ML2 must have been captured both at the start and at the end of photo #12's exposure time.

This last detail is of great interest because for once we can know the precise time that it took to travel a certain stretch of road (not just a maximum time interval) and we can then calculate the actual speed (not just the minimum possible speed.) Considering the exact distance of 4.65km and the exposure time of photo #12 (4.6 minutes), from which we must subtract the interval of 1.5 minutes from the double stop at the locked gate, it results in an actual average speed of 90km/h.¹²

(12) On a bizarre note, 84-90 km/h is the ML2 speed estimate given in Bunnell's book, despite considering a different path of the light.

We have reached again the same estimate for the speed of the light (i.e., road traffic) obtained in [Figure 59](#), one that is strikingly high. Is this a plausible speed, considering the conditions of the terrain?

On page 62 of his book, Bunnell explains—after mentioning the many ranch trails existing in Mitchell Flat along the fences inclosing the properties—the following:

Vehicles driving ranch trails move slowly (10 to 20 mph [16 to 32 km/h] is about the limit), especially at night when headlight beams are moving up and down because of rough terrain. MLs, in contrast, are likely to travel cross-country at much higher speeds, on the order of 50 to 100 mph [80 to 161 km/h] and sometimes much faster. The only time truck and automobile speeds get fast enough to be possible MLs is when they are traveling Nopal or the 101 Ranch roads [our emphasis].

It may seem incredible that an automobile can travel so fast (over 80km/h) through a road like Nopal which is crossed by many fences (see [Figure 62](#)). For example, besides the locked gate, there exists a double gate at the fenced cow pen where the reference mercury vapor light resides. The fact is that the locked gate is the only obstruction to travel, since the other fences that cross the road are only “cattle guards” (see [Figure 63](#) and [Figure 64](#) below).

Although “it was necessary to slow down to cross the many cattle guards because they were only one vehicle wide and rough or impossible to cross with road speed,” Bunnell also explains that “most folks driving Nopal tended to drive a bit fast which was dangerous mostly because you could come over a small hill and discover animals lying in the roadway” [our emphasis].

We have mentioned in a previous chapter that monitoring station camera *Roofus* was unable to record vehicle traffic on Nopal Road west of the locked gate, as Bunnell tested by driving that portion of the road with car headlights on high beam. This was another reason that led him to think that the lights tracked on May 7 and 8, 2003 were not vehicle lights but mystery lights flying above ground, since they were within *Roofus*' cone of visibility. Nevertheless, from our analysis it follows that there could be exceptions to the inability of the camera to see vehicle lights on the closest portion of Nopal Road when, exceptionally, “looming” conditions were met in the area.

Finally, there is a singularity that we have been unable to clarify: the “huge expansion” (*sic*) of the light filmed by *Roofus*, right before it faded completely (see [Figure 55](#)). According to the Nopal Road traffic hypothesis, it had nothing to do with the “explosion” appearing in photo #9. There is no corroboration either in photo #12, where it should indeed appear (see [Figure 49](#) and [Figure 52](#)), considering that the “expansion” would have been seen in the direction labeled E in [Figure 61](#). At that precise spot, there is no change in the direction of the road that could cause the headlights of a vehicle to point in the direction of *Roofus* station.

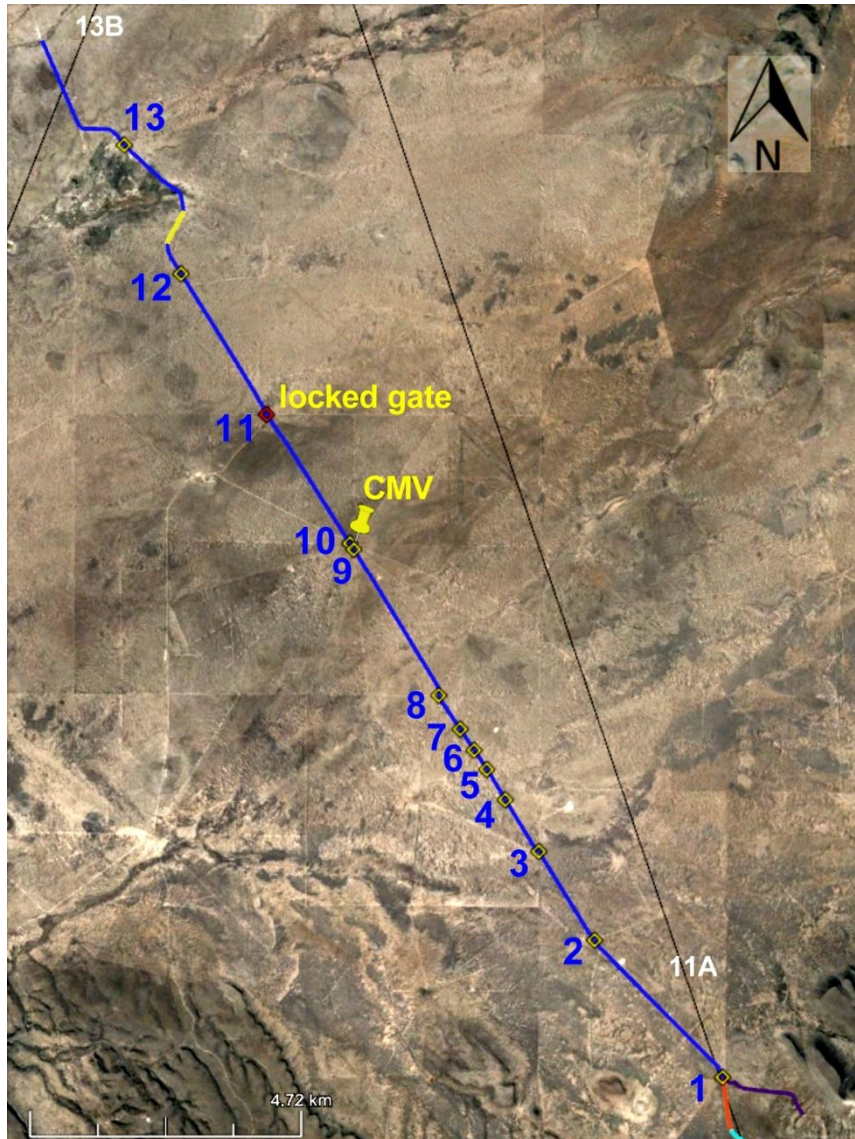


Figure 62. “Obstacles” on Nopal/Escondido Road. The map shows the points at which the dirt road crosses fences. The displayed stretch of road is between the initial and the final azimuth of ML2 (directions 11A & 13B from the Viewing Center).
 CMV: center mercury vapor ranch light.
 (Image : Google, Landsat/Copernicus.)

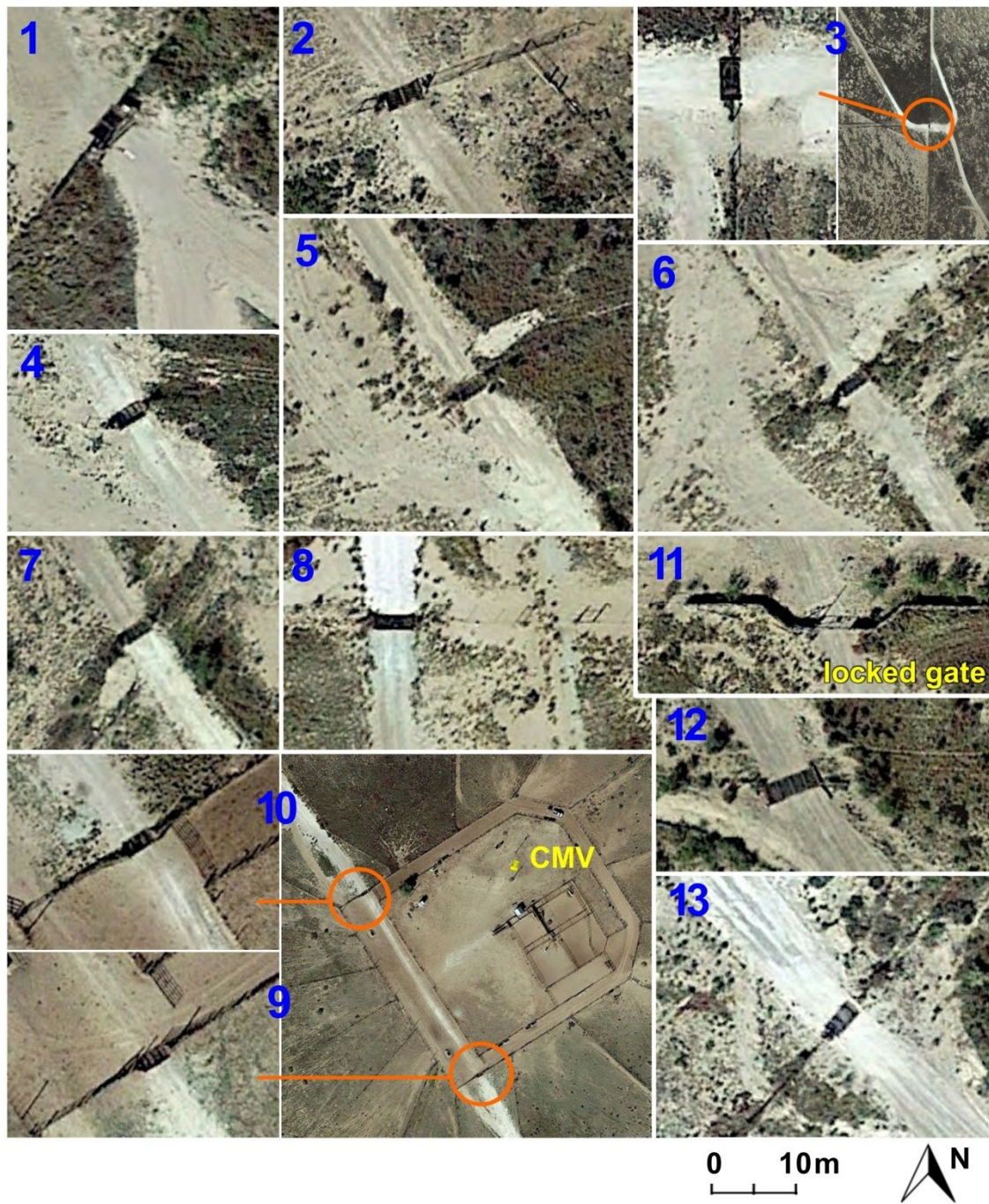


Figure 63. A closer look at the “obstacles” on the stretch of Nopal/Escondido Road shown on the previous map (Figure 62) reveals that all of them but the “locked gate” (No.11) are *cattle guards* that do not impede traffic.

CMV: center mercury vapor ranch light.

Scale at the bottom applies to all the images except the two containing orange circles.

(Images: Google, Landsat/Copernicus.)



Figure 64. A *cattle guard* (or *cattle grid*) is a type of obstacle used to prevent livestock from passing along a road which penetrates a fence. It consists of a depression in the road covered by a transverse grid of bars or tubes fixed to the ground so that the gaps between them are wide enough for an animal's feet to enter, but sufficiently narrow not to impede a wheeled vehicle. (Image credit: www.publicdomainpictures.net).

Event dated May 8, 2004, 21:04:31hours (CDT). Photo #14

After an unrecorded ML observation in the company of a group of college students in the MLVC, and as soon as Bunnell had put his equipment in place, a second and closer ML came in sight toward the south moving left to right (Note 53). Because of the heavy wind, only a single picture was achieved (photo #14—see Figure 65 below). The light disappeared “soon after.” Unlike the other photographs, this one was taken from the picnic area to the east of the Viewing Center.



Figure 65. Photo #14 (ML2), May 8, 2004, shortly after 9:04pm, Mitchell Flat, Marfa (Texas). Uncropped picture. © James Bunnell.

Since the existing, separate video camera had not captured either of the lights, Bunnell asserts that these first two MLs “were located north of *Roofus*’ field of view and therefore closer to the View Park.”

We suspect that what appear in the photo are, once again, the lights of a vehicle approaching on Nopal Road. We cannot confirm this since the only photo available does not contain details of the distant landscape that can be used as a reference to locate the lights with any precision. If our theory is correct, the vehicle was more than 9km away from the camera and not, as Bunnell feels, flying “higher than and near to a post in the View Park boundary fence” (p.100). (See Figure 66.)



Figure 66. A light “fairly close to the View Park”? (Bunnell *dixit*). A mere look at photo #14 does not allow to get a reliable idea of the distance at which the light was located. That is, if it was “near a post in the View Park boundary fence” (as Bunnell claims) or some 10km away (if it was caused by the lights of a vehicle). In order to realize how deceitful appearances can be, please compare the light of photo #14 (top) with that of the enlarged image (center) of a long-exposure of the headlights of cars on Highway 67, a picture taken by Bunnell from the Viewing Center, looking southwest (http://www.marfatxlights.com/uploads/3/4/4/9/3449257/6709213_orig.jpg).

We know for certain that the latter were located over 20km from the camera! Appearances are even more deceptive if the background landscape is hardly visible, as in photo #14 and in the bottom picture, a retouched version of the center picture.

Event dated May 8, 2004, >21:04:31 hours (CDT). Photos #15, #16 and #17

Almost immediately after photo #14 was taken, a third light (ML3) appeared at 148.8° some 14 miles (22.5km) distant (Bunnell also gives the following coordinates for the starting location: 30.0901° N, 103.7862° W). It remained visible for 3 minutes, 54 seconds. Three photographs were taken (photos #15, #16 and #17—see **Figure 67**), all from the east end of the watching platform at the Viewing Center. The light was traveling mostly NNW, as established by *Roofus* station, and extinguished at 148.3°.

According to Bunnell, it was “clearly flying well above local terrain eliminating any possibility that these light tracks were being generated by vehicle headlights” (p.101). The movement of this light, that traveled a short distance from starting to end points (2.5km in a straight line, from Bunnell’s triangulations), was especially erratic: “ML3 was high and changing altitudes rapidly...and just before going out, it jumped vertically a significant distance.” At first, it moved left and then right, then left again as seen from the Viewing Center. Bunnell’s estimates for the initial flying altitude was 122m over the terrain, an actual path of 3.8km, and an average speed of 58km/h. This is “a typical travel speed for Nopal Road,” Bunnell reports, but then argues that the ML could not have been traveling on Nopal for several reasons, including that “the path followed by ML3 does not align with Nopal ranch road or any ‘cattle trail’ or fence line.”

As in other cases studied above, the given position of the start of ML3 does not correspond with the azimuth of the same spot obtained with the help of Google Earth, and a deviation of 3.5° (>1,350m) appears, extending to 4.0° (>1,550m) if related to the given coordinates. Again, this is a clear indication of calculations based on wrong data that would prevent assigning the route followed by the light to any recognized terrain path. As we will show graphically later, there are factual differences in the locations estimated by Bunnell.



Figure 67. Top: Photos #15, #16 and #17 (ML3), May 8, 2004, after 9:04pm, Mitchell Flat, Marfa (Texas). © James Bunnell.
Bottom: Composite of the three photos.

The origin of the luminous tracks in photos #15 (Figure 68) and #16 (Figure 70) becomes quite obvious when we superimpose the images on a Google Earth rendering of the landscape on which we have highlighted the local dirt roads that are visible from the Viewing Center (see Figure 69 and Figure 71 below). There is only one road and the comparison it is straightforward, without appreciable effects of looming. Clearly, the camera captured the headlights of a vehicle coming from the Whirlwind Mesa, southeast of Mitchell Flat, as shown in Figure 72 and Figure 73 (to be precise, the road is located on a range of slopes and mesas between Whirlwind Mesa and Mitchell Mesa).



Figure 68. Photo #15 (ML3a), May 8, 2004, after 9:04pm, Mitchell Flat, Marfa (Texas). Uncropped picture. The rainbow-like pattern is the spectrum of the ML, obtained by using a Mylar diffraction grating insert between the telescopic lens and the camera. © James Bunnell.

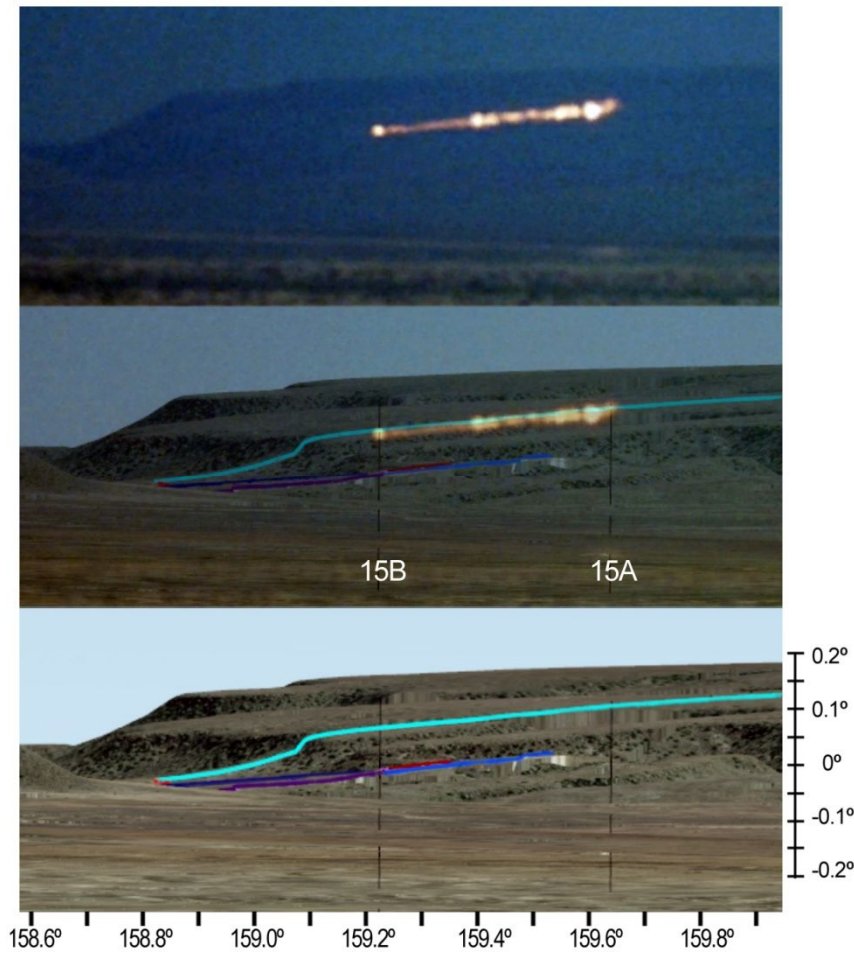


Figure 69. Photo #15 (ML3a), May 8, 2004, after 9:04pm, Mitchell Flat, Marfa (Texas). Correlation between visible local road running through Whirlwind Mesa and luminous track.
 Top: Close-up of Bunnell's photograph.
 Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.)
 Center: Combined image, as a comparison. Lines 15A and 15B point to the start and the end of the pictured luminous track.
 Horizontal scale at the bottom of the figure: true north azimuths.



Figure 70. Photo #16 (ML3b), May 8, 2004, after 9:04pm, Mitchell Flat, Marfa (Texas). Uncropped picture. The rainbow-like pattern is the spectrum of the ML, obtained by using a Mylar diffraction grating insert between the telescopic lens and the camera.
 © James Bunnell.

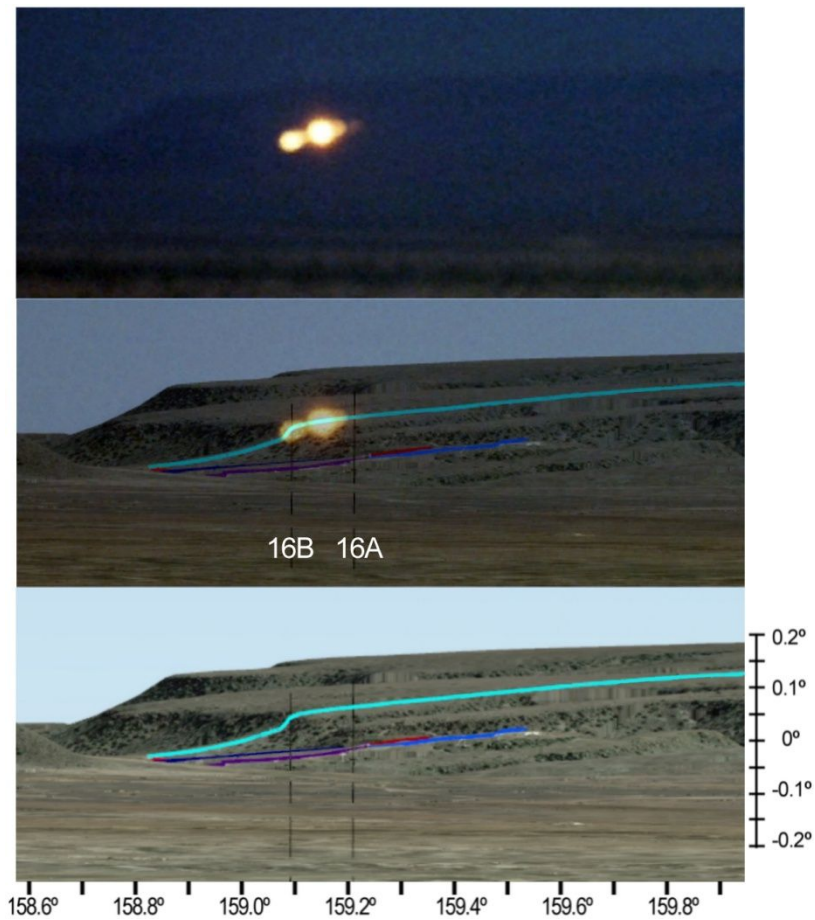


Figure 71. Photo #16 (ML3b), May 8, 2004, after 9:04pm, Mitchell Flat, Marfa (Texas). Correlation between visible local road descending from Whirlwind Mesa and luminous track. .
 Top: close-up of Bunnell's photograph.
 Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.)
 Center: combined image, as a comparison.
 Lines 16A and 16B point to the start and the end of the pictured luminous track.
 Horizontal scale at the bottom of the figure: true north azimuths.

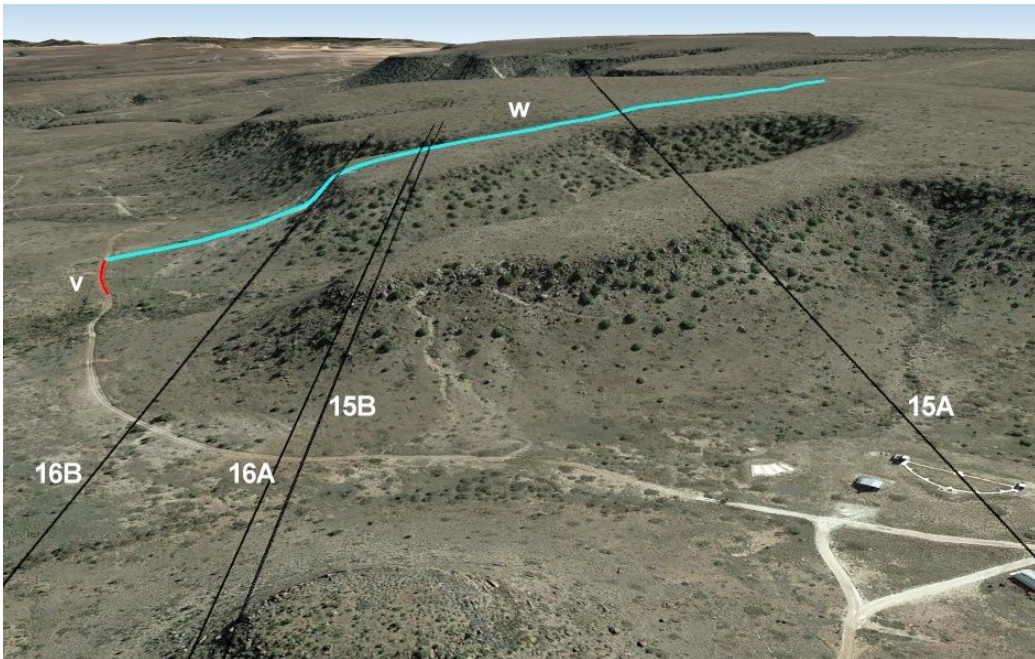


Figure 72. Photos #15 and #16 (ML3a/b), May 8, 2004, after 9:04pm, Mitchell Flat, Marfa (Texas). Simulated bird's-eye view of the area of interest, near Whirlwind Mesa. (Image: Google, Landsat/Copernicus.)

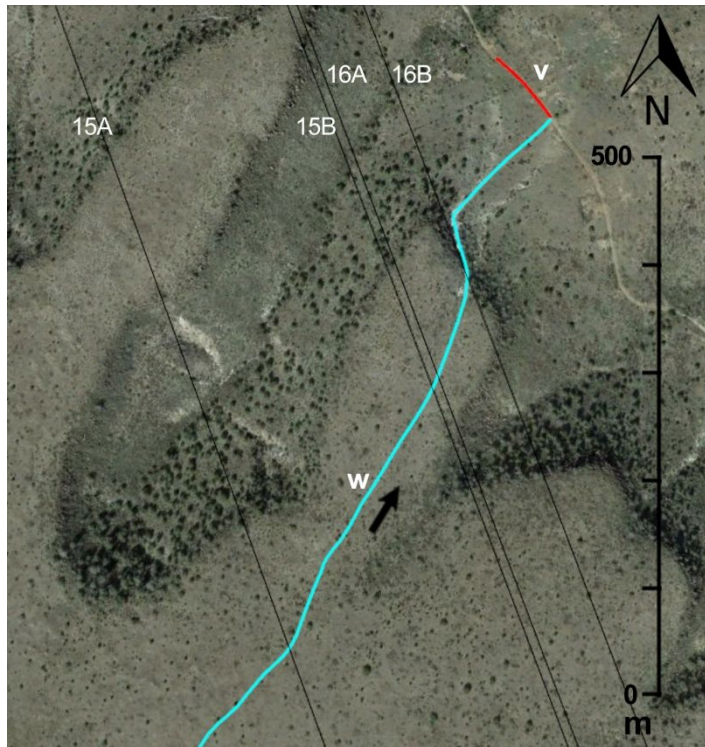


Figure 73. Photos #15 and #16 (ML3a/b), May 8, 2004, after 9:04pm, Mitchell Flat, Marfa (Texas). Map of the area of interest, the northeast side of Whirlwind Mesa. (Image: Google, Landsat/Copernicus.)

Logically, one would expect the luminous stroke in the next image of the series (photo #17—see [Figure 74](#)) to have been caused by the same vehicle continuing its way farther northward. However, the interpretation of the followed route becomes more complex (see [Figure 75](#), [Figure 76](#), and [Figure 77](#) below) as there are more stretches of road as possible candidates. Not to forget the possibility of looming distortion that may have elevated the luminous trails.



[Figure 74](#). Photo #17 (ML3c), May 8, 2004, after 9:04pm, Mitchell Flat, Marfa (Texas). Uncropped picture. The rainbow-like pattern is the spectrum of the ML, obtained by using a Mylar diffraction grating insert between the telescopic lens and the camera. © James Bunnell.

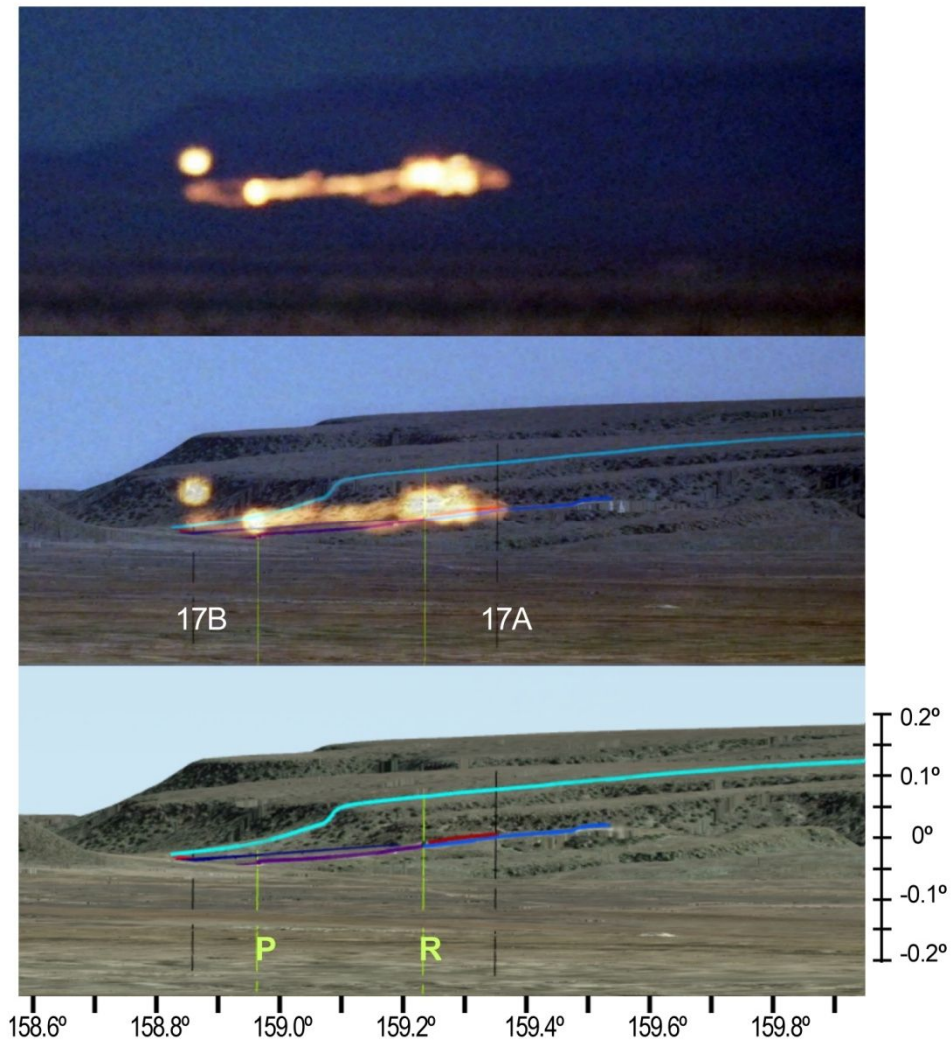


Figure 75. Photo #17 (ML3c), May 8, 2004, after 9:04pm, Mitchell Flat near Whirlwind Mesa, Marfa (Texas). Correlation between visible local roads and luminous tracks.
 Top: close-up of Bunnell's photograph.
 Bottom: Google Earth image. (Image: Google, Landsat/Copernicus.)
 Center: combined image, as a comparison.
 Lines 17A and 17B point to the extreme positions of the pictured luminous track. **P** and **R** mark the location of two stretches of road that point toward the camera at the Viewing Center.
 Horizontal scale at the bottom of the figure: true north azimuths.

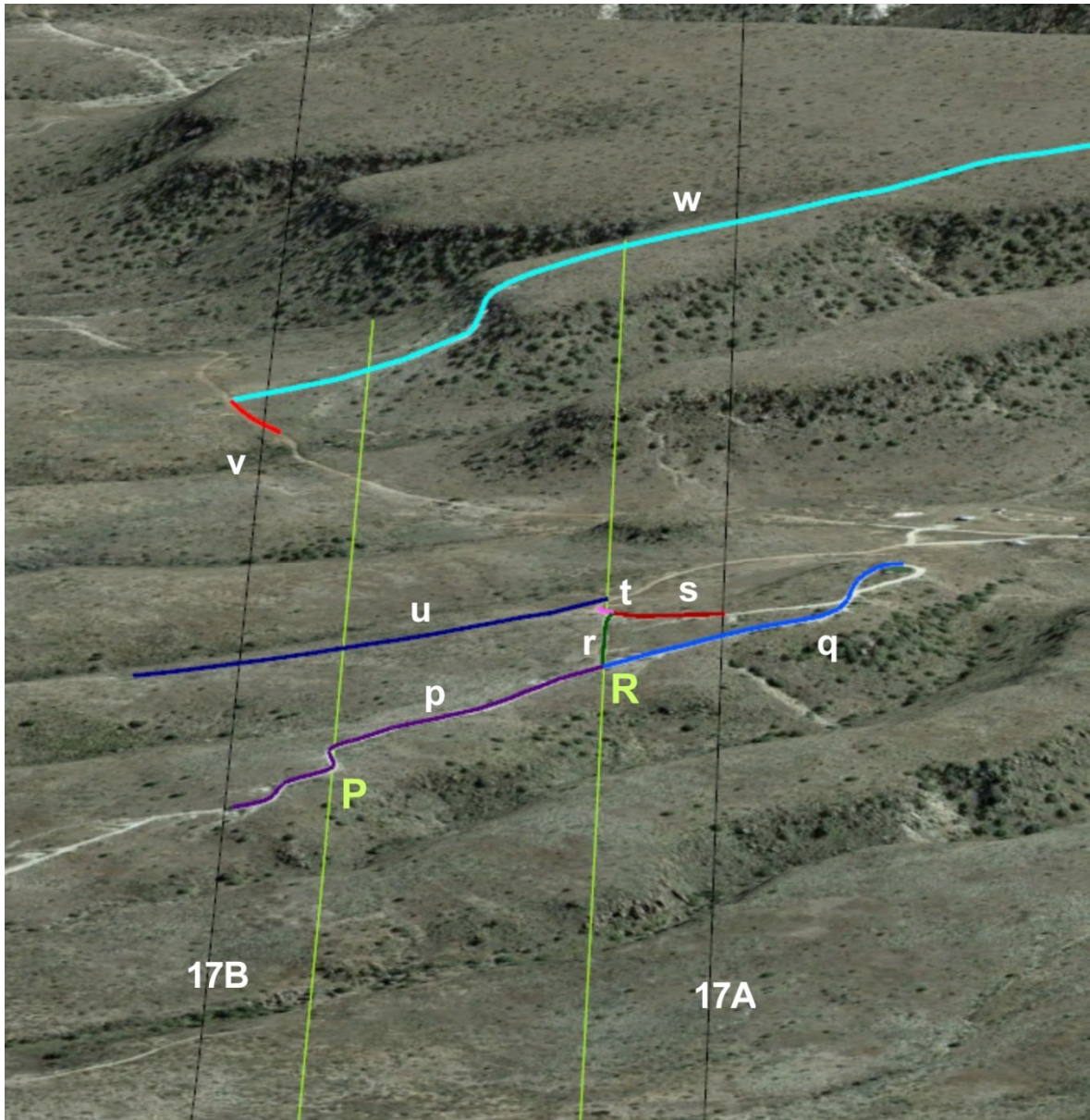


Figure 76. Photo #17 (ML3c), May 8, 2004, after 9:04pm, southeast of Mitchell Flat, near Whirlwind Mesa, Marfa (Texas). Simulated bird's-eye view of the area of interest, showing the dirt roads visible from the Viewing Center. Note that the headlights of an approaching vehicle would move to the left in the blue/violet stretches of road, and to the right in the others, with two exceptions in the lower area at directions **R** and **P**, where there are stretches of road pointing toward the Viewing Center (**r** and the central turn on **p**). (Image: Google, Landsat/Copernicus.)

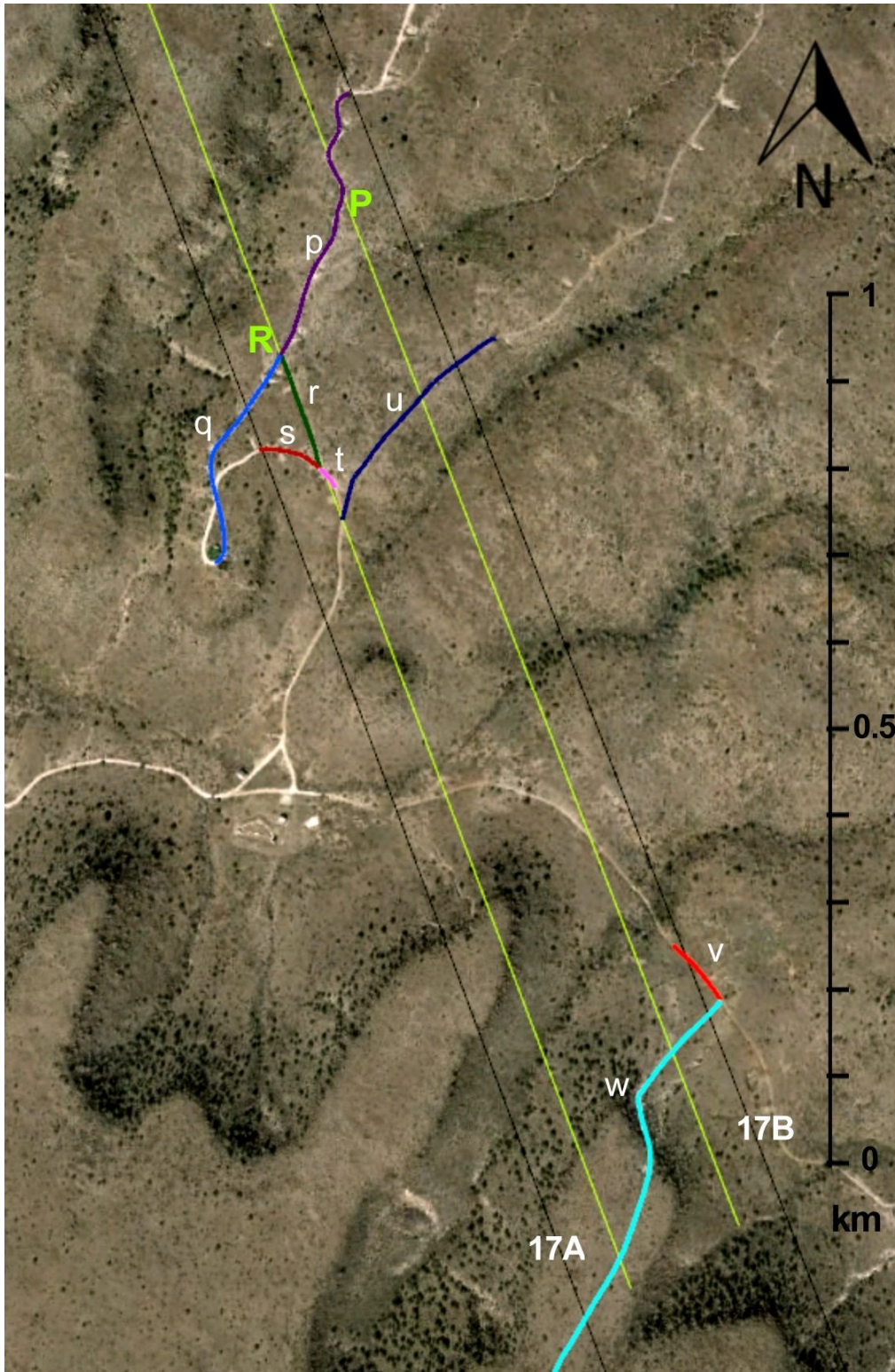


Figure 77. Photo #17 (ML3c), May 8, 2004, after 9:04pm, southeast of Mitchell Flat, near Whirlwind Mesa, Marfa (Texas). Map of the area of interest. See caption of **Figure 75**. (Image: Google, Landsat/Copernicus.)

In order to facilitate the discussion, we have highlighted in [Figure 76](#), [Figure 77](#), and [Figure 78](#) the road sections visible from the Viewing Center (these are labeled with a lowercase letter). A conservative criterion has been used, not to exclude from this selection the road sections standing at the limit of the geometric visibility, those which could be visible provided looming conditions existed.

Let us analyze now what was the section really travelled by the light in photo #17. Firstly, we will consider the luminous track between directions R and 17B. Road section **w** is immediately discarded as it relates to the two pictures previously taken. The dilemma that arises concerns sections **u** and **p**: considering the increase in brightness observed in directions P and R, the obvious choice would be the **p** section of the road. As is evident from [Figure 77](#), the alignment of road section **r** with the Viewing Center would explain the bright spot in direction R. Similarly, there is a change of direction in the **p** section that would justify the bright spot on the light trace in the P direction. Headlights from a vehicle driving on road section **u** cannot explain the increased brightness observed in the above-mentioned directions.

If the greater part of the ML3c luminous track was caused by a vehicle traveling along road section **p**, the rest of the track remains to be explained, namely the part between 17A and R. In this case, a dilemma arises between road sections **q** and **s** (see [Figure 77](#)). Below, we will examine both possibilities and their implications.

Possibility 1) The vehicle in question first drove by road sections **t**, **s**, and the non-visible section of the road loop, then traveled by section **q**. If this is what happened, photo #17's exposure would have commenced when the vehicle had already traveled half of road section **q** and reached direction 17A, since no luminous trace appears west of line 17A. This option has a drawback: it does not explain the brightening observed in the R direction. On one hand, crossing through **r** is not included in this route; on the other hand, any crossing through **t** and **s** (which might also explain such luminosity increase) would not have been captured in the photograph, as the time exposure started later, when the vehicle was already at the intersection of road section **q** with direction 17A, as we have just pointed out.

Possibility 2) The vehicle drove by road section **s**, but not by section **q**, linking with **p** through **r**. At first sight it might seem an impossible combination, but there is a way out. As [Figure 78](#) shows, the driver of the vehicle could have missed the detour where section **r** begins (just after section **t**), going through section **s** before realizing the error. To retrace his steps, he could have traversed back just about 75m through section **s**, to deviate later by section **r** and continue his way through road section **p**. If the correction maneuver were carried out backwards, the vehicle headlights would have continued pointing in the general direction of the camera, which would explain why the intensification of the photographed luminous trace extends to the right beyond direction R. That is, the headlights would have been recorded twice passing through section **s**, first moving to the right and then to the left, maybe at a lower speed if the vehicle was moving in reverse (incidentally, a

lower speed would contribute to a higher intensity of the luminous track in the photograph). In short, this option is not as far-fetched as it might appear at first sight and, in fact, may well turn out to be the most likely solution.

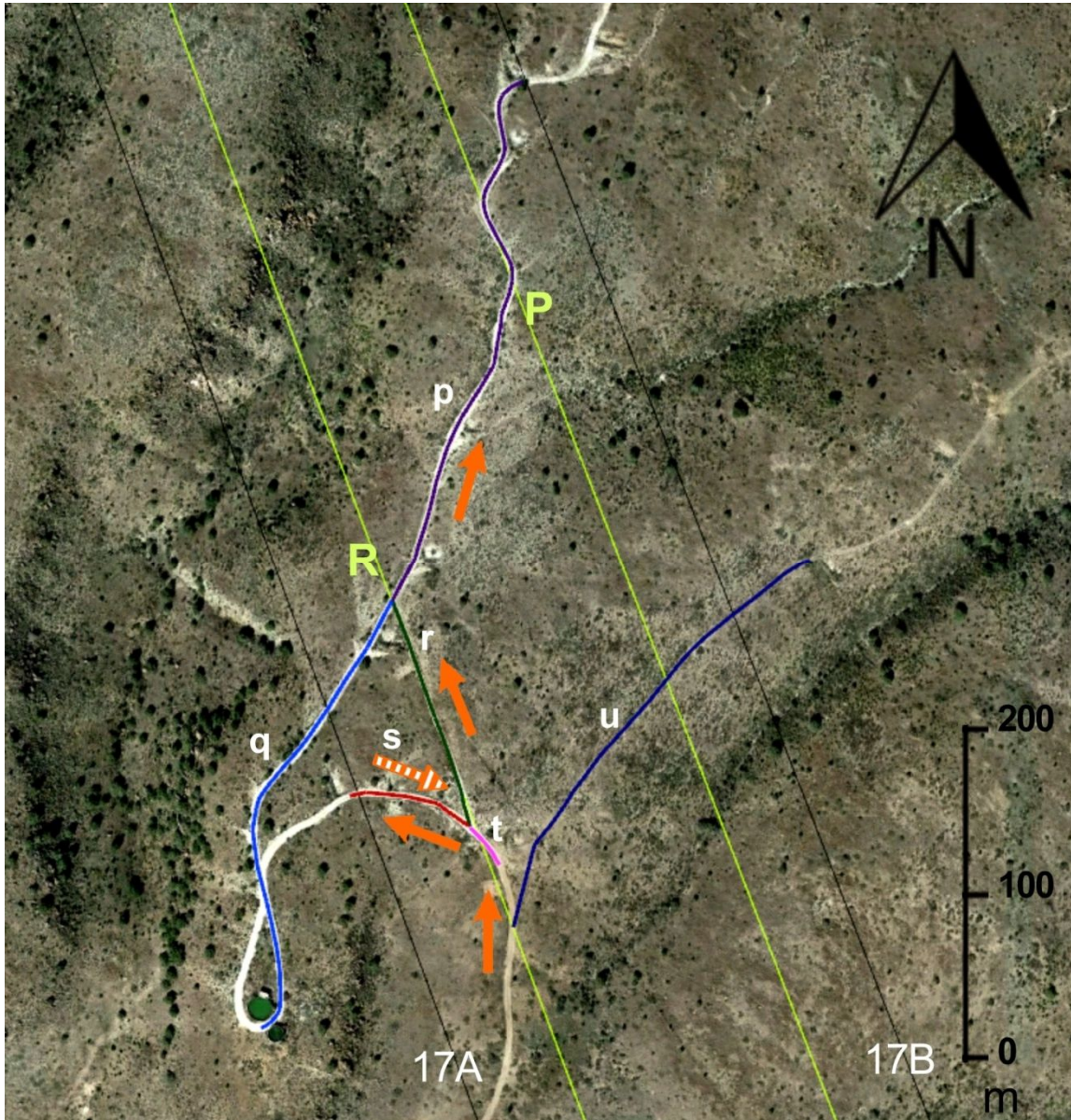


Figure 78. Photo #17 (ML3c), May 8, 2004, after 9:04pm, southeast of Mitchell Flat, near Whirlwind Mesa, Marfa (Texas). Map of the area of interest showing the travel direction of a hypothetical vehicle, including a possible reversing maneuver on stretch of road **s**. (Image: Google, Landsat/Copernicus.)

In order to finish the analysis of photo #17 we must check the origin of the round blob that can be seen on the left side of the luminous rod, above it. As **Figure 75** shows, this light blob is farther from the local road sections than any other point of the light trail. However, a deviation in elevation of only 0.07° with respect to the apparent position of the visible roads in direction 17B is within what could be

expected if there had been a looming effect. According to [Figure 77](#), the circular light blob could be related to one of the following road sections: **w**, **v**, **u**, or **p**. The alignment of sections **w**, **u** and **p** departs much from the camera direction (line 17B). Following this criterion, road section **v** seems to be the best candidate.

The obvious question is why the raising caused by atmospheric refraction was stronger at this point in comparison to other points along the luminous trail. There are two possible answers, and both can be applicable simultaneously. If there was only one vehicle, each point of the luminous trace corresponds to a different instant of time. Thus, it is not impossible that the atmospheric conditions were slightly different when the vehicle was on road section **v**. On the other hand, the curvature of the light rays due to refraction may also have differed for rays coming from different places. Note in this regard that section **v** is about 700m farther from the Viewing Center than the other road sections involved.

In summary, the interpretation of the luminous shapes in photo #17 is complicated and there are details still to be clarified, but the previous discussion about the main features of the imaged trails should not make us lose sight of the general context that clearly points to the lights of a road vehicle.

In his book, Bunnell rejects the vehicle headlights explanation, on the grounds that ML3 (photos #15, #16 and #17) was located far from the background mesas and, therefore, it was flying above local terrain. His conclusion is based “on *Roofus* data and direction from the View Park.” Unfortunately, we cannot attach any reliability to triangulations pairing data from a video camera that had an uncontrolled clock with data from photographs that lack time information. Besides, it has been confirmed that there are errors in Bunnell’s azimuth data from the Viewing Center. On top of that, reasons were found to believe that the estimated azimuths from the *Roofus* station could also be wrong.

The map in the following [Figure 79](#) compares the ML3 positions as indicated by Bunnell in map 8 of his book (red stars on our map) with the positions that we have deduced, and which were all found to be confined to a circa 2km wide area much farther away from the Viewing Center (orange circle in [Figure 79](#)). In fact, differences concern not only azimuth, but also distance. Actual distances to the camera would range from 28.7 to 30.2km instead of 19.7 to 22.3km.

Finally, it is worth noting that (uncalibrated) spectra were obtained in photos #15, #16 and #17 by using a Mylar diffraction grating insert between the telescopic lens and the camera (for unknown reasons, no spectrum appeared in photo #14). These show continuous spectra interpreted to indicate “chemical combustion processes” (Bunnell’s book, p. 101), rather than plasma.

The reader will not be surprised to know that the spectra obtained do not contradict the vehicle hypothesis. Like any incandescent light bulb, halogen lamps—the most common head lamp to be found on cars in 2003 and 2004—produce a continuous spectrum of light, from near ultraviolet to deep into the infrared.

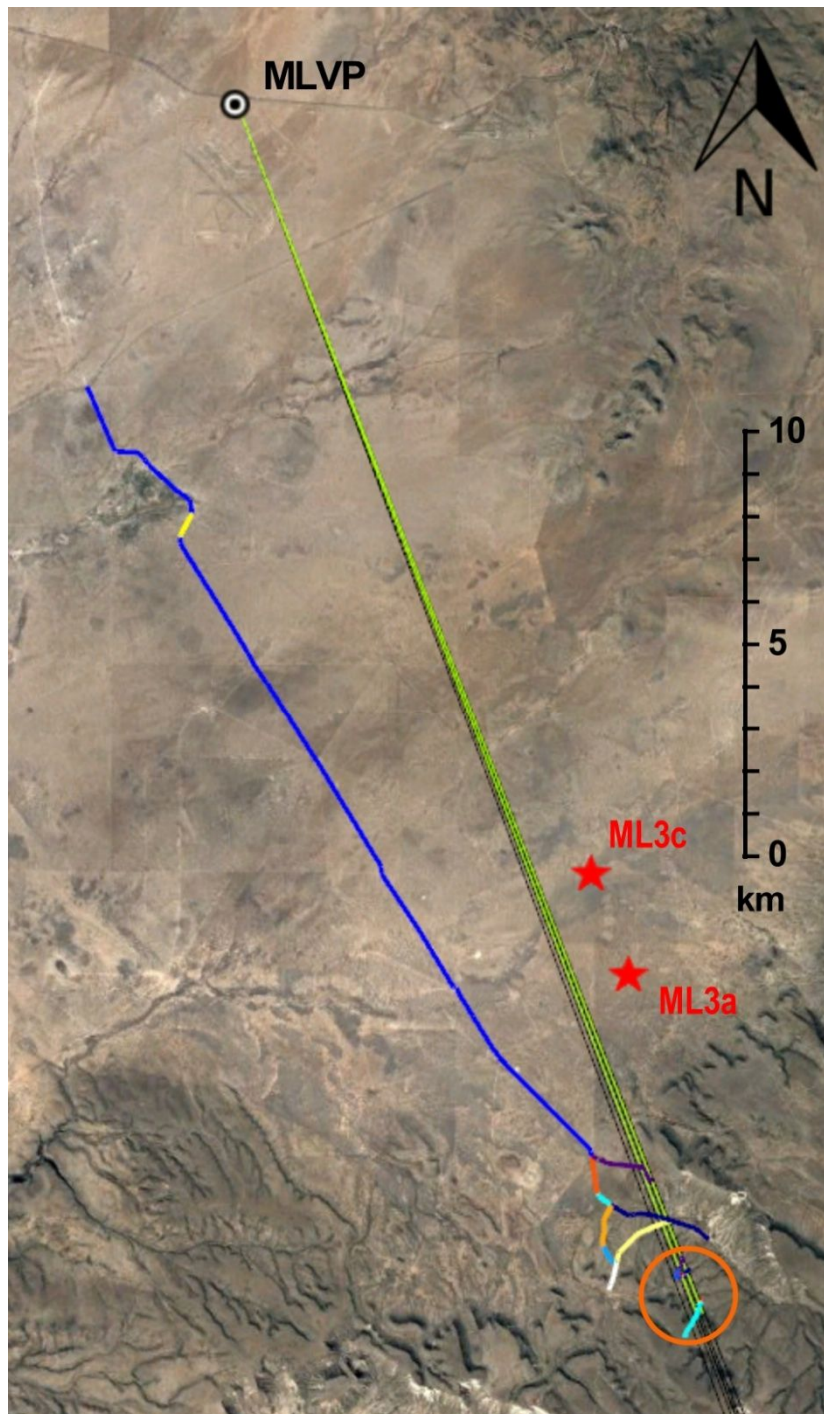


Figure 79. Events of May 8, 2004, Mitchell Flat, Marfa (Texas). Map of the area. (Image: Google, Landsat/Copernicus.) Viewing direction and angular span of the luminous tracks in photos #15, #16 and #17 (ML3a/b/c). The red stars indicate the starting and end points of ML3 according to Map 8 in Bunnell's book. These estimated locations would be grossly misplaced (actual locations inside the orange circle, near Whirlwind Mesa).

CONCLUSIONS

A word on “classic” Marfa Lights

That night we drove east of town on U.S. 67 to see the Marfa Mystery Lights. Against the shadowed outline of the Chinati Mountains, odd yellow and white lights darted about, merging and dividing, disappearing, then reappearing seconds later in a different spot. They seemed to be dancing, which added to the air of enchantment. There have been numerous explanations—gas from petroleum deposits, optical illusions, electrical discharges from crystal formations—the most plausible being that they are reflected lights from the highway. James Dean was reportedly so fascinated by them that he bought a telescope. Your perception of what is real or at least normal get tested.

Lawrence Wright, God Saves Texas, Penguin Random House, 2019.

Before reading these Conclusions, we invite the reader to return to the Introduction, where we pointed out some key aspects such as the irrelevance of the “founding” observation of Ellison, in 1883.

We also highlighted the fact that the more conspicuous Marfa lights, those visible for many decades to the SW from the Viewing Center located near the WWII Army Airfield, have been satisfactorily explained as headlights¹³ of vehicles approaching the city on US Route 67 (the old Presidio-Marfa road).

As we indicated, this explanation has been “rediscovered” again and again through time in successive studies of unequal quality. We also noted that some of these studies included, however, spurious conclusions about essential ingredients of the explanation that in fact do not play the central role assigned to them, such as the effect of atmospheric refraction (Note 34) or the reflection of the lights on the ground (Note 39).

We will make here our own contribution in this regard by comparing actual time exposures—objective pieces of evidence devoid of any observer's interpretation—to simulated images obtained using Google Earth, a powerful tool that is at the base of all the analyses made in this work. The concordance of the photographed lights with the simulation of vehicle headlamps tracks is so good (see Figure 80) that it confirms once again the explanation in question. It also makes it clear, in case it was still necessary to prove it, that what you see is what you get. In other words, there is no need to involve major atmospheric distortions, nor are novel, physical mechanisms required so that the lights of the Hwy 67 vehicles are directly visible from the MLVC.

There are countless time exposures of these “classic” MLs. For example, the Kirby Warnock picture in the cover of the aforementioned *StarDate* bulletin (Note 34) or the photo taken by the students at Lexington High School (Note 38). The picture shown in Figure 81 brings another perspective of these lights, as it was taken from a location some 7 miles south of the MLVC, the usual place from which most photographs are shot. It is a 20-minute time exposure of the Marfa plains that shows, one more time, just how “car headlights crawl along the horizon” (Note 55).

(13) Red tail lights (moving in the opposite direction) cannot be seen with the naked eye but can be photographed, as this interesting time-lapse shows: https://www.youtube.com/watch?v=0kqv_3RQnKc

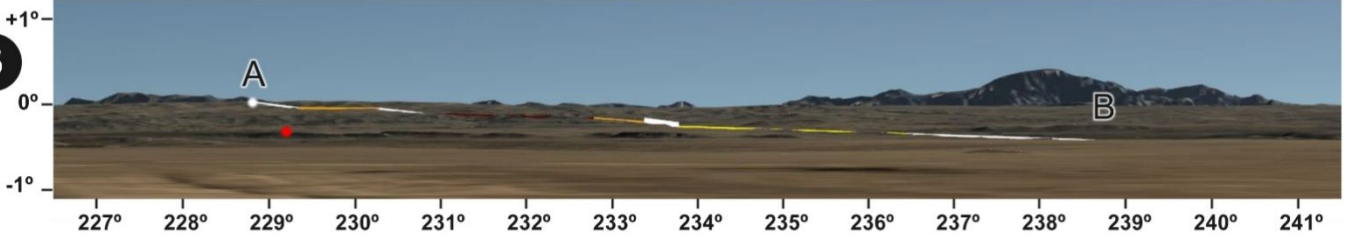
1



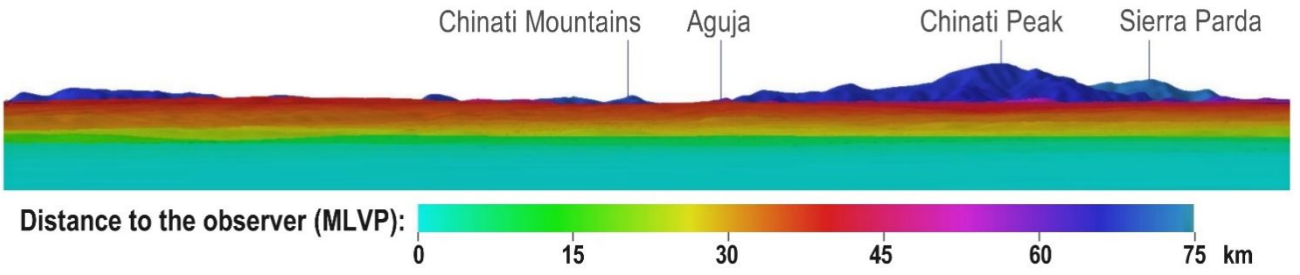
2



3



4



5



6

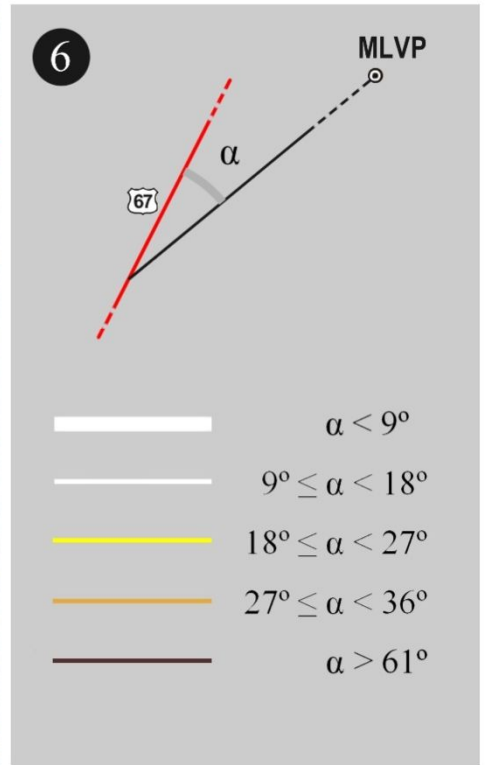


Figure 80. Simulation of the most conspicuous "Marfa lights" (actually, car lights on U.S. Route 67), as seen by visitors at the Marfa Lights Viewing Center (MLVC).

1 & 2: Time-exposure photographs of automobile lights on Highway 67 (image 1 is a composite of two successive exposures). These pictures turn out to be a compendium of the "Marfa lights" observed between the telephone tower's red light (to the southwest) and the Chinati Peak (farther to the north). Almost all available visual materials—from snapshots to video footage—documenting alleged mystery lights in that area, show lights that overlap the luminous tracks in these long-exposures. As a side note, both exposures were taken from the MLVC but not exactly from the same spot, hence the slightly different relative position of the red light.

© James Bunnell (Note 54).

3: Google Earth simulated view of the U.S. Route 67 as seen from the MLVC, with added axes showing the angular elevation and the true azimuth. The route trace is color-coded according to the degree of alignment with the viewing site: the better the alignment with the MLVC, the lighter the line, as specified below (see 6). Headlights of vehicles traveling north to Marfa come into view at point **A**, where the route starts to descend. There, the highway points to the MLVC and the car's lights look brighter. In their apparent course to the right, they appear and disappear many times, depending on the terrain obstacles and the local direction of the route. The lights become no longer visible after reaching point **B**. This simulation is in good agreement with the photographs shown above (1 & 2), although the location of point **B** is only approximate. (Image: Google, Landsat/Copernicus.)

4: View of the same area with the terrain colored according to the distance to the viewing site (MLVC). The more distant regions are represented by fading blue hues, as shown in the accompanying color scale. © Ulrich Deuschle, 2019, www.udeutschle.de

5: Map of the region of interest including the color-coded route section between points **A** and **B**, from the simulated view above (3). (Image: Google, Landsat/Copernicus.)

6: Reference for the color-coded route section displayed in the panorama (3) and map (5) above. $\alpha = 0^\circ$ would correspond to a perfect alignment of the road with the Viewing Center (MLVC).



Figure 81. Long-exposure picture of car lights on U.S. Route 67 taken from a location some 7 miles south of the MLVC. Because of the different perspective, this view does not match with what we see in most pictures of the local night traffic, since they are usually taken from the Viewing Center area, like the exposures shown in **Figure 80**. Note that the red light of the telephone tower appears here at the right of the Chinati Peak. © Ansen Seale.

Summary of results

As we also indicated in the Introduction, the present work centers on the allegedly inexplicable lights observed and photographed in other directions, i.e., those which could in principle have an anomalistic origin, and therefore be of interest.

Photographs reviewed

The choice of the material to be examined was clear from the very beginning: we have concentrated on the photographic material obtained by James Bunnell. His long-term *in situ* study, even with all its limitations and pitfalls, constitutes the most comprehensive and systematic research effort undertaken in relation to the Marfa Lights. Incidentally, it is worth noting that “the first gigantic *jet* ever recorded over continental North America” was filmed by two of his unmanned video cameras on May 13, 2005 (Note 56).

Specifically, we have examined what Bunnell considers the best image examples he has been able to document, presented in his latest book—*Strange Lights in West Texas*—for the years 2003-2007, focusing our analytical work on the period 2003-2004, as it overlaps the FOTOCAT Project’s photographic catalog, ending 2005 (Note 47). This was not the optimum period for Bunnell as far as output quality is concerned. He still used cameras loaded with 35mm film, only one of his unmanned video cameras was operating (*Roofus*) and he still lacked experience in some regards. However, Bunnell not only gives full validity to the examples of this period but also considers some of these photos as the best ones that he has accomplished of the real thing.

In short, our examination has covered a total of 17 photos, corresponding to events that occurred on four different dates: February 19, May 7 and May 8, 2003, and May 8, 2004. Three of the pictures taken on May 8, 2003 (really relevant ones, as we will show) were not reproduced in the book. All the photos analyzed were obtained in a narrow time frame of about two hours (that is, between 20:20 and 22:33, according to Bunnell’s data). All were shot from the Viewing Center (MLVC), mostly from the SW Plaque located in the southwestern part of the premises.¹⁴ Most of the lights that appear in the Bunnell’s ML photos studied were located in directions between SSE and S. One reached up to the SSW.

In the set of 17 photos, 4 bear no details of the landscape or the sky that allow checking the claimed information. On those occasions we have only been able to raise some possibilities of explanation, without the possibility of a sound verification. Even so, the similarity with the rest of the reviewed and solved material is clear enough, and there is no reason to think they are an exception (i.e., have a different nature). For example, the three photos of the February 19, 2003 event. A fourth photograph in the insufficient information category is photo #14, the first one of the May 8, 2004 case.

(14) Exceptions are photo #14 (taken from the picnic area to the east of the MLVC) and photos #15-17 (taken from the end of the viewing platform of the MLVC).

Conclusive evidence for the vehicle explanation

Time exposures of vehicle lights on Highway 67 (see, for example, [Figure 80](#) & [Figure 81](#)) show images extremely analogous to some of the Bunnell's shots. The appearance of the phenomenon is not dissimilar to automobile lights. On the other hand, as it has been remarked sometimes, the area "is littered with trails, paths, and dirt roads...there are countless locations where people can be with their cars, and their headlights" ([Note 57](#)).

After a thorough study of all the selected photos, we have concluded that they show vehicle headlights traveling on Nopal/Escondido Road—which crosses Mitchell Flat—as well as on other local dirt roads farther south—those located in the Escondido Ranch area and the mesas that border Mitchell Flat. The distance to the moving vehicles would vary between ~8km (photo #13) and ~30km (photo #15). As for the number of vehicles involved, the first photo of each of the two cases of May 2003 would show a vehicle apparently unrelated to the later activity carried out farther north. On the other hand, photo #7 and possibly #8 on May 7, 2003, recorded the passage of two different vehicles on Nopal Road.

Our conclusion is based on the sheer coincidence of the light tracks in the photography, with the position of a number of local roads (named above), under simulated analysis through the Google Earth program. Additionally, there are added circumstances that reinforce our explanatory model beyond any reasonable doubt. On the one hand, the resulting overall coherence of the model. It is not simply a mass of random coincidences. On the other, there is a whole series of peculiarities that make full sense in the light of the vehicle interpretation (see [Figures 82 to 84](#)).

Namely:

- the "spiral" of photo #5
- the brightest points in photos #5, #8, #12 and #13 (the last two not included in Bunnell's book)
- the gap appearing in photos #6, #10 (this one not included in Bunnell's book) and #11
- the gap appearing in photo #9
- the differences in intensity of separate luminous tracks in photos #6 and #9

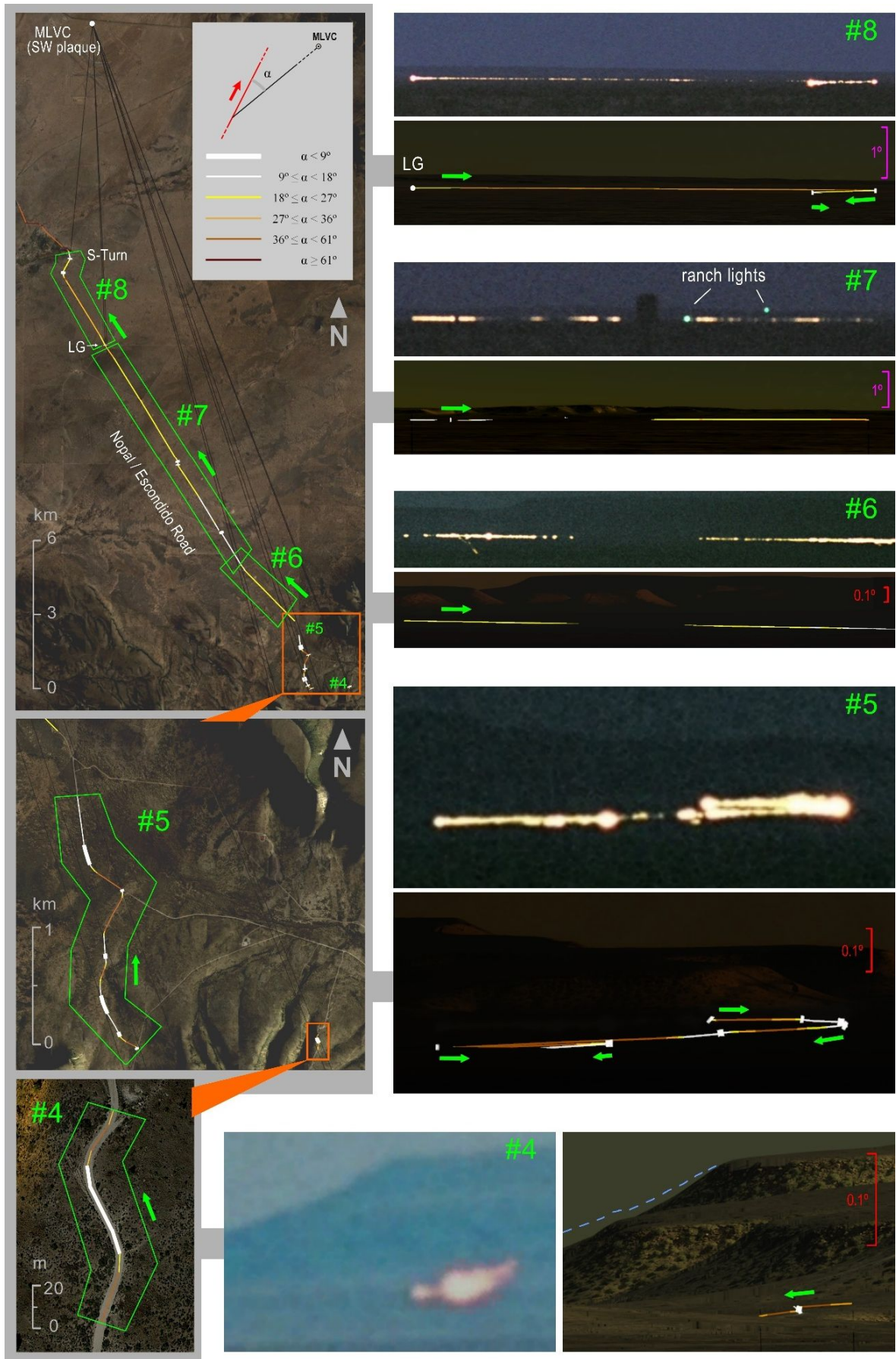


Figure 82.

Figure 82. Photos #4 to #8 explained (events of May 7, 2003).

Right column: a close-up view of each photo is compared with a Google Earth-generated view of the same portion of landscape to show the correlation between the photographed light tracks and some relevant stretches of local roads.

Left column: explanatory maps.

(Photos: © James Bunnell. Simulated views and maps: Google, Landsat/Copernicus.)

As in **Figure 80**, a color-coded representation of the roads has been used to visualize their degree of alignment with the camera (the better the alignment, the lighter the line, as specified in the gray insert). As expected, most of the brighter spots in the light tracks turn out to match the points of the road in which a vehicle's headlights would practically point at the camera.

Green arrows indicate the vehicle's traveling direction on the maps and the equivalent apparent movement of the lights in the simulated views.

Notes:

- A bright spot has been added to the simulated view of photo #8 at the place of the locked gate (labeled "LG") assuming that the involved vehicle stopped there for some time, lights on.
- Light tracks are more elevated than the corresponding road paths in all these examples due to atmospheric refraction. The same effect is exhibited in the mesa profile in photo #4: the blue dashed line in the image at the lower right corner marks the photographed background profile, to be compared to the simulated one.
- A height of 1m above the ground has been considered for the headlights' path in all these Google Earth simulations except for photos #4 and #5. In these cases, a height of 2m and 3m, respectively, has been entered to facilitate the view of the left end of the simulated tracks. (The program only allows to enter integer values into the path's altitude field.)
- In photo #6, lines branching off from the main light track would have been caused by some type of camera shake, and the bright spot on the left would reflect a temporary stop of the vehicle, as discussed earlier in this report.

Figure 83. See below. Photos #9 to #13 explained (events of May 8, 2003).

See description of **Figure 82**.

Notes:

- A bright spot has been added to the simulated view of photo #12 at the place of the locked gate (labeled "LG") assuming that the involved vehicle stopped there for some time, lights on.
- The Google Earth-generated view for photos #10 and #11 does not display the rightmost portion of Nopal/Escondido Road but it might become visible under certain atmospheric conditions (not considered in this simulation).
- In photo #9, the peculiar feature at the right end would have been caused by some type of camera shake, as discussed earlier in this report.

Figure 84. See below. Photos #15 to #17 explained (events of May 8, 2004—photo #14 not included because insufficient available information).

See description of **Figure 82**.

Notes (photo #17):

- The section of the road definitely not visible from the MLVC has not been color-coded on the map.
- The final (northernmost) stretch of the road does not show up on the left of this simulated view but it might become visible under certain atmospheric conditions.
- The isolated luminous blob on the left would be related to the initial (southernmost) stretch of road, slightly "raised" because of atmospheric refraction.
- The right-end section of the light track would be related to the road branch marked as "s" on the map (see the report main text for more details).



Figure 83.

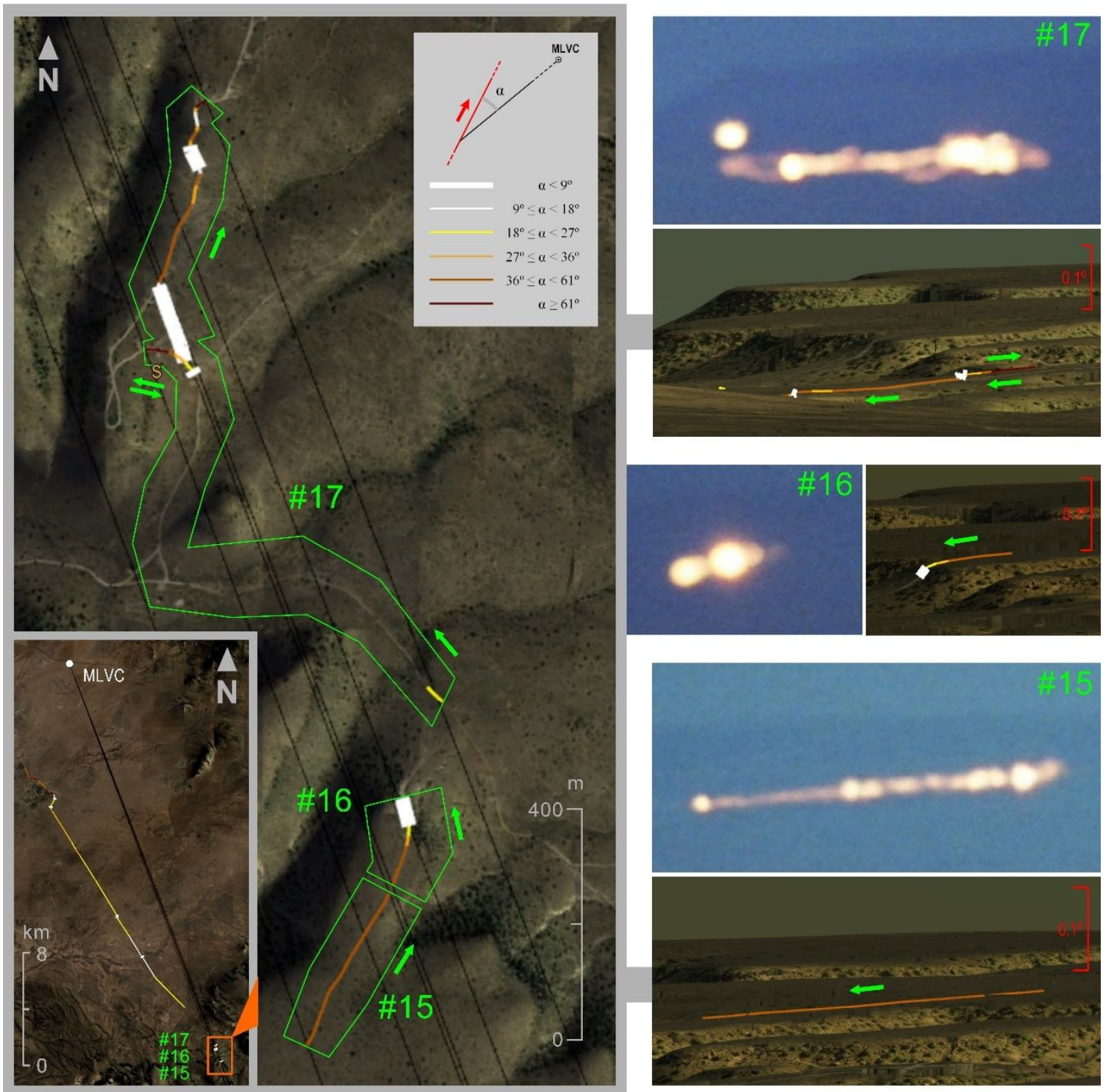


Figure 84.

When this study was finished, we learned of another Bunnell's photograph that includes another of the crucial elements that confirms our explanation that even the rarest Marfa Lights are car headlights. It was a picture made on May 7, 2003, one which we could place after photo #6 and practically overlapping with photo #7.¹⁵ We will call it photo #6A. It shows a tiny gap coinciding with a double curve on Nopal Road (see **Figure 85**). Actually, we can find the same gap in the same day's photo #7, and in next day's photos #10 (directions 10E-10F in **Figure 40**) and #11 (direction 11E in **Figure 46**).

Let us also emphasize that the spectrum of the lights that appear in photos #15, #16 and #17 is a continuous spectrum that, in principle, is compatible with the lighting of a vehicle that uses halogen lamps (quite usual in the period under consideration). The traffic explanation is also compatible with the intriguing absence of ground marks, burns or any other abnormal effects of MLs physical presence.

Alleged counterevidence against the vehicle explanation

Exceptionally, we admit that some details do not embrace a simple interpretation, but neither do they have weight enough to discard the automobile explanation. These are the following features:

- An anomalous bright spot in photo #6 (direction 6B). It does not appear in a similar photo the next day. Does it correspond to a temporary detention of the running vehicle?
- Isolated luminous blob in photo #17. Could it be related to a certain section of road plus a refractive effect?
- For another anomaly in the same photo #17, we have suggested a possible brief path of the vehicle in reverse (perhaps made to correct a route mistake).

(15) <http://nightorb.ipower.com/www.marfalightsresearch.com/7401.html> (image #29 from the slide show).

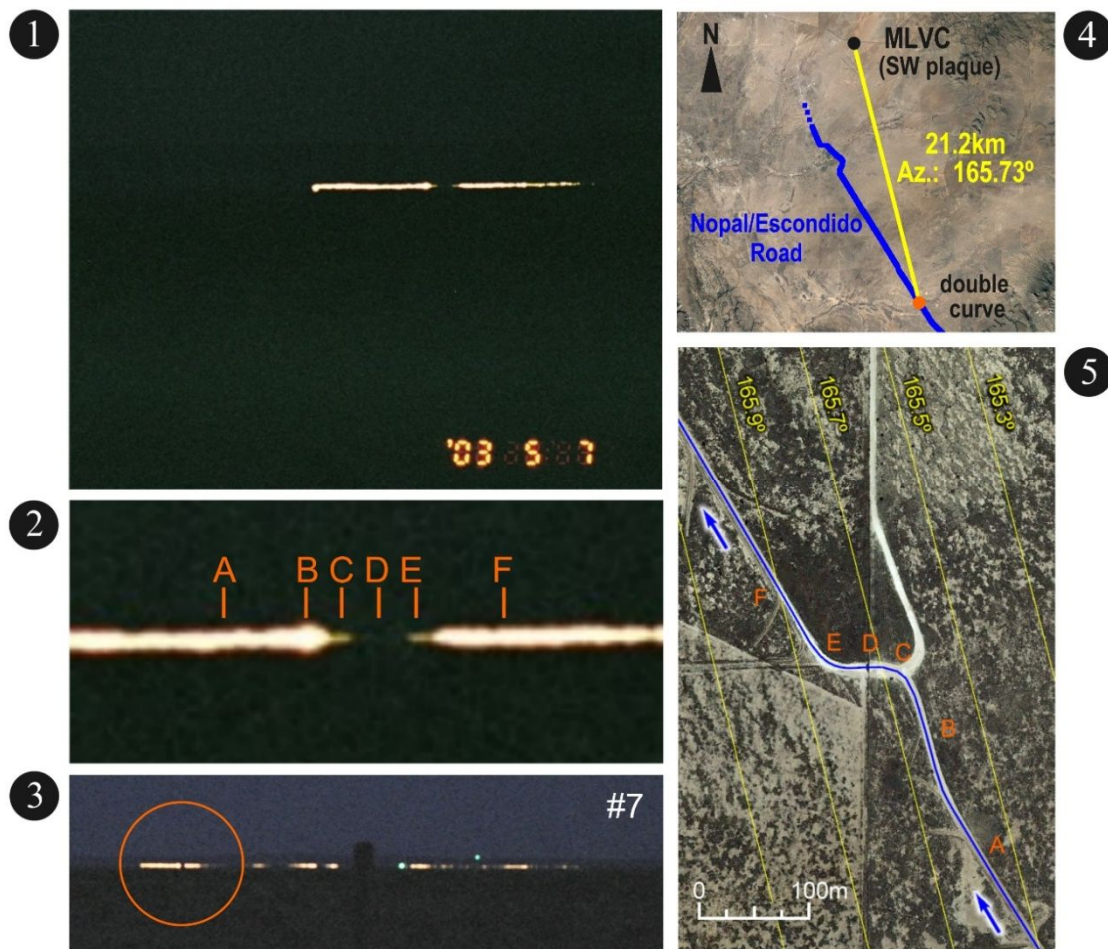


Figure 85. Upper left is another photograph taken during the May 7, 2003 event. It was unknown to us when we numbered and studied the several pictures of that date (namely, photos #4 to #8, of which #7 and #8 were taken with a different camera). It turns out that this time exposure was made after photo #6, with the first camera. It is compared with photo #7—taken with the second camera—which captured the same light trail with a gap, although in a less detailed view (more zoomed-out). We have ascertained that the location of the gap coincides with a double curve on Nopal/Escondido Road. By assuming that the photographed lights were car headlights, it allows us to perfectly explain all the gap features down to the last detail (see below).

1: Cropped image of the "new" May 7, 2003 photograph, photo #6A.

2: Close-up view of photo #6A showing details of the gap.

3: Partial view of photo #7 (circled in orange: the interrupted light trail also appearing in the "new" photo 6A).

(1, 2 & 3 photographs: © James Bunnell.)

4: Map illustrating the location of the double curve photographed from the Viewing Center (MLVC).

5: Close view of the double curve. Yellow lines and numbers indicate (true north) azimuth from the SW plaque at the MLVC, farther north. Orange letters mark different parts of the road that can be closely related to the appearance of the luminous trail. See features marked with the same letters in (2). The road course is very similar before and after the double curve, therefore a vehicle driving along **A** and **F** will leave a similar light trail in the time-exposure. On the stretch of road **B**, the slight change in direction makes car headlights point directly at the camera at the MLVC, hence the noticeable brightening of the light trail, just before the quick fading due to the turn to the left (**C**). With the car following a course almost perpendicular to the direction of view, headlights get virtually out of view around **D** to gradually reappear at **E**, when the vehicle turns to the right.

(4 & 5 images: Google, Landsat/Copernicus.)

In his correspondence with us, Bunnell has pointed out that the lights appearing in the photos we have analyzed in this report show “behaviors inconsistent with vehicles.” The following table lists such supposed “anomalies” with their corresponding photographs, as well as our own interpretation, in the context of the automobile explanation:

ML behavior inconsistent with running vehicles (according to Bunnell)	Photos	Our interpretation
Absence of headlight beams	All	Visibility of headlight beams depends entirely on the presence of dust (and/or mist) in the air ahead of the vehicle. On the other hand, a distant headlight beam is less discernible from the glare of the headlamp. In case the headlight’s direction is close to that of the observer, the foreshortening also makes the beams less noticeable. The two latter considerations also apply to the terrain features illuminated by the headlights.
Absence of taillights	All	Taillights are far less bright than headlights and, especially at great distances, may be barely visible or just not visible at all. Besides, when both car headlights are in sight only one taillight is usually visible, the other one being concealed by the vehicle body. Also, a distant car’s taillight may go unnoticed amidst the glare of the headlights, because of the angular proximity to them. On the other hand, the brighter the headlights appear due to a better alignment to the observer’s line of sight, the less visible become the taillights, which are just pointing to the opposite direction.
Explosive events	#9	Camera motion
Circular or “folded” light tracks	#5, #17	Road layout quirks
Combustive characteristics (photographic evidence “reveals, in exquisite detail, a burning ball of light, clearly inconsistent with vehicle head lamps”)	#1, #2, #3, #14	Entirely subjective appraisal
Decaying (energy decay) and elongation features	#2, #3	Obstruction of lights due to terrain and vegetation, as well as road direction changes
Altitude changes	#9, #17	Just apparent (deduced from wrong data or assumptions)
Ejected material	#6, #9	Camera motion

Bunnell has also indicated as incompatible with the automobile explanation the high estimated speed in the events of May 2003, which we blame on errors in the data he used to calculate it. Considering the corrected data, the resulting speed estimates are within reasonable margins for conventional vehicles.

Errors in the input data

In any analysis of this nature, it is essential, as a preliminary step, to check input data as much as possible. In our work, this has turned out to be of paramount importance: in most cases where the images' spatial and temporal data have been contrasted (with the help of Google Earth and astronomical software), we have discovered errors in the position, time or timing indicated by Bunnell.

For example, as we have pointed out from the very start, the various azimuth errors of key importance found while checking the pictures, derived from erroneous magnetic readings.¹⁶ See text box in the introduction for more details.

Errors were also found in the reported time and exposure length of some of the photos of May 2003, which include useful astronomical information that can be checked. Thus, photos #11, #12 and #13 were obtained with a camera whose clock (as shown by the time stamp) was slow. On the other hand, the exposure time attributed to photos #9 and #11 is shorter than the real one and, in general, we have found inconsistencies in the timing of the different phases of the events of May 2003. We suspect that the latter is due to an incorrect synchronization of the photographic record obtained from the MLVC with the video recording from the *Roofus* automated station. In fact, Bunnell confirmed to us that the *Roofus* camera clock was "uncontrolled and found to drift." We have to recall that for all sightings of 2003-2004, no images from *Roofus* have survived for inspection and checking.

The consequences of these time and timing errors are not limited to the temporal sphere. It should be noted that when trying to triangulate the position of the lights from the two series of images, that is, those in the photos and the *Roofus* video (by then available to Bunnell), an incorrect synchronization of both series of images would have led to an erroneous calculation of the position of the lights (see **Figure 86**). Hence, the positions Bunnell estimated by triangulation for these May 2003 cases cannot be considered reliable.¹⁷ Not only in terms of azimuth and distance, but also in terms of the height from the ground he occasionally deduced.

(16) In addition to the azimuth errors already found, more erroneous azimuths for the same mesas' landmarks have been identified:
<http://nightorb.ipower.com/www.marfallightsresearch.com/7301.html> (image #12 from the slide show).

(17) In fact, up to three different sets of triangulated coordinates were furnished by Bunnell for the sightings under examination. It occurred, he states, "because they were not adjusted for timing issues...one significant source of error was time. If you are trying to calculate intersections using video, getting the right frame is critical. My video recorders have clocks and overlay time data, but I found that these uncontrolled clocks drifted. *Starting in late 2005* [our emphasis], I began pulling time data from satellites..." The cases we reviewed are from 2003 and 2004. So, the author admits that there have existed "time-induced positional errors (best guess)."

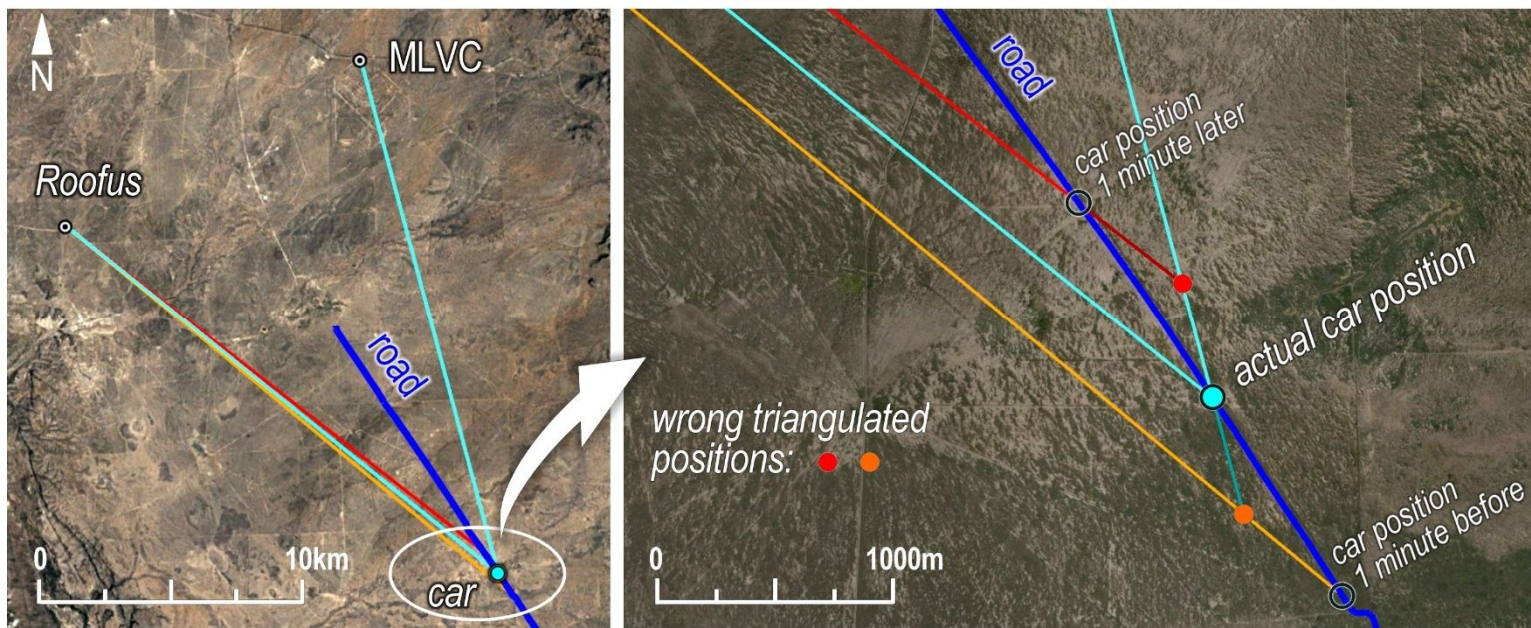


Figure 86. Example illustrating the effect of the time mismatch on the estimated position of a light (i.e., car or any other vehicle) calculated by triangulation. At the left, general scheme. At the right, close-up detail. This method involves plotting the azimuth lines to the light source (car or other vehicle) from both the location of the photographic camera at the MLVC and the video camera at the *Roofus* station (light blue lines). The point of intersection of the two lines determines the car position (light blue spot). Note that for a car in motion the result will be correct as long as the azimuths correspond to the same instant. In the detailed image, the azimuth line from the MLVC has also been paired with *Roofus* azimuth lines pointing to the car position one minute before/after (orange/red lines). The intersection of the lines in those cases gives wrong estimated positions (orange/red spots) that even lie off the road. In this example, a car speed of 60km/h has been assumed.

In practice, we should expect even greater errors due to both inaccurate azimuths and time issues also affecting the photographic data, not only the data from the camera *Roofus* like in this example. After all, without a methodical timing, how can one tell the precise time at which a moving light was at a particular position from the light track captured in a several-minute long exposure? (Images: Google, Landsat/Copernicus.)

So far, we have just listed the errors that can be verified directly, without taking anything for granted. Regardless of the above, if our automobile explanation is correct there must necessarily be additional problems in the deduced directions of the lights filmed on video (azimuths from the position of the *Roofus* station). In the present research report, we have set out just an approximation to the real problem, since the original videos obtained through the *Roofus* camera at the time are no longer available for examination.

Moreover, if the explanation we offer is the correct one, it would also imply that, in certain cases, the complementary information provided by Bunnell would be the result of his personal, *a posteriori* interpretation of what was captured in the images, not a direct observation at the time of the event. We have already had the opportunity to discuss a good example of this situation in relation to photo #9, by seriously questioning the reported motion direction of the light and the very

existence of a final “explosive event.” There is no reason to doubt Bunnell's honesty. It is simply to recognize that there is information that can be affected by human error and/or subjective interpretation and, therefore, may not be reliable. In order to get around the problem in the analysis, we have stuck to the facts as far as possible, by strictly relying on objective information derived from the photographs.

Vehicle lights misidentified: a discussion of the causes

It is abundantly clear that there were errors in the data used by Bunnell concerning the photographs: incorrect azimuths and erroneous temporal data. Those, together with probable similar problems in the data derived from the *Roofus* video footage, led Bunnell to mistakenly place the lights at wrong (triangulated) coordinates in his own study, away from the roads, and hence to dismiss the possibility of vehicle lights.

But how did he come to think that he had observed “authentic” MLs in the first place? Why did he mistake car lights for genuine mystery lights? What did go wrong with the precautions and protocols to rule out conventional lights? Were the car headlights unrecognizable due to unusual exceptional weather factors?

We cannot dismiss the statement by Bunnell himself recognizing that “two major obstacles hindered this investigation: (a) infrequency of occurrence of the lights and (b) the need to discriminate between man-made and naturally occurring light sources.” In particular, he writes: *The most difficult aspect of identifying man-made lights is being able to recognize and exclude vehicle lights within Mitchell Flat because this region has many unpaved roads* (Note 58).

No wonder then that any in-force protocols for identifying “genuine” MLs would focus on “excluding vehicle lights”. Basically, lights originating at or stopping at a known ranch house, appearing at a road entry point, or pausing at the location of a ranch gate, as well as lights kicking up dust or projecting a light beam, were assumed to be vehicle headlights. Lights to be considered as MLs had to exhibit one or more “typical movement patterns,” including “pulsing, on-off sequences, step changes in brightness, and/or splitting and merging.” Also, examples of “on-site observations [revealing] yellow-orange or reddish color and/or sudden changes from yellow-orange to bright red.”

Nevertheless, Bunnell concludes: *However, none of these characteristics alone are [sic] sufficient to assure that the light is an ML until all contextual factors have been considered. Both MLs and vehicle lights may exhibit one or two of these characteristics. For example, car lights on Highway 67 may appear to be merging and/or splitting, a “mystery” created when an observer sees two or more cars following a curved roadway. Context provides the distinguishing information.*

Having said that, we have found out, to our surprise, clear indications that should have allowed Bunnell to recognize car activity during the May 2003 events. These

indications are related to two special features of Nopal Road, namely the locked gate and the S-Turn, widely mentioned throughout this work and perfectly known by Bunnell. At this point, the question of what did go wrong remains in the air.

We have wondered if there were atmospheric effects that could have made car lights unrecognizable. Well, we have not spotted any mirage (e.g., multiple images) affecting the photographed lights, despite having unequivocally detected one distorting the contiguous landscape in photo #10.¹⁸ However, the comparisons made have revealed the effect of atmospheric refraction raising the apparent position of the light trails, when located very close to the horizon. We have referred to this important optical effect—never mentioned by Bunnell in his book—as “looming.” The effect is more noticeable in the photography of more distant lights, which are the photos with more zooming and, therefore, with less field of view (<7°, horizontally, in the photos analyzed here). For example, see photos #5, #6, #9, #10 and probably #4. This effect is not apparent in photos #15 and #16, be it due to different atmospheric conditions or to the fact that the lights were slightly higher than in other cases and were affected differently. In any case, these are very small deviations, of the order of 0.1° (0.2° in the worst case), difficult to discern in photos with less zooming, as in photos #7, #8, #11, #12 and #13 (whose horizontal field of view is greater than or equal to 25°).

Therefore, although the *appearance* of the lights analyzed here does not seem dramatically distorted by the atmosphere to the point of being able to confuse the observer, we still might consider another source of confusion, this time related to the lights' position. A strong "looming" effect raising the apparent position of vehicle headlights could make them visible in stretches of road normally hidden by the terrain. Thus, they could confound an observer *familiar* with the local visible roads, even if the lights maintained the appearance of plain distant vehicle headlights.¹⁹

Truth be told, Bunnell does not seem to have been able to identify some automobile lights after the fact, despite having at least one clear photographic counterexample for comparison. On November 20, 2002, he took some time-exposure photographs of an unknown light visible in an area where automobile lights on Nopal Road do not normally show up (Note 59). In order to find out if it might have been only a pickup, he sent a vehicle down the road and back with high beam lights on, obtaining a time exposure of the return trip. Bunnell found “clear differences” between the pictures of the unknown light and that of the known vehicle. The former did not show “any of the telltale red brake lights that are expected where vehicles cross cattle guards and deep ravines,” nor did they show

(18) Actually, Bunnell would have probably recognized the mirage effects with ease. In his last book, he states he observed from time to time the appearance of "vertical elongation" and/or "stacking" of local lights, indicative of temperature-inversion mirage conditions.

(19) In fact, when dealing with the May 8, 2003 event, we have already pointed out that the ML observed by Kerr Mitchell from his ranch must have been vehicle lights on Nopal Road, even if vehicle traffic on that road was normally below his horizon (concealed by the terrain).

“red tail lights embedded in the (...) light track.” He also noted that the unknown light tracks continued “through regions where vehicle lights drop out of sight because of low spots in the roadway.” We have already addressed some of these problems. Nevertheless, Bunnell overlooked (or disregarded) that the distinctive signature of the S-turn was also present—at the right place—in photos of the unknown light. We consider that this is a conclusive proof of vehicle lights. The same luminous signature can be found, for example, in photo #8 of the May 7, 2003 event (see [Figure 87](#)).

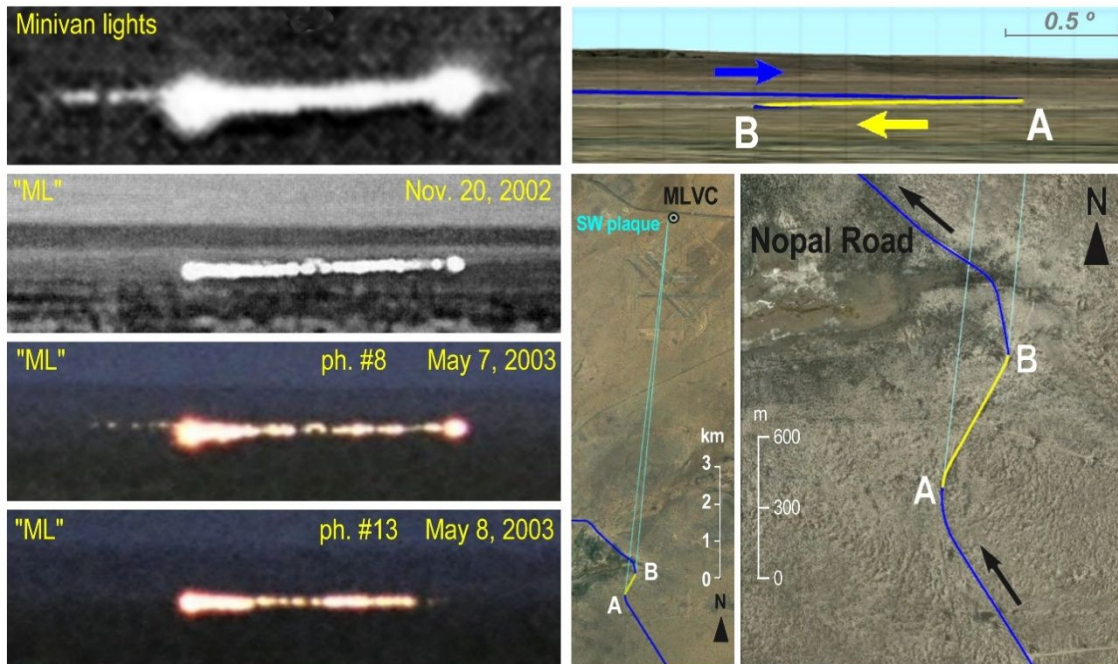


Figure 87. Left: Comparison of the light track of a minivan with those of three alleged Marfa mystery lights photographed on November 20, 2002, and May 7 & 8, 2003 (photos #8 & #13). All of these lights were visible from the Viewing Center (MLVC) toward Nopal Road’s S-turn located some 10km south of the MLVC. In view of the strong similarities we are forced to conclude that all these images show just vehicle lights. Note that the fourth image (photo #13) fails to show the complete track (right end not captured). (Photographs: © James Bunnell.) Right: Google Earth simulated view of the S-turn as seen from the MLVC, plus maps of the area (images: Google, Landsat/Copernicus). At **A** and **B** points, the headlights of a northbound vehicle point toward the Viewing Center, causing the two flashes at both ends of the photographed light tracks. The dimmer light track to the left and slightly higher than the main track—noticeable in some of the photos—corresponds to the vehicle approaching point **A**. On the contrary, the pictures do not show any light track to the right of flash **A** because the terrain blocks the view of northbound vehicles moving away from the S-turn.

Other cases reviewed

Before providing a final assessment of the implications of our results for 2003-2004, we cannot ignore this question: are the other three cases that Bunnell highlights in his book (occurred in 2006-2007), any better than those selected in our main study? In order to give an adequate response to this query, we decided to expand our initial field of analysis to those three cases as well. We will show our

findings in Appendix 3. Having made an initial evaluation of these newer cases, we can safely state that (1) they are very similar events to those studied here, and (2) they cannot be used as evidence of any geophysical anomaly. In fact, this preliminary examination is enough to explain partially or totally—once again—some of these cases as car headlights observations.

Conclusions

We are now summing up our approach and findings:

(1) The original scenario, the most popular one, which is still sold to visitors who come to Marfa attracted by the mystery, considers some mystery lights that can be watched practically every night from the Viewing Center built for this purpose. Today there is a broad consensus deeming the vast majority of these lights, those observable in the direction of the Chinati Mountains, as caused by vehicles traveling through the U.S. Route 67, as various investigations have revealed. The “classic” MLs have long been explained. We ourselves have verified it, as shown in **Figure 80**.

(2) The scenario posed by Bunnell takes for granted a real, unexplained phenomenon of geophysical nature, moderately infrequent, visible in other directions than the “classic” (i.e., frequent) MLs. According to his on-site investigation, he estimates that the “true” mysterious lights at Marfa would appear “on less than 12 nights a year.”²⁰ We have analyzed a selected sample of the very best, representative photographic cases of these so-called “genuine” Marfa Lights events. They were obtained during a long-term extensive investigation carried out by Bunnell, one of the top experts in the field.

3) To begin our research protocols, all original data have been checked to the last possible limit. For this purpose, we have used specialized software like Google Earth and Stellarium. As a result, errors in reported azimuths and times have been detected. This has a major implication: the positions deduced by triangulation—which placed the lights outside the local roads—are unreliable.

4) Then, we have tested the simplest hypothesis, one already postulated by other investigators: the light track phenomena observed are produced by car lights. In every single event when geographical verification has been possible (assisted by Google Earth, for example), the photographed luminous trails match with local roads.

(20) http://www.marfatxlights.com/car_lights1.htm

In conclusion, these findings powerfully weaken, if not fully discard, the existence of an inexplicable, recurring anomalous phenomenon close to Marfa, Texas. As of today, there is no definitive, objective evidence of an unexplained ML phenomenon.²¹ On the contrary, there is only anecdotal evidence in the form of unproven testimonies. Any hypothetical unusual phenomenon in the area would not be infrequent—as Bunnell *et al.* already assumed—but extremely infrequent or just plainly non-existent.

It is worth remembering that, by definition, “mystery lights” are supposedly recurring phenomena associated with a particular location. Although they would manifest without prior notice and in a relatively large area, we must emphasize that it is incomprehensible that a systematic on-site investigation has failed even to prove ML’s existence.

It is plainly obvious that, in the present circumstances, it makes no sense to continue talking about the “Marfa mystery lights.” Otherwise, we would fall for what we could call the shrinking-phenomenon paradox: deeming the area as a true natural laboratory of recurrent anomalies while admitting that strange occurrences are currently non-existent. Paradoxes aside, faith in the systematic apparition of strange lights on Marfa's plains can only be maintained by looking back to (and overrating) anecdotal evidence to support the belief. Yet it is a methodologically-risky position since it is the rigorous investigation that has to give answers, rather than unchecked testimonial accounts. Opting to believe in apparently-anomalous anecdotal stories as the foundation of a novel geophysical phenomenon, rejecting the outcome of systematic investigation demonstrating MLs are car lights, is simply preposterous.

(21) Although outside the scope of this work, it is worth mentioning a paper which reports unidentified luminous phenomena photographed by two of Bunnell's automated monitoring stations on June 3, 2005, in particular an "extremely bright luminous object." See: Karl D. Stephan, James Bunnell, John Klier & Laurence Komala-Noor, "Quantitative intensity and location measurements of an intense long-duration luminous object near Marfa, Texas," *Journal of Atmospheric and Solar-Terrestrial Physics*, Vol. 73, 2011, pages 1953-1958. However, it is not a compelling piece of evidence for the ML phenomenon, or of any other form of geophysical anomaly for that matter, for three main reasons:

- The quite limited available information (B&W video footage—stacked images—of a bright light at a distance of about 26km from the nearest camera).
- The unrepresentativeness of the event (duration over 3 hours, the extreme intensity of the light, and the correlation with a severe thunderstorm make the event highly atypical and distinct from “raw” Marfa Lights, as the paper admits).
- The most than probable identification of the light source as a power-line arc (despite the objections raised in the paper).

In this respect, in a more recent paper that Karl D. Stephan co-authored with Mickhail L. Shmatov, “Advances in ball lightning research,” published in the *Journal of Atmospheric and Solar-Terrestrial Physics*, Vol. 195, 15 November 2019, the authors explain: “One of us published a photographic record and quantitative analysis of an incident near Marfa, Texas which was, in retrospect, probably a power-line flashover that persisted for more than 3 h and was probably induced by a lightning strike. Although most lightning-induced flashovers occur at the poles that support the lines, flashovers directly to ground may occur if, for example, a lightning channel predisposes the power-line current to follow a direct path to ground rather than through a ground wire on a pole.”

As an unexpected outcome of our research, it turns out that the process by which we have been able to solve and explain the cases analyzed here, also allows direct questioning of the second level “anecdotal evidence.” *A priori*, testimonies considered to be valuable are those from local observers, who are both familiar with the area and reliable. A good example is the late rancher Kerr Mitchell, who disinterestedly collaborated with Bunnell's research, facilitating the installation of video cameras in his lands. Apparently, he only observed the topical, local mystery lights twice. Assuming they were “genuine” MLs, it says much about the very low frequency of occurrence of the hypothetical phenomenon. But the observations had an impact on him: “You see some strange things out here, but what I saw made me a believer” (Note 43). Nevertheless, one of the two sightings was that of May 8, 2003, one exhaustively covered here and found perfectly explained. The relevance of this fact is even greater if we consider that “Kerr observed that this ML was probably the brightest he had ever seen” (Note 46).

Finally, we want to state, for the record, that we started our investigation basically from a neutral position. We wanted the data to carry us to one or the other conclusion. We have taken James Bunnell's research very seriously and have spent an enormous amount of time examining his data, either published or reported directly to us. Nobody in his right mind can accuse us of having a hidden agenda to discredit the Marfa Lights. We have found what we have found after over one year of a painstaking study. We have been extremely lucky to receive original photographs showing elements of the landscape and even stars, in most of the cases studied. This has allowed us to reach conclusive results in a rigorous manner. We wish to emphasize that, ultimately, the merit belongs to James Bunnell, who has generated the extensive material that we have been able to examine. He is to be commended for all the years he has dedicated to this study and the vast expenditures (travel and equipment) he has spent in it. A recognized merit that will undoubtedly leave him with a bitter taste, since our findings do not match what he might expect.

APPENDIX 1: METHODOLOGY AND PROCEDURES

We have approached the so-called Marfa Lights phenomenon by analyzing a sample of the best—in fact, unique—photographic evidence purporting to show that this is a phenomenon unknown to science. By examining the contents of the photographs—mostly showing unidentified light trails across night landscapes, occasionally including some stars and isolated ranch lights—we have tried to obtain as much information as possible regarding location and time. As a first step, this information has been used to verify the supplementary data supplied by the photographer. Then, we have focused in checking the most basic explanatory hypothesis: the photographed lights belonging to vehicles driving on local dirt roads. We have found out that the analyzed evidence is widely consistent with this explanation, to the point of making unnecessary any further check regarding more exotic hypotheses.

In order to perform all the spatial (geographical) checks, we have used Google Earth, a computer program that renders a 3D representation of Earth based primarily on satellite imagery. Most of what follows has to do with the use of this program for this purpose (and also with its limitations).

Necessary time checks have been possible for a number of photographs showing stars. For this task, we have used Stellarium, a well-known planetarium software.

Geographical checks using Google Earth

The Google Earth program enables users to visualize Earth landscapes from various angles in three dimensions. The program maps the Earth by superimposing satellite images, aerial photography, and GIS data onto a 3D globe. Throughout our study, we have used Google Earth Pro (the current standard version of the Google Earth desktop application as of version 7.3) for Windows.

Photo Overlay tool

While Google Earth has not any knob or slider to adjust the field of view of its images, we can use the Photo Overlay tool (from the Add menu) to zoom in/out from a given observer's location. Using this powerful implement to overlay an image (an actual photograph of the landscape, a grid, etc.) allows to specify the angular width of the overlaid frame and, therefore, to modify the field of view of the landscape shown on the screen. The required input parameters which must be entered in the New Photo Overlay dialog box are summarized below.

- First, the user must specify the camera location, that is, *latitude*, *longitude*, and *altitude* (above either ground or sea level). We have used the following coordinates for the camera location depending on the considered photograph:

Photo #	Camera location	Latitude	Longitude
1-13	SW plaque at MLVC	30° 16.499' N	103° 53.067' W
15-17	watching platform at MLVC	30° 16.500' N	103° 52.972 ' W

We have specified an arbitrary–yet reasonable–altitude of 1.7m above ground in all the examples.

- Second, camera viewing direction is defined by entering *heading*, *tilt*, and *roll* angles. Heading is an azimuth angle that takes the value 0° when the camera points at the true North and increases clockwise (for example, 90° corresponds to the East direction). The tilt angle can take a value between 0° (camera pointing to the ground below–the nadir) and 180° (just above the observer–the zenithal direction). Usually, it is convenient to assume a tilt angle of 90°, which implies a horizontal line of sight (camera pointing to the astronomical horizon). The roll angle specifies an anticlockwise rotation of the overlaid image and can take values between +180° and -180°. The default value of this angle is 0°, corresponding to a horizontal frame. A roll angle of 180° implies an upside-down image.

- Third, the field of view is set by entering the *horizontal* and *vertical angles* of the overlaid image. The maximum value that can be entered is 110°. In practice, since the aspect ratio of the chosen image is to be maintained, it suffices to specify only one of the angles, after selecting the option “lock aspect ratio”. The other angle will be adjusted automatically. When overlaying a photograph of the landscape, we may enter an exact angular dimension, if we know the field of view, or just an initial guess to be fine-tuned later.

Finally, the transparency of the overlaid photo can be adjusted with a slider. Once the settings are saved, when we double-click on the photo's icon (a camera icon displayed in the Places panel) we are “flown” into the photo from whichever view currently on display. The photo's icon appears also on the terrain, at the camera location, when its checkbox is ticked in the Places panel.

Measuring azimuth and elevation on rendered landscape images

The aforementioned heading angle of an overlaid image corresponds to the (true north) azimuth of the center of the image from the camera location. Likewise, the tilt angle corresponds to the angular elevation of that center point plus 90°. Therefore, the Photo Overlay tool can be used to measure the azimuth and elevation of any point of the simulated landscape just by setting the observer's place as the camera location, aiming the virtual camera at the point of interest, and reading the resulting values of the heading and tilt angles.

The overlaid image may consist of a simple cross marking the center of the frame, preferably with a white background to facilitate its merging with the rendered landscape image by adjusting its transparency.

We can also add a scale reference by overlaying instead a pair of graduated axes (see [Figure 3](#)) or even a complete grid (see [Figure 6](#), center). In these cases, the field of view must be selected accordingly. For example, by overlaying a grid with 20 horizontal divisions and selecting a horizontal angle of 2° , we can implement a scale of 0.1° per division. (Note that a grid with *equally spaced* divisions is an approximation only suitable for narrow view angles; for wider angular widths, one must consider the “perspective distortion” linked to a central projection.)

Comparing photos with rendered landscape images

The most obvious use of the Photo Overlay tool is to match a landscape photo to its corresponding rendered image. After specifying initial values of the input parameters (see above) and setting a certain degree of transparency of the overlaid photo to facilitate the comparison, it is necessary to operate by trial and error until achieving the best visual match between both the rendered view and the actual one. This is accomplished by readjusting the heading angle and the field of view, but also tweaking the tilt and roll angles if necessary.

When viewing the resulting composite image, we can right-click on it to access the menu and then select Properties to modify the transparency as well as fine-tune the rest of parameters at any time.

To make the comparison possible, the scene must contain at least two well-defined landmarks. A photo of a homogeneous terrain and a flat skyline, for example, would not include enough useful information to guide the matching process. [Figure 88](#) shows six main landmarks that appear in the set of photographs analyzed in this study. A-D are reference points belonging to the profile of the background mesas. E and F are mercury vapor ranch lights.

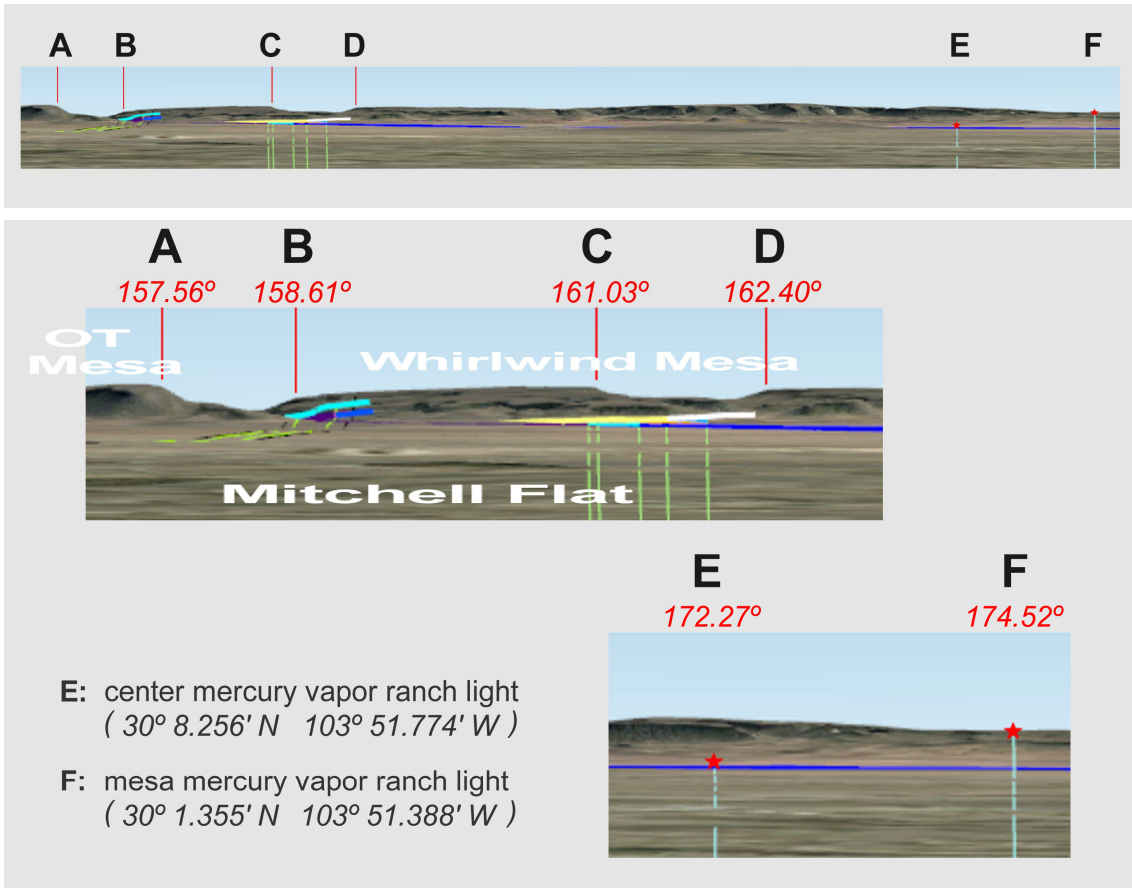


Figure 88. Main landmarks considered in our study. Red figures: azimuths from the SW plaque at MLVC. (Images: Google, Landsat/Copernicus.)

The following table shows which of these landmarks are present in each of the photographs studied in the present work:

Photo #	A	B	C	D	E	F
1						
2						
3						
4	•	•	•			
5			•	•		
6			•	•		
7	•	•	•	•	•	•
8					•	•
9			•	•		
10			•	•		
11	•	•	•	•	•	
12					•	•
13						
14						
15	•	•	•			
16	•	•	•			
17	•	•				

In principle, photos #1, # 2, #3, #13 and #14 do not show any of these points of reference and would not allow a precise identification of the landscape. However, because photos #12 and #13 partially overlap, it has been also possible to deduce where the camera was pointing at when photo #13 was taken.

Checking the correlation between light tracks and local roads

Although we can activate the Roads layer, from the primary database shown on the Google Earth sidebar, it does not include some of the dirt roads of interest here. On the other hand, the roads actually included in that layer may become poorly visible in low-level or ground-level landscape views, compared to more map-like aerial views. To overcome these problems, we have added manually the path of all the roads to be checked in our study by making use of the Path feature from the Add menu.

When creating a path, Google Earth allows not only to customize the appearance of the line (color, width) but also to specify its altitude relative to the ground. Since the focus is on checking the path of the vehicle headlights rather than the road path itself, we have considered an altitude of one meter above the ground in all the examples (except when stated otherwise—see [Figure 82](#)). Headlights height above ground surface is lower than one meter in most vehicles, but only integer values can be entered into the path's altitude field and choosing zero meters (ground level) is less realistic.

We have used different colors to identify different roads and even different sections of the same road. Also, two color ranges have been used to make a distinction

between stretches of road according to the travel direction of the headlights (either rightward or leftward) as seen from the observer's location (see for example [Figure 17](#)).

It is convenient to specify a width not too small for the path lines, not only to make them more noticeable but to have an indication of how visibility changes along the path. When rendering a landscape image, Google Earth determines which parts of a path are visible and which parts are hidden. As the path line has a certain thickness, a thinner stroke may result at some places, in the transition between full visibility and non-visibility (see, for example, the blue line toward azimuths 190° and 201° in [Figure 51](#)).

Additionally, in some of the figures included in the Conclusions chapter, we have used both color and width to introduce a “third dimension” into the rendered road images. Here, we refer to the degree of alignment of the headlight beam with the observer's position, which strongly affects the perceived brightness of the lights. Headlights, as devices being primarily intended to illuminate the way ahead of the vehicle, look brighter as the travel direction approaches the direction of the observer. Representing the headlight path only with a uniform line means missing this key feature (i.e., alignment), which has to be compared with the brightness and thickness of the photographed light tracks.

Besides the alignment of the headlight beam with the camera in a horizontal plane—which is the one that we have considered—there are a number of other factors which also affect the brightness of the captured light track, as long as the camera settings are maintained. To start with, the corresponding alignment in a vertical plane, that can vary due to changes in the slope of the road. Another obvious factor is distance: the closer the vehicle, the brighter its lights appear. Less obvious, the lower the apparent angular speed, the brighter the light track will appear in photographs (when using the same exposure time and aperture). Of course, fog and haze conditions affect the visibility, and atmospheric refraction may also alter the way that the headlights are observed. Terrain and vegetation, when not blocking completely the view, can partially hide the lights reducing their apparent brightness.

All things considered, we have found evident correlations between the light tracks in the photos and local roads in the rendered images (with minor discrepancies in elevation, to be commented later).

Limitations of the comparisons

Comparing photos and rendered images of the landscape is possible because, at the outset, both photography and Google Earth (as a landscape viewer) share basically the same type of projection: central projection. Besides, comparisons are possible because the Google Earth's rendering process and the data on which it is based are reliable and detailed enough.

Problems may arise when photos show lens distortion (beyond the natural “distortion” due to perspective). Wide angle lenses, including zoom lenses shot at its wide end, typically suffer from barrel distortion while pincushion distortion is usually present on telephoto lenses, as well as zoom lenses shot at the longest focal length.

On the other hand, only full-frame photos should be used with the Overlay tool for comparison purposes. Alternatively, cropped photos are also appropriate as long as they keep the same optical center of the original full-frame image. Otherwise, it would be impossible to precisely match the perspective in the photo and its rendered counterpart, especially for wide-angle images.

The MLs photos that we have analyzed would be not free of mild lens distortion. In addition, we have not had access to the negatives to absolutely ascertain that the available images are full-frame pictures. There exist further issues with the very content of the set of images. These are night shots where some of the landmarks of interest, pertaining to the profile of the background landscape, are not clear-cut features actually (see landmarks A-D in [Figure 88](#)). One might think that some of these photos are less problematic because they contain more landmarks. Unfortunately, this also implies wider horizontal angle and poorer resolution. Consequently, landmarks can be located with less precision.

Having said that, while all of the above would be of serious concern for very precise comparisons, as a matter of fact it truly has little impact on our study of the correlation between light tracks and local roads. Most of the eerie-looking light strokes that we have compared with the rendered road paths have lengths of tenths of degree or even full degrees. However, uncertainty in visually establishing the position of the landmarks do not exceed a few hundredths of degree in our examples, making any eventual misalignment rather irrelevant.

Refraction effects

Google Earth imagery does not consider atmospheric refraction. The program provides realistic views of the landscape that consider Earth's spherical geometry but assume that light rays are unaffected by the atmosphere. In reality, light deviates from a straight line due to the variation in air density as a function of height. Thus, every element of the landscape normally appears displaced slightly above its geometric position. Furthermore, in case of strong ray-bending, distorted images of the objects may result, as well as mirage phenomena involving one or more inverted images.

Atmospheric refraction operates in a vertical plane and alters the apparent elevation but not the horizontal angles. The effect is basically confined to a small region close to the horizon, but it cannot be neglected because most of the photographs under analysis show precisely a zoomed-in view of the horizon. When comparing those photos with Google Earth images of the same area, we have matched the upper part of the mesas profile (specifically, landmarks A-D),

assuming that its apparent position was not displaced by refraction (see, for example, the interpretation made of the outline appearing in photo #4, at the lower right corner of [Figure 82](#)). In practice, this assumption implies dismissing refraction effects for elevations above roughly 0.1° over the horizon. Some of our comparative figures display a graduated vertical axis to indicate the angular elevation in the rendered image (e.g., [Figure 16](#)). That scale is also directly applicable to the overlaid photographic image included in the figure, provided that the above assumption is fulfilled.

The road sections of interest in our study were very close to the horizon for an observer placed at the camera location, most of them being at angular elevations between -0.2° and $+0.1^\circ$. Not surprisingly, the related light tracks in the photographs appear to be displaced upward a few minutes of degree because of refraction. The fact that light tracks and Google Earth road paths do not exactly overlap has not precluded a positive identification of the roads involved, given the close parallelism of the paths and the significant additional clues that confirm the connection.

Since our main goal has been to verify or refute the alleged mysterious nature of the photographed lights, no attempt has been made to estimate the exact magnitude of the existing refraction, nor have we studied the dependence of refraction on local meteorological conditions (primarily, vertical air temperature gradient).

In the photos we have analyzed, refraction not only affects where the car lights appear but also—in certain cases—whether they appear at all. Some road stretches that are hidden to the observer may become visible due to a stronger bending of the light rays (see [Figure 43](#) and related comments in the main text, as an example of the changing appearance of a light track in consecutive days). The increasing of altitude of a road's path created with Google Earth may help to visualize the effect for a particular road, although the resulting image should not be considered an accurate simulation of the landscape as it was actually observed (see [Figure 82](#) regarding photos #4 and #5).

Other issues

Finally, we must warn our readers about some problems encountered while using the current version of Google Earth. We have overcome them by taking special care and double-checking any result before considering it valid.

One issue concerns the roll angle applied to an overlaid image. As we enter a non-zero value for the roll angle in the Photo Overlay dialog box, the program displays the overlaid image rotated accordingly, with a horizontal view of the rendered landscape in the background. After exiting the setting mode, every time that we select and view that overlaid image, it appears horizontally on the screen, and it is the background landscape that is rotated. In any other case—when the overlaid image is not selected and, thus, not displayed—the rendered landscape is

supposed to appear non-rotated, that is, horizontal. Sometimes (it is not clear in which circumstances) this reset does not happen, leaving a “residual” roll angle applied to the landscape that may even interfere with the view of the next overlaid images created during the same session.

Another issue worth mentioning has to do with the visibility of paths. We cannot expect Google Earth to account for certain specific factors that affect visibility, like vegetation or refraction. Anyway, the problem arises when sometimes the program fails to apply the visibility constraints imposed by the mere geometry of the terrain. This becomes plainly obvious, for example, when a rendered landscape image shows a road path *below* another one known to be *closer* to the observer, a blatant impossibility unless the terrain were transparent. When we have encountered this kind of problem, we have made an independent assessment of the visibility based on the elevation profile from the observer’s place to the points and paths of interest, to find out which roads would be definitely hidden to the observer. Then we have created paths only for the sections of road that would be actually visible (see for example [Figure 76](#)).

Astronomical checks using Stellarium

Although Google Earth (desktop version 7.3) displays the Sun and the brightest stars above the landscape, it does not show the Moon and the planets, and, besides, you can only select dates from the current year (by using the time slider of the “Show Sunshine” tool). On the other hand, the feature “Sky in Google Earth”, a complete sky-only viewing mode, is not intended to show specifically the portion of the sky visible from a given geographical location at a given time.

We have used a separate planetarium program, Stellarium, to perform astronomical checks on the photos showing star tracks (namely, photos #7 to #13). Our purpose has been to estimate both the time and the exposure time of those photographs from the positions of the stars, considering the starting and end points of their tracks. Ultimately, this has allowed us not only to verify or correct the time information given by the photographer, but also to work out minimum-speed estimates for some of the mystery lights that appear in the images, to be compared with the speed of a vehicle.

Determining times from star’s positions

In order to obtain the time for a given position of a photographed star, we have followed the steps described below.

- 1) Measure the coordinates x and y of the star’s position on the photo. For convenience, we can set the origin of the coordinate system at the center of the photo, and measure x and y in pixels. Measure also the width of the photo, in the same units.

2) With the help of Google Earth, determine the heading, tilt, and roll angles of the photo, as well as its angular width. For more details, see the above sections "Photo Overlay tool" and "Comparing photos with rendered landscape images".

3) Calculate the azimuth and altitude angles of the star's position from the coordinates and width measured in step 1 and the photograph's parameters obtained in step 2, making use of the formulas listed in [Figure 89](#) (which also includes a diagram illustrating the general geometry of the problem).

4) Use Stellarium to identify the star. First, input the following data: the camera's geographical coordinates (see table in "Photo Overlay tool" section), the known date, and an estimated/guessed time. It is important to convert local time (in our case, either CST or CDT) to Coordinated Universal Time (UTC).

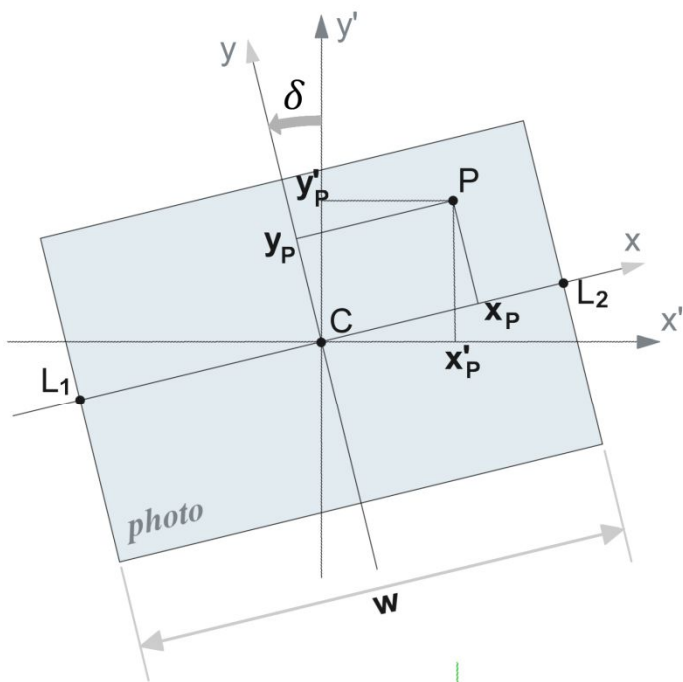
The table below shows the stars that we have considered in each of the photos:

Photo #	γ Cen	δ Cen	ϵ Cen	π Cen	ρ Cen	γ Cru	LW Vel	M Vel
7	•	•						
8				•	•	•		
9			•					
10			•					
11			•			•		
12				•	•	•		
13				•			•	•

5) Finally, determine what time would correspond to the star's azimuth and altitude angles estimated from the photographic data in step 3. To this purpose, select the star identified in step 4 and adjust the time in Stellarium to get the computed azimuth and altitude angles that best match the angles estimated from the photo.

In practice, we have concentrated on matching the azimuth angle because our estimates of angular elevation from the photographs might be slightly less accurate (see the "Refraction effects" section on the problem of determining the level of zero angular elevation in the photos) and, besides, the computed elevation angles may not correspond exactly to the actual photographed angles, depending on atmospheric factors. Stellarium simulates the so-called astronomical refraction (i.e., the lifting effect of Earth's atmosphere on the observed position of heavenly bodies, especially when they are close to the horizon) when its feature "Atmosphere" is switched on. However, since the program employs a refraction model that assumes certain particular conditions of air pressure and temperature, the results are only approximate if those conditions are not met.

When carrying out time calculations for photographs showing several stars, we have chosen as final result the arithmetical mean of the values obtained for all the stars considered, with the aim of minimizing errors. In our examples, the difference between that average time and the time computed for any particular star did not exceed 0.5 minutes.



$$\lambda_P = \arcsin \left(\frac{f \sin \lambda_C + y'_P \cos \lambda_C}{\sqrt{x'^2_P + y'^2_P + f^2}} \right)$$

$$\varphi_P = \varphi_C \pm \arccos \left(\frac{b}{\sqrt{x'^2_P + b^2}} \right)$$

$$\begin{cases} + & \text{if } x'_P \geq 0 \\ - & \text{if } x'_P < 0 \end{cases}$$

where:

$$x'_P = x_P \cos \delta - y_P \sin \delta$$

$$y'_P = x_P \sin \delta + y_P \cos \delta$$

$$f = \frac{w}{2 \tan(\epsilon/2)}$$

$$b = f \cos \lambda_C - y'_P \sin \lambda_C$$

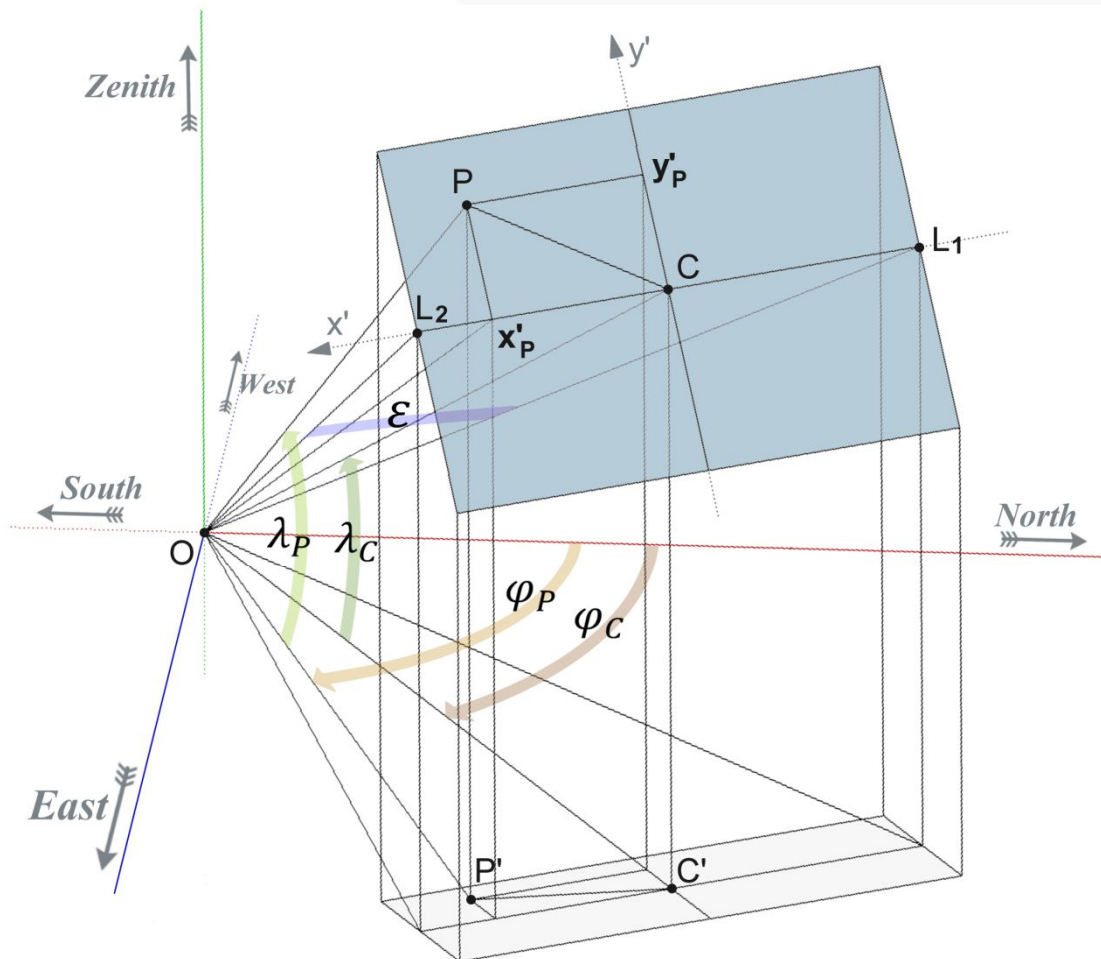


Figure 89. Calculation of the altitude angle λ_P and the azimuth angle φ_P of a given point **P** from an overlaid photo.

x_P, y_P : coordinates of the point **P** measured on the photo, referred to a Cartesian coordinate system with its origin at the center **C** of the photo.

w : linear width of the photo (expressed in the same units than x and y).

ε : angular width of the photo, corresponding to the angle L_1OL_2 in the figure.

δ : *roll* angle of the photo as defined in Google Earth (Photo Overlay tool).

φ_C : azimuth angle of the center **C** of the photo (*heading* angle in Google Earth).

λ_C : altitude angle of the center **C** of the photo (*tilt* angle in Google Earth minus 90 degrees).

Notes:

- Azimuth angles are measured clockwise from the geographic North.
- Azimuth angle φ_P is undefined when the altitude angle λ_P equals either 90° (zenith) or -90° (nadir).
- Altitude angles are measured upward from the horizontal plane containing the camera location **O**.
- Coordinate axes x, y, x' and y' belong to the same plane, perpendicular to the **OC** direction.
- The 3D diagram on the bottom depicts a particular case where $\delta = 0^\circ$, for sake of simplicity.

The consistency of the results may be assessed graphically by comparing the photograph under study with a view of the sky generated by Stellarium for the camera location and the computed time obtained. Any graphics editor program allowing to overlap images can be used for this purpose. It is recommended to choose “Perspective projection” (gnomonic projection) in Stellarium and switch “Atmosphere” on. The astronomical view should be centered at the same angular coordinates (azimuth/altitude) of the center of the photo, and both centers must coincide when performing the comparison. The horizon line in the photo (the zero-elevation angle level) must be marked to facilitate its matching with the corresponding horizon line in the sky chart.

Final remarks

We have devoted this appendix to describe not only *what* we have checked during our study, but also *why* and, particularly, *how* we have done it. We have gone into great detail on the procedures and software employed, without neglecting their limitations to complete the overall picture.

What was intended to be a brief review of the last James Bunnell’s book grew into a more ambitious undertaking, when we decided to verify—as far as possible—if the photos in that book defied conventional explanation, as its author claimed. Undoubtedly, the work we have performed could be enhanced with the addition of further checks and developments. To mention some: more analysis on meteorological conditions and refraction effects appearing in the photos, supplementary visibility checks based on elevation profiles, or a throughout treatment of error propagation in the obtained estimates. But these are topics that either fall outside the main scope of our inquiry or are not essential to the discussion. Moreover, once we were fully convinced that we had reached a solid conclusion, our objective was fulfilled, and we closed the study.

As a final remark, we wish to emphasize the following:

First, despite our detailed account of possible sources of error—included here for the sake of completeness and to satisfy the curiosity of the most demanding reader—the fact is that the results of our comparisons are accurate enough to strongly support the identification of the lights as vehicle’s headlights.

It might be that the actual angular elevation of one of the lights was -0.03° instead of the estimated -0.05° , but it suffices to take a look at our diagrams and supplementary data to realize that this would make little difference to our arguments. Certain photograph might have been taken 30 seconds before our estimated time, yet we would still conclude that the camera clock was wrong if our estimate is 22:32 and the time registered by the camera was 22:22. A more accurate estimate of the minimum speed derived from one of the photos might lead to a figure of 57.9km/h instead of 56.6km/h, for example, and the conclusion would be the same, the figure is consistent with the speed of an ordinary vehicle.

In an exercise like this, no one would demand the analysts to provide, let us say, the “license plates of the vehicles involved,” or the “names of the drivers,” for that matter. That would be absurd. The bottom of the issue is that the evidence favoring the car explanation turns out to be overwhelming and now, the burden of proof rests on the anomaly proponents. But the key point is that we have been able to demystify the set of photographs claimed to be the best evidence for the period considered.

Last, we hope that the contents of this appendix may encourage and assist our more technically-oriented readers to apply similar procedures to the study of other photographs of Marfa lights, as well as other alleged mystery lights reported elsewhere (for example, the famous Hessdalen lights, especially in instances when they are seen grounded instead of airborne).

Actually, after carrying out a long series of comparisons with photographs, we are still impressed by the precision of most of the landscape images rendered by Google Earth, even when they are severely zoomed-in. This makes Google Earth a powerful and—generally—reliable tool, indispensable for checking anomalistic claims of this nature.

We also hope to benefit in the near future from software improvements and new applications allowing to perform all the required checks in a more straightforward way.

APPENDIX 2: COMMENTS ON BUNNELL'S RESPONSE

In science, it is extremely uncommon for an investigator who studies, reviews or critiques another's work and arrives at a different conclusion, to ask the original author for offer his comments on the study, review, or critique. For us, however, doing so is ethically mandatory. For two reasons. First, once we discovered that the original author had made mistaken inferences, deductions, and conclusions from the same database, we wanted to see if it sparked any positive reaction or feedback. Second, to give him a fair opportunity to contribute any new proof to refute or debunk our down-to-earth, conventional criticisms and findings.

Therefore, we sent our paper to the original author of the book whose photographs we selected to analyze, Mr. James Bunnell. Predictably, he would not agree with our conclusions (i.e., that his observations and photos are explained in an ordinary way as lights of road traffic). But he has not provided any argument that is not already in his book and that we have not already refuted in this essay. We would have liked Bunnell to realize the solidity of our findings, that Marfa Lights are produced merely by vehicles traveling on local roads.

This section of our monograph will reproduce in full Mr. Bunnell's Response to our research, dated December 13, 2018 (in italics), followed by our own comments in the form of a respectful dialogue. The educated reader currently has all the data to form a definitive opinion.

This is my response to an unfinished manuscript titled "THE MARFA LIGHTS, FOTOCAT Report #8" by Vicente-Juan Ballester Olmos (VJBO) and Manuel Borrás Aymerich (MBA). Their draft manuscript (referred to in this response as Report #8) is a flawed recalculation and a re-writing of my book, Strange Lights in West Texas. The magnitude of the effort to produce this review (92+ pages generated by 2 people over 13 months) is impressive. At the outset, I wish to express my appreciation for VJBO's willingness to include my complete response.

As profusely indicated in the paper, and summarized in the Conclusions, the authors found many major actual calculation flaws in the prior work by Bunnell. Assessing the value of a series of images and descriptions obviously requires first showing the basic information. From that, a detailed deconstruction process has revealed the errors in the estimates that took him to mistaken conclusions. It is hardly re-writing a book. We are happy to receive credit for releasing his full Response for all to consider.

My book, Strange Lights in West Texas, is the last of four books describing my investigation of mysterious lights that make surprising but infrequent appearances east of the small West Texas town of Marfa, USA. This last book in my collection includes color photographs of these mysterious lights along with updated theories regarding their origins and potential significance to science. However, the book is not a formal report of scientific findings. It was written for general public

consumption and is intended to provide useful information to visitors who plan to visit the Marfa Lights View Park, a state provided facility on Highway US90, situated at the northern edge of Mitchell Flat with clear views of the ranching region where MLs are sometimes seen. Information most important to the visiting public includes how to distinguish mystery lights from mundane ranch lights and vehicle lights in Mitchell Flat, and how to avoid becoming confused by nightly car traffic on Highway 67, a distant mountainous road that is clearly visible from the View Park.

Regardless of the book's target public, calculations are calculations. We have plainly demonstrated that azimuthal and time errors have led Bunnell to mistakenly place the lights off the local roads or dozens of meters above the ground.

Sr. Ballester Olmos and Sr. Borraz Aymerich have taken on a task of testing my claims that a precious few lights seen in this West Texas location can be justifiably called mystery lights. Are the lights I dare to call Mystery Lights (MLs for short) truly mysterious? Or might it be that I too, like many visitors, have been seeing only mundane car lights and incorrectly pronouncing them "mysterious"? Let me first outline for the reader what I believe to be the misplaced/erroneous methodologies and judgment rules used by the Report #8 authors to explain away the mysterious aspects of these lights. It should be noted at the outset that they have limited their focus to a very small subset of ML events reported in my book, reviewing only three of the earliest ML nights in the 12-year project.

Four actually. In any case, the evidence for this "small subset" of events is among the best visual and photographic evidence Bunnell has been able to offer as material proof of the reality of "authentic," unknown Marfa Lights. However, the rest of the pictures printed in his book have also been examined in Appendix 3 of the present monograph, with results supporting our conclusions.

As for the "erroneous methodologies and judgment rules," the reader is now in a position to evaluate where the errors come from. Renewed emphasis follows, after Bunnell's enumeration of "our" errors.

My broad conclusions regarding FOTOCAT Report #8 methods and judgments:

- *Error #1: Only Car Lights*

As I understand it, FOTOCAT authors used Google Earth to find terrain that best matched my ML photographs. Once the ML location was identified to their satisfaction, they would use Google Earth to search for a nearby ranch road or vehicle trail. Whenever a suitably located ranch road was found, they felt justified in concluding that headlights of a moving vehicle on the located road were the probable light source. This, of course, leads to a conclusion that Bunnell has no basis to claim that he has photographed a mysterious light.

The approach of first verifying the simplest hypothesis is perfectly normal and adequate. Then, the results are weighted and checked, as we did in every single case presented by Bunnell as proof of an extraordinary phenomenon.

If a reader accepts this FOTOCAT Report #8 strategy for dismissing my identified MLs, then he or she is thankfully spared from reading Report #8 because there are ranch roads and vehicle trails everywhere in Mitchell Flat. Ranchers use big ranch trucks with 4-wheel drive and plenty of ground clearance. They check fences, visit water tanks and windmills, salt blocks, hunt for coyotes, hunt for new born calves, etc. Finding a nearby road or rough vehicle trail in Mitchell flat is not difficult, so if that is all that is required to dismiss my claim of mysterious light behavior, then they may believe that has been accomplished.

It is not so easy to find matching roads. If our study would have considered the positions facilitated by Bunnell (with wrong azimuth data) we could not have been able to explain practically anything! The found coincidences are rather remarkable and significant. Moreover, many such coincidences are directly related to the main local road (Nopal), not with obscure paths.

However, MLs are not headlights and they do not behave like headlights. Where we have a disconnect is in understanding the difference between vehicle headlights and MLs. What makes MLs mysterious are behavioral characteristics.

In other words, Bunnell neglects the matching roads and prefers to focus on alleged "behavioral characteristics," a much more uncertain terrain and one quite open to varied, subjective interpretation...

They appear to:

✓ *Be in the air, not on the ground.*

This is not obvious, for none of the photographed lights is seen against the sky. In fact, it is an unreliable estimate based on the same wrong data which put the lights at wrong locations on a map.

✓ *Originate mostly in the SSE part of Mitchell Flat and travel mostly to the NW.*

Considering the role played by Nopal Road according to our results, this is even predictable.

✓ *Cross above fence lines and pass locked gates at speeds not possible on the ground.*

We have not encountered any example of lights crossing fence lines. Regarding the question of overrated speeds, it has been covered and corrected in this monograph.

✓ *Expend energy, decay, and fall once their energy is exhausted.*

This turns out to be just an unfounded personal interpretation of the luminosity of the light tracks in the time exposures.

- ✓ *Exhibit combustion processes that, when magnified, do not look like headlights; they look like ongoing combustion events.*

Similarly, as above.

- ✓ *Eject burning particles from time to time.*

The two examples proposed by Bunnell and studied by us admit a simpler interpretation: camera shake.

- ✓ *Routinely go out completely for a while and then restart further down track.*

As we have been able to verify in some cases, this would be caused by terrain features blocking the view of the lights.

*Readers please note: It is these ML behavioral characteristics that make mystery lights mysterious. These are behaviors **inconsistent** with vehicle headlights and they are behavioral aspects that cannot be discovered using Google Earth.*

It is precisely the use of a tool like Google Earth what helps to both understand and explain most of these supposed “mystery” characteristics.

Before moving on I want to acknowledge that my ML directional bearings from the View Park can be misleading (as the authors discovered) because of the way that data was collected. ML photographs reviewed by FOTOCAT Report #8 involve my earliest data from the years 2003 and 2004. During that time frame I searched from the View Park with binoculars for possible MLs. Whenever an unknown light popped into view, I would make a mental note of where it was first spotted relative to the background mesa profile, or other terrain features, while I continued to observe the light closely. If it started to exhibit ML characteristics, I would consider it a possible ML candidate and would then record a magnetic start bearing using a handheld compass, based on my memory of where it first appeared. This vector acquisition method resulted in noisy data in direction vectors from the View Park.

“Misleading” applied to his ML directional bearings from the View Park is certainly an understatement. From the vector acquisition method described by Bunnell we could expect noisy data in direction vectors indeed. However, it would rather be an additional problem to add to the others encountered in his work. What we have clearly pointed out is that, in the actual photographs, the landscape landmarks which Bunnell systematically uses as a reference to find any moving light’s location are assigned wrong magnetic azimuths. In other words, some of his basic magnetic readings from the View Park are erroneous, and so are the MLs’ direction vectors derived from them. But these azimuthal data, presented by us in **Figure 4**, do not have “noise” or random errors, they all bear a fairly systematic deviation! What he is now saying does not apply to these data. Apparently, he has failed to understand our point.

At the time, that was okay for my purposes because I knew night camera Roofus would be collecting accurate direction and time data.

Azimuth data from the monitor station could complement but never replace data from the View Park. It is impossible to triangulate a position with direction data from only one place.

What was reported in my book were the noisy direction vectors from the View Park because that is where visitors are going to be located when looking for the lights.

In short, it seems that Bunnell has not fully understood our criticism. On the other hand, he dismisses the relevant “coincidence” of light trails with roads, since “there are ranch roads and vehicle trails everywhere in Mitchell Flat.”

- *Error #2: Looming*
FOTOCAT authors also conclude that any photographic evidence suggesting an ML under review might be flying above terrain (and therefore not a vehicle driving on a road) can be discounted based on their declaration of “Looming” (i.e. mirage conditions). I will offer some critique of that judgment and readers may draw their own conclusions (see below: 5. ML1 on May 8, 2003).

This is a very simplistic summary of the arguments put forward in our work.

- *Error #3: Camera Shake*
One of the characteristics of MLs is that they sometimes eject burning particles, as is the clear case with one ML being reviewed in Report #8. In another case, my camera managed to capture photographic evidence of an ML exploding, with evidence of burning remnants falling toward the ground. Both ML photographs were dismissed in Report #8 as camera shake. In this response, I will provide information in support of particle ejections (see below: 4. ML2a on 5/7/2003) and take FOTOCAT readers directly to the exploding ML case (see below: 5. ML1 on May 8, 2003) so you have a basis to judge for yourselves the validity of their dismissal on grounds of “camera shake.”

All this depends on how the luminous forms are interpreted. Yet context is crucial and, as everything points to vehicle lights, Bunnell’s interpretation does not hold.

My comments regarding specific FOTOCAT event analysis:

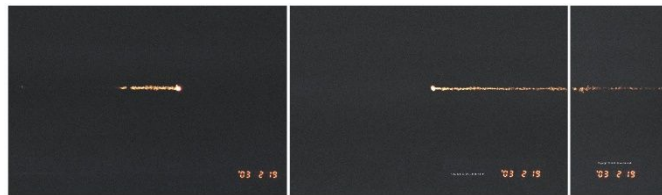
1. Event dated Feb. 19, 2003

When time exposures of moving lights are reduced in size, the characteristics that clearly define the ML may get lost. An ML passed in front of me that may have been optically closer than any other MLs that I have photographed. Its behavior was captured in three clear photographs (Fig. 19, 20, and 21 in my book). What sets these photographs apart from vehicle traffic can be clearly seen in photographic detail because this ML

was close enough to reveal details of its ongoing combustion process. A characteristic gap (off state) is in evidence as are a couple of fuel-rich moments that occur at the end of the first photograph (Fig. 19 and on the book's cover). The ML goes out and then restarts in Fig. 20 with another fuel-rich burst of light. Fig. 21 clearly shows loss of brightness and a bit of elongation as the ML nears exhaustion of its energy and then goes out before a fourth photograph can be taken. Report #8 attributes the source of these incredible photographs to nothing more than a vehicle driving west on Nopal Road (but fails to explain why anyone driving between those two sharp curves on a very dark night would risk turning off their headlights between the turns). Report #8 concludes that "Bunnell's opinion is based on personal interpretation, not on testable data." I disagree. VJBO's 'personal interpretation' versus mine can absolutely be tested to see who is correct. If my very detailed photographs are headlights of a vehicle, then it should be very easy to photograph a passing vehicle at night and produce images that contain magnified details like my book cover image and book images (Fig. 19 – 21). When he gets them, VJBO will include them next to my photographs using the same scale as my book. [VJBO has accepted the challenge.]

Bunnell book's Fig. 19-21 correspond to our monograph's photos #1-3:

Appearance may provide some clues but, in the end, we must focus on context, as we just commented above.



For Bunnell, the light tracks in photos #1-3 look like "combustive processes." For us, they look like—for example—a star seen through a telescope under bad seeing conditions (https://en.wikipedia.org/wiki/Astronomical_seeing). If the star-like object moved to the right and then stopped to maintain a fixed position, we would capture something like the upper image in the following **Figure 90**, a simulated, color-corrected, time-exposure to match photo #1, based on <https://web.archive.org/web/20070908185446/http://www.damianpeach.com/pickering.htm>

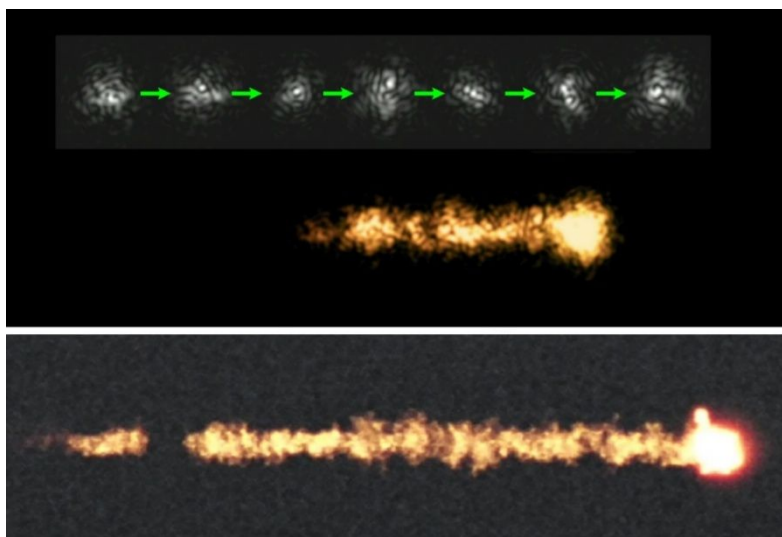


Figure 90.

Now, compare the resulting “combustive pattern” with that of the lower image, which is the original photo #1. We are not claiming this is exactly the explanation for the chaotic, complex texture of the light tracks in photos #1-3. Our point is, an atmospheric optical effect (presumably caused by refractive variations associated with turbulence along the light ray paths) would produce a similar effect, therefore it seems a more plausible explanation than Bunnell’s fully speculative, unknown combustive process.

It is most important to emphasize the general context of the event. Every time that we have studied an alleged ML picture that includes enough details of the background landscape, we have been able to find a specific stretch of road matching the light track. Photos #1-3 lack this type of information; hence we could not thoroughly substantiate the traffic scenario. Yet, with the exception of the “texture” of the luminous trail, the main features in photos #1-3 are very similar to those found in photos which definitely show vehicle lights, such as photos #12 and #13. In [Figure 91](#) below, we compare light tracks in photos #1, #2, #12 and #13 at the same angular scale (focal length in first two photos: 300mm; last two photos: 80mm).

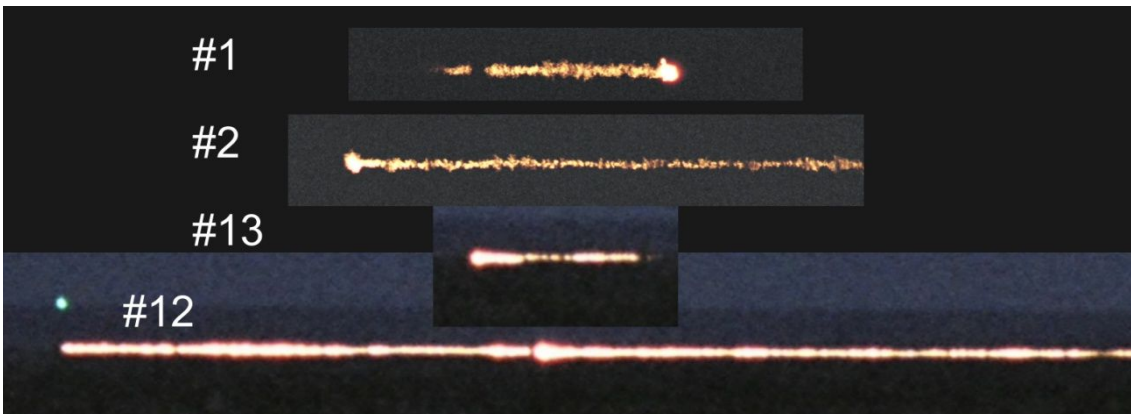


Figure 91.

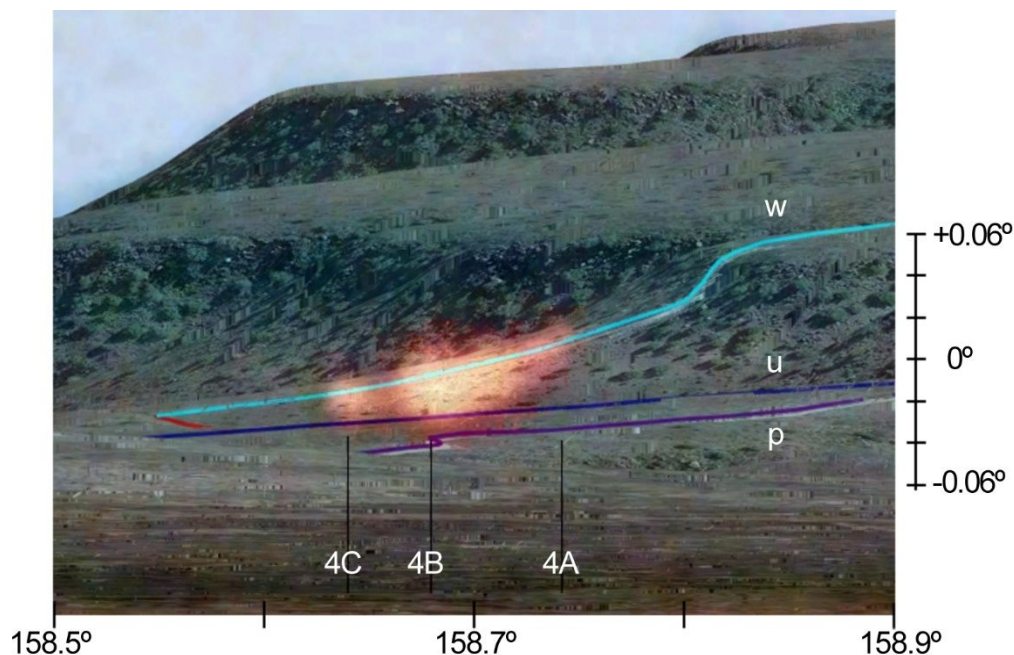
Finally, Bunnell asserts that if his “very detailed photographs are headlights of a vehicle, then it should be very easy to photograph a passing vehicle at night and produce images that contain magnified details” like those photos #1-3. This is uncertain. Assuming that we could manage to recreate elsewhere both the luminous source (similar headlights, viewed at the right distance, similar vehicle speed and apparent course) and the recording set (same lens, film and photographic settings) it still could be difficult to meet the precise atmospheric conditions required. However, we guess that more or less similar pictures could be found in Bunnell’s files, among the subset of photographs that he must have cast aside over the years as suspected or confirmed vehicle lights.

2. Event ML1a on 05/07/2003

FOTOCAT Report #8 authors use Fig. 23 from my book as the basis of their [Figure 13](#). It is intended to be a closeup view of where the first ML event on 5/7/2003 took place. Their figure superimposes my ML light onto a section of

background mesa to which they have added colored lines representing three roads that must be otherwise hard to see in their image. Road “w” goes right through the middle of the ML illumination while road “p” is lower and has a jag toward the camera that they suggest may explain extreme brightness of the assumed vehicle. I ask the authors to please provide coordinates of this location so that your readers and I can zoom in on the location using Google Earth to better understand road system orientations. The notion that headlights on a jeep or ranch truck located approximately 15 kilometers from my camera at the View Park could be producing enough light to illuminate a soccer stadium strains credibility.

This is the mentioned illustration (our [Figure 13](#)):



Some clarifications are in order. First, prior to Bunnell’s response we had instructed him on how to use Google Earth to create picture-like perspectives (he was more familiar with other mapping tools). On the other hand, there are plenty of detailed maps and images with azimuth marks in our report to permit easily locating each and every feature we mention. We cannot understand why he had not yet carried out his own verifications at the time of writing what is supposed to be his final response. Second, the claim “producing enough light to illuminate a soccer stadium” is exceedingly exaggerated (bear in mind that [Figure 13](#), reproduced above, shows a very close-up view of the light). As anyone can realize, car lights on Highway 67 (more than 20km away) look the same, as the photographs show.

3. Event ML1b on 5/7/2003, shown as Fig. 24 in my book
 Their Report uses [Figures 15, 16 and 17](#). [Figures 16 and 17](#) provide daytime images with road locations outlined in color. MBA or VJBO, please

also provide coordinates for this location so that your readers and I can zoom in using Google Earth to better understand how the road system you have identified exactly matches the configuration of my photograph. I am not able to replicate your results.

See clarification above. His book's Fig. 24 corresponds to our monograph's photo #5.

*4. ML2a on 5/7/2003, shown in FOTOCAT Report #8 as **Figure 22**. Report #8 addresses this ML using **Figures 18 to 22**. My finding regarding this ML is that it does exhibit particle ejections that take the form of two converging streaks of light extending down and to the right, indicating that this ML is in the air and not a ranch truck on one of the subsequently selected ranch roads.*

This is our photo #6 (cropped). Our reasoning is exactly just the opposite: after having established a direct relationship between the light track and a local road, we then deduce that the "streaks of light" cannot be ejections. From there, logically, it has to be an artifact due to camera shake.



FOTOCAT Report #8 dismisses the particle ejections as being "camera shake." They do not explain how it is that the camera shake produces converging lines. Nor do they notice that my little book contains multiple clear images showing ML particle ejections (for example, three ML ejection images on page 111 of my book, four more on page 113, one on page 121, one on page 125, three more on page 126, one on page 129 and one on page 131). Particle ejections are ML characteristics, not something one would expect from vehicle headlights and certainly not "camera shake."

Definitely, the relevant question is: can Bunnell prove that this cannot be due to camera shake? Obviously, he cannot. Our text has covered this in detail. Even independent expert opinion was sought. A camera shake when capturing a light that varies over time can lead to complex effects. In this example, one possibility would be that there were two successive micro-shakes (back and forth every time) along slightly different directions. Anyway, it must be remembered that our overall explanation is simpler (no hypothetical unknown phenomenon ejecting particles is

needed) and specifically able to account for the matching of the light track with Nopal/Escondido Road.

With regard of Bunnell's list of 14 "ejection images" (actually 12, since two are duplications), the most spectacular ones, that is, those belonging to the October 19, 2006 event, are not due to camera movement, they are "optical" artifacts instead (optical/infrared, to be precise, as these are photos taken with a camera with the IR filter removed). For more details on this topic, see the following Appendix 3.

5. ML1 on May 8, 2003 shown in my book as Fig. 28 and 29

*Report #8 provides a lengthy discussion of this remarkable ML capture (Report **Figures 32-37**). Their draft reproduction of my book image Fig. 28 [our **Figure 33**] is not nearly as clear as mine and that is a pity because there are four important aspects deserving comment and reader attention.*

- a. The ML clearly follows an ascending trajectory in a straight line for a significant distance. There are no straight-line roads that long anywhere in the mesa region.*
- b. During the climb it experiences an off state (typical ML behavior) that cannot be explained as an obstruction because the ML is flying above all potential obstructions. This conclusion is supported by Roofus data that the ML is north of the mesa region seen in the background plus there is clear evidence of falling remnants after the ML explodes.*
- c. The ML reaches an estimated altitude of 80 to 90 meters above terrain where it experiences an explosive event. The photograph captures an increase in brightness prior to the explosive event as well as falling remnants from that event.*
- d. Direction of travel to the West is clearly shown by the falling remnants demonstrating mass and momentum to the west.*

*Report #8 contends that this is not an ML flying in the air. They claim it is headlights of a ranch truck driving on the ground and being loomed up into the sky even though there are no signs of mirage conditions anywhere that night [Please see chapter 8 of my book for additional information regarding mirage conditions observed in Mitchell Flat.] VJBO/MBA try to explain the significant image gap as terrain obstruction. Amazingly, they claim this straight-line, high-flying ML can be dismissed as nothing more than headlights on some ranch truck driving **East** on a road. They dismiss the explosion and falling remnants as camera shake? Readers should take a good look at that photograph in my book. The photograph speaks for itself. In my opinion, there is clear evidence of a long, straight, climbing trajectory followed by an ML explosion that results in what are clearly falling remnants. Report #8 completely fails to make their case, in my opinion.*

This is our photo #9, see cropped version herewith. Let's not deceive ourselves, it is not true that "The photograph speaks for itself." Any interpretation must be preceded by a thorough study, which is what we have done. Bunnell states that "there are no signs of mirage conditions anywhere that night." Wrong. There is a mirage clearly visible (although not affecting the light track) in the following picture that same night, taken 3.5 minutes later! (Our photo #10, see the second attached cropped copy.) On the other hand, when we refer to the "looming" effect we do not consider just the lights of a vehicle "loomed up into the sky", but rather a whole strip of the landscape (containing the lights in question) appearing at a slightly higher angular elevation than usual from the observer's position, by the effect of refraction.



In our analysis of this event we have already shown that:

- The "ascending trajectory" is not a proven feature.
- There is a road near the mesa region that can explain the apparent path of the light track.
- Since it is not proved that the light "is flying above all potential obstructions", the "off state" speculation does not hold. Actually, we have shown that the gap in the light track was caused by the terrain.
- We are told that *Roofus* data indirectly support the conclusion that the light was not in the ground. However, Bunnell does not say a word about any of our criticisms of the data he extracted from *Roofus*.
- Bunnell sees an "explosive event" and "clear evidence of falling remnants" where we just see the effect of camera shake. In fact, we have provided similar examples showing up in other pictures of his.

In Conclusion

There are many additional points that I might make regarding mistaken speed calculations, misplaced ML routes, etc. I have not responded to their review of 2004 MLs, but if I do that, this response would be as lengthy as the FOTOCAT Report #8; readers of this discussion would fall asleep long before reaching the end. That's unnecessary. There is more than enough here (and certainly in my book) to make my case that my ML photographs, even the very earliest ones, are

not pictures of headlights. For unclear reasons FOTOCAT has a rule that limited their investigation to only my 14 and 15-year-old photographs, but FOTOCAT readers need not be so limited. Any readers who do have my book are encouraged to read the stories in Chapter 1 and to spend, even 5 or 10 minutes, viewing more than 60 additional color ML photographs in Chapter 6. You will be able to realize quickly that these ML photographs surely do involve something more than just car lights!

The stories in Bunnell book's Chapter 1 are anecdotal accounts. Why should we go back to unsubstantiated evidence when we supposedly have a set of objective evidence to examine? (Examining the hard evidence is precisely what we have done with the present monograph.) As for looking into the "more than 60 additional color ML photographs in Chapter 6," we have finally done it as part of our homework and found that two out of the three presented events are, once again, related to vehicle lights. In the third case (October 19, 2006) the absence of references in the background precludes any verification but -as mentioned above-, the alleged "ejections of material" that accompanied this event have turned out to be optical artifacts. We refer the reader to Appendix 3 for more details.

In my opinion, FOTOCAT Report #8 fails on many levels, as noted in this response, to make the argument for headlights as the source of my ML photographs. Has FOTOCAT #8 persuaded me that any of the reviewed MLs reported in my book might have been headlights? No. Not even close.

Presumably, this sums up Bunnell's conclusions. Blinded by faith. We have not found any serious counterarguments in his rebuttal. If there were any, we would have considered them, as we are not personally committed to any preconceived idea. He obviously avoids facing some of our most severe criticisms (e.g., the light dynamics that point to the locked gate or the S-curve in some of the photographs).

*The biggest problem I have **with any effort** (e.g. the FOTOCAT Report #8) that discounts the very existence of Marfa's mysterious light phenomena is that I have seen MLs firsthand many times, so I know they exist even though they are rare.*

At the end of the day we contrast a claim ("I've seen them, and I know they exist") with forensic results (the examination of presented evidence points to car lights): faith *versus* science. If Bunnell wishes to play in the field of science, he should present better evidence. The evidence he has offered to date contradicts his interpretation.

Seeing the Marfa Lights for real is something that cannot be done from halfway around the world because ML behaviors are what make them mysterious. VJBO and MBA are both bright men. If they had taken the trouble, time, and expense to investigate on site in Marfa long enough (maybe 40 to 60 nights) to witness ML behaviors a few times in person, impractical as that might be, I suspect they might have gained a different perspective.

Bunnell is a serious investigator. No doubt about it. But he should know that science is not based on seeing to believe. Nor on personal interpretations or opinions, but on hard, solid, and documented proof tested by independent researchers. Proof that may become universally accepted. Proof that, although obtained in Marfa, Texas, can be transmitted and shared to be studied in Madrid, New York, Moscow or wherever, by any peer. The argument of “you have not been there” is more typical of a credulous person than a scientist.

I felt, having grown up in West Texas, that there would be a simple answer to the Marfa Lights mystery. I am an engineer (Bachelor of Science in Mechanical Engineering with graduate work in aviation) and am retired from 37 year of work in the defense industry (USA; last at BAE, Director Mission Planning). What convinced me to investigate the Marfa Lights was getting to see them in jaw-dropping-action and having that experience melt my skepticism. I am firmly convinced that the Marfa Lights I have written about are physical phenomena begging for scientific research that will unlock the treasures they hold and advance our knowledge into this new realm. There are already books available that argue that MLs are nothing more than misidentified car lights. Apparently, the authors of this FOTOCAT report are on their way to adding yet another. I hope they change their minds. Negative books from multiple authors are building a wall around earth lights phenomena, making it almost impossible for young talented scientists to obtain grant money and move the investigation forward. My own contribution is minor in relation to the kinds of studies that could and should be done. I am now retired from this pursuit, but I do want the effort to document and understand Mother Nature's gifts to continue. I frankly hope more young people will read my work and be excited about the possibilities of understanding what people in far west Texas have seen for more than a century. By the way, if you ever do get out to Marfa, go out to the View Park and look around. Go at night and take a picture or two. I am sorry you won't be able to talk to the ranchers, some now deceased, who helped so much with my camera stations. They had seen these mysterious lights since childhood, and they knew where the traveled roads were and where they weren't. They hated Marfa Light seekers who occasionally invaded their cow pastures and left trash, but they knew the lights were real and mysterious. They really wanted to know what the lights were. So did I. I still do.

Ironically, Bunnell does not realize what he has accomplished. He has got independent researchers like us interested in the subject and we have taken the trouble to seriously ponder and probe the evidence he has gathered. We have not written a report to present a negative opinion on the matter, but to show the honest conclusions we have arrived at after an in-depth, objective study. The problem is that the conclusions turn out to be contrary to those of Bunnell and he does not like them because they clash with his convictions.

APPENDIX 3: RECENT CASES REVIEWED

Introductory notes

As mentioned earlier, Bunnell's book *Strange Lights in West Texas* presents his best evidence in the form of photographs collected during seven nights between 2003 and 2007. So far, we have focused on reviewing the first four examples within the scope of FOTOCAT's database, ending December 31, 2005. Regarding the three remaining photographic examples from the 2006-2007 period, we have come across additional images from which useful information can be obtained by applying contrast-enhancement techniques (histogram equalization and gamma correction). This, along with the insight gained from previous ML analyses, has made it possible to explain two of the three last cases. Our findings for the 2006-2007 events strongly reinforce our conclusions regarding the previous cases. First, we will summarize the descriptive facts about the 2006-2007 photographic examples.

In the book's Introduction we included a table listing the camera lenses used in every event of the 2003-2004 period (photographs #1 to #17). As an additional information, pictures for the last three cases of 2006-2007 were shot with a digital SLR camera (*Canon 300D*) with infrared filter removed and a spotting scope (*Celestron C5 Schmidt-Cassegrain 1250mm*), one that was already used to take photos #14-17 of May 8, 2004.

In these three more recent examples, one would expect to find precise coordinates of the ML locations triangulated from the data provided by the multiple video cameras available at the time. Surprisingly, this is not the case. The first two events (dated August 11 and October 19, 2006) were only recorded by one of the three automated stations operating at the time (*Owlbert* and *Snoopy*, respectively). The third one (dated July 23, 2007) involved a ML "too far north to be seen and recorded by any of my automated night cameras, so the actual distance from the View Park is unknown"—in Bunnell's own words.

Contrary to the photographs of October 19, 2006, those of August 11, 2006 and July 23, 2007 were shot during moonlit nights and display some details of the landscape. This has allowed us to identify most of the "mystery" lights in the photographs taken during these two latter events.

Event dated August 11, 2006

During the last minute of a five-minute appearance, “a dozen pictures” of a ML were shot from the locked gate on Nopal Road at 00:16 (CDT). About an hour after the event, a “magnetic flux density disturbance” suspected to be related to the ML was measured in the photographer’s hand meter.

We have analyzed the sequence of 13 photos presented in a 2012 Bunnell’s documentary.²² As we show in **Figure 92**, the photographed lights are most likely the headlights of a vehicle located two times farther than estimated by Bunnell. As the figure legend explains in detail, the alleged ML light tracks match the local road stretches, and the motion direction is consistent with the proposed vehicle explanation.

The speed of travel would be around 30km/h, a result that is consistent with that scenario.

As a side note, it seems that the times given in the book are slightly erroneous since they differ from the timeline indicated for four of these photographs, reproduced by Bunnell in another source of his.²³ Here, times are in line with the Exif data embedded in these four images.

(22) <https://www.cultureunplugged.com/documentary/watch-online/play/10523/Marfa-Lights> (watch between minute 14:42 and 15:00).

(23) <http://web.archive.org/web/20070223150125/http://www.nightorbs.net/owlbert.htm>

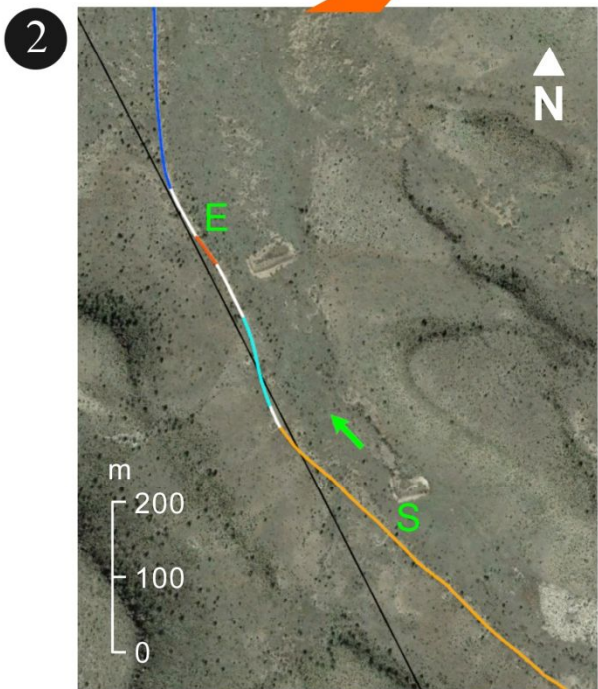
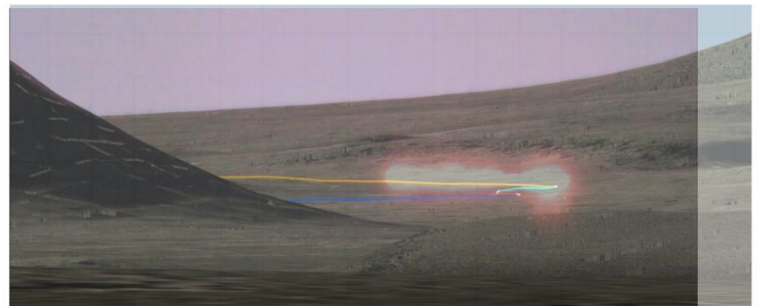
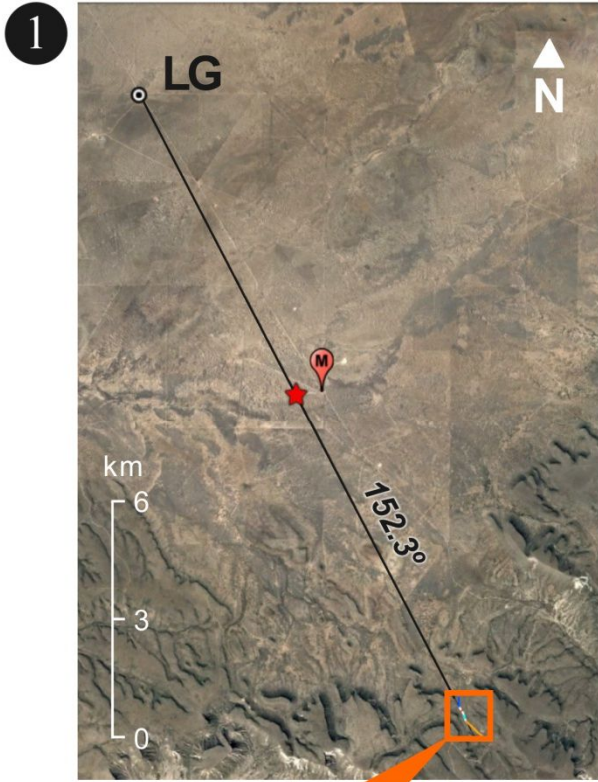


Figure 92. Event dated August 11, 2006.

1: Map showing the location of the camera at the locked gate (LG), the final position of the alleged flying ML according to Bunnell's triangulation (red star), and the spot where he later measured the magnetic disturbance (M). We have concluded that what appears in the photographs are the lights of a vehicle traveling north on a local dirt road within the orange rectangle, visible at an azimuth of around 152.3° from the locked gate. This is very close to the direction indicated by Bunnell: a measured magnetic bearing of 145° which corresponds to a true north azimuth of 152° (Marfa magnetic declination in August 2006 was $+7.0^\circ$, according to

<https://www.geomag.nrcan.gc.ca/calc/mdcal-en.php>).

2: Close view of the involved road section. Letters S and E mark the approximate starting and end positions of the vehicle as deduced from the photographs. The dark blue and light blue color sections denote that the headlights would be seen moving from right to left from the locked gate. Analogously, the sections on orange and red colors correspond to a left to right movement. The white stretches of road point directly to the locked gate, resulting in apparent motionless intervals.

3: Composite of the six first photographs in the series of 13 shots (we have contrast-enhanced the image). The light moves to the right and then stops, remaining apparently stationary in the two next photographs (not included).

4: Composite of the last five photographs (contrast-enhanced by us). Note the repositioning of the camera, compensated here by shifting the image rightward to maintain the vertical alignment with the previous composite image (3). The light moves slightly to the right starting from a different position than the last one shown above. Finally, it seems to get hidden behind the terrain while the final shot hints to a possible course reversal (not noticeable in this composite image).

5 & 6: Comparison of the composite images (3) and (4) with a Google Earth simulated view of the landscape (7). The different road stretches are identified by the same colors shown in (2). The light tracks match the orange and red road stretches, and the motion direction is consistent with the proposed vehicle explanation, in both cases. Note that the photographic sequence would have missed the drive along the light blue road stretch, coinciding with the repositioning of the camera. There is a detail that needs further clarification: this simulation fails to account precisely for the final disappearance of the light hidden behind terrain closer to the camera.

7: Google Earth simulated view of the landscape as seen from the locked gate.

8: Enlarged view of the road section of interest visible in (7).

(Maps and landscape view: Google, Landsat/Copernicus. ML photographs: © James Bunnell.)

Event dated October 19, 2006

According to Bunnell's book, he "took 152 ML photographs of one very interesting ML" that started at 19:36:08 CDT²⁴ and lasted 21 minutes and 49 seconds. Cropped images of 42 of the photos are reproduced in his book's figures 38-43, identified by a number between 330 and 444, inclusive. Exposure times varied between 0.6 and 8.0 seconds. The coordinates of the camera given in the book correspond to a place next to Barlite Ranch, from where the ML was seen toward the southeast. No directional bearings were taken on site and, besides, "it was such a dark night that no background terrain was captured in any of the photographs." Only a general location information is provided, based on data from one of the cameras at the *Snoopy* station.

Besides the images reproduced in the book, 41 additional photos can be found at an old Bunnell's website,²⁵ where he wrote that "the ML appeared twice or else there were two separate MLs," and went on to reproduce images of an "ML1" observed from 20:59:10 to 21:03:27 CDT (23 early photos, out of which only one appears in the book, photo 330) and an "ML2" observed from 22:03:03 to 22:07:16 CDT (26 photos, including book's photos 343, 345, 349, 352, 366, 371 and 374). However, there is no mention of any further ML manifestation despite the fact that the book reproduces 34 subsequent photos (identified by numbers between 395 and 444). Even more, the last image in that website, which should be labelled as photo 376 according to the numbering in the book, is followed by this caption: "End of October show." Quite confusing.

The above times are in conflict with the starting time (19:36:08 CDT) stated in the book. In fact, the latter seems inconsistent with dark night conditions, as sunset took place only 15 minutes before. It is reasonable to think that the times mentioned in the website are the right ones. Furthermore, they are consistent with the times given in a more recent Bunnell's website, which reproduces four photos of the event.²⁶ According to this last reference, photos 330, 415 and 444 were shot at 21:03, 22:42 and 22:46 CDT, respectively.

In the absence of any visible feature of the landscape, we are not able to infer true observation bearings nor detect any possible repositioning of the camera. Therefore, we cannot draw any final conclusion about the nature of these lights, although vehicle lights are the most obvious possible explanation. In any case,

(24) The book states "CST" but, on that date, CDT was actually observed. Likewise, while Bunnell gives 19:21 "CST" as sunset time, he should have indicated 19:21 CDT. Central Standard Time (CST) is 6 hours behind Coordinated Universal Time (UTC), whereas Central Daylight Time (CDT) is 5 hours behind UTC.

(25) <http://web.archive.org/web/20061210185841/http://www.nightorbs.net:80/owlbert.htm>

(26) <http://nightorb.ipower.com/www.marfalightsresearch.com/7401.html>
(image #12 from the slide show).

what we find here is a blatant case of misinterpreted evidence, as we will show in a minute.

Bunnell interprets some features from the photographs as “explosive bursts” resulting in “red (heated) atmospheric extensions that, unlike MLs, were wind responsive.” He considers the evolving “leg” patterns seen in some sequences as “heat trails” (heated air) being “blown away by wind”, fading and going out as they cooled. Nevertheless, similarity of the patterns in all the images and positional symmetry are solid arguments against the above interpretation and point to mere photographic artifacts instead.

In his book, the most distinctive “leg” pattern appears for the first time in photo 397. Its shape remains unchanged in the two following photos 398 and 399 (see [Figure 93](#), top right images). This implies that there were no changes during at least four seconds, the exposure time of photo 398. This may seem strange, but perhaps even stranger is the reappearance of an *identical* “leg” pattern in photo 412, more than half a minute later, at a completely *different* position relative to the ML. This is hardly consistent with any supposed random explosive process involving heated air.

The pattern is somehow present in, at least, 15 other pictures of this series, fainter and vaguer, yet still reminiscent of the two “legs” (see [Figure 93](#)). In most of those images, it appears more separated from the ML, and seemingly with a tendency to fade as the separation increases.

Furthermore, the cropped images in the book suggest that the *positions* of both the ML and the intriguing double pattern are connected in some way. We have confirmed this by comparing less-cropped images of the sequence of photos 396-406 (see [Figure 93](#), left column). The symmetry of the positions with respect to a fixed point (C) on the photos is obvious. We find the same connection in photographs of the August 11, 2006 event, where a similar luminous pattern appears on the upper part of the images (see [Figure 94](#)). Definitely, the heated air scenario makes no sense here.

Therefore, it is safe to conclude that the so-called “leg” patterns showing up in the photos of October 2006, in all their varieties, are just optical artifacts (maybe optical/infrared, to be more precise). They are associated with the photographic equipment used (a *DSLR* camera coupled to a spotting scope) and are similar to luminous patterns appearing not only in photos of the previous August 11, 2006 event—as we have shown—but also in photo #57 of the July 23, 2007 event reviewed below (see the second contrast-enhanced composite image in [Figure 100](#), where a luminous shape can be seen just above the skyline, at the right) as well as others of Bunnell’s photos (see [Figure 95](#)).

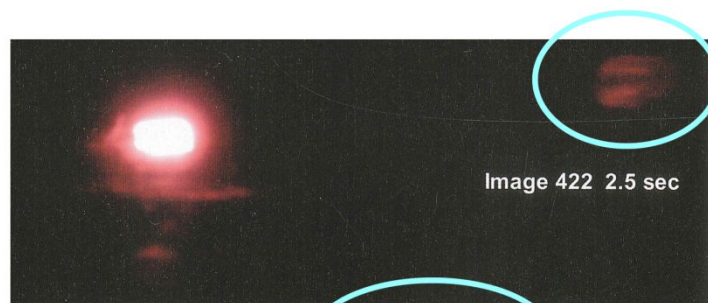
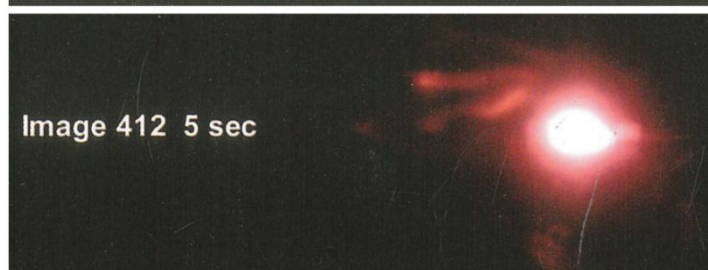
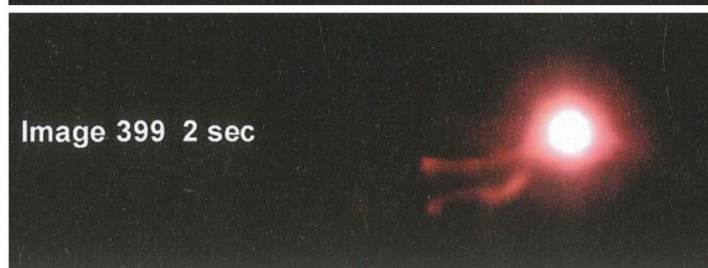
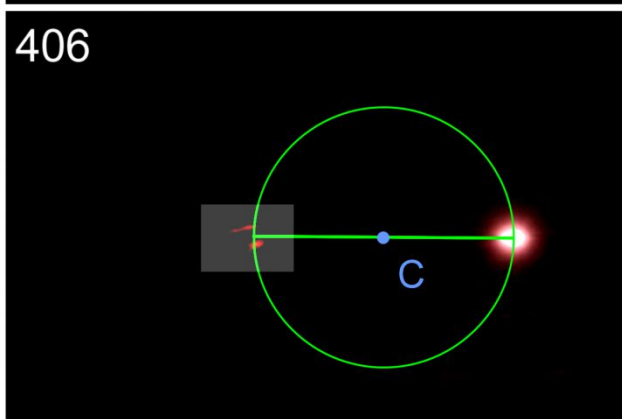
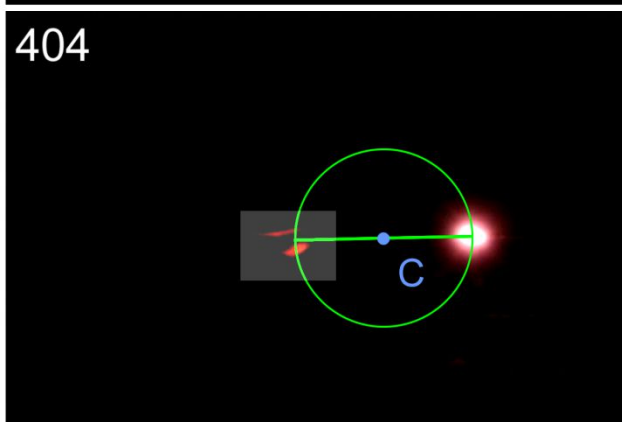
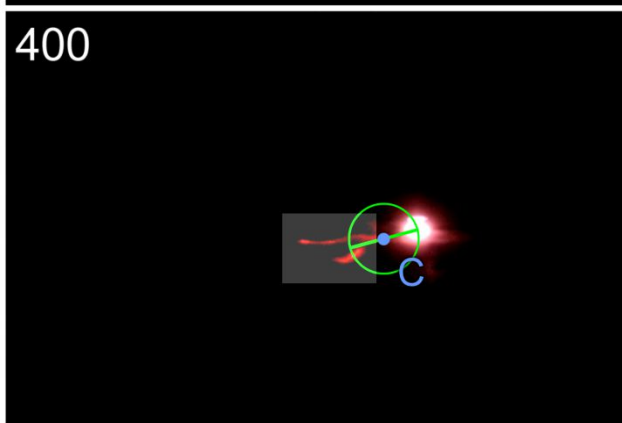
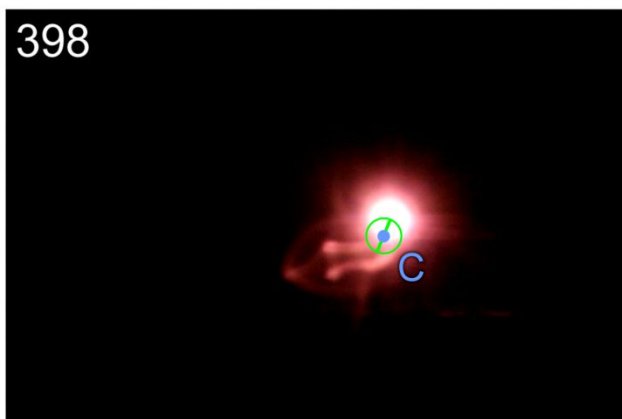


Figure 93. Event dated October 19, 2006.

Left: sequence of photographs showing alleged “heat trails moving left with the wind” while the ML was moving in the opposite direction. Only photos 398, 400, 404 and 406 are shown, from a video presentation available at <http://www.bbc.com/travel/gallery/20180116-the-mysterious-ghost-lights-of-marfa-texas>, where they are reproduced much less cropped than in Bunnell’s book. We have increased the height by a factor of 1.12 to match the relative proportions of the images in the book. We have also contrast-enhanced some portions of the photographs (gray rectangles) to highlight the “trails.” Note the obvious point symmetry connecting the positions of both the ML and the “trails” around a central point C. This is indicative of a lens effect creating optical artifacts.

Right (top): “leg” patterns showing up at different positions and times without changing their shape (images of photos 397, 399 and 412 from Bunnell’s book, including the text in white).

Right (bottom): other examples of “leg” or “trail” patterns, circled in blue (images of photos 422, 424 and 426 from Bunnell’s book, including the text in white).

(Photos: © James Bunnell.)

We will not discuss here the specific causes of these artifacts, which are not typical lens flares. Finding out what particular kind of artifact is involved must consider their two key properties: an unchanged luminous pattern or shape and their positional symmetry. They are not simple ghost images of the actual photographed lights. Apparently, the symmetry center (C in the figures) is not located at or near the center of the photographs (although we cannot be certain of this since the images in **Figure 93**—left column—and **Figure 94** might not show the photos in full frame).

However, in the expert opinion of photographic analyst Andrés Duarte, this is a known type of ghosting called “Schmidt Ghost”, caused by a reflection in the correction plate of the Schmidt-Newton and Schmidt-Cassegrain telescopes.²⁷ “The shape of the Schmidt ghost is a characteristic pattern specific to each telescope,” adds Duarte.²⁸

(27) <https://iopscience.iop.org/article/10.1086/648457>

(28) <https://www.cloudynights.com/topic/254071-anybody-know-how-to-process-out-a-schmidt-ghost/>

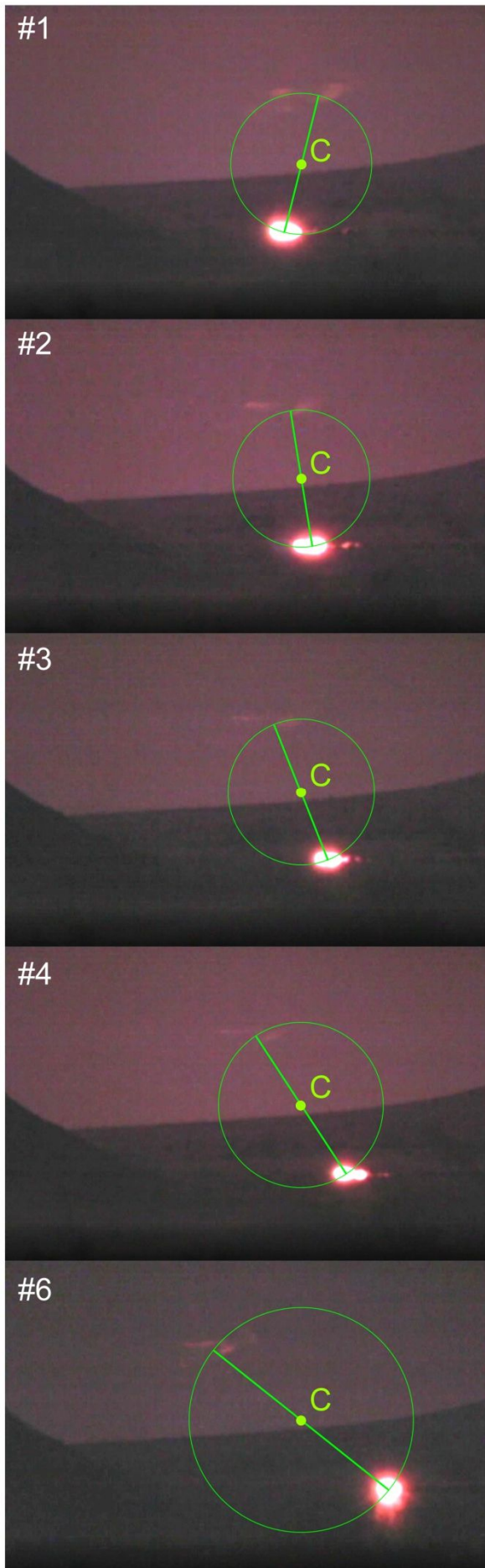


Figure 94. Lens-flare-like artifacts in photographs of the August 11, 2006 event, reminiscent of the patterns appearing in the photographs of October 19, 2006. The upper luminous shapes are neither clouds nor trails but optical artifacts, as evidenced by the symmetry with central point C. Images from Bunnell's documentary at: <https://www.cultureunplugged.com/documentary/watch-online/play/10523/Marfa-Lights> We have contrast-enhanced all the images. They might be somewhat cropped. (Photos: © James Bunnell.)

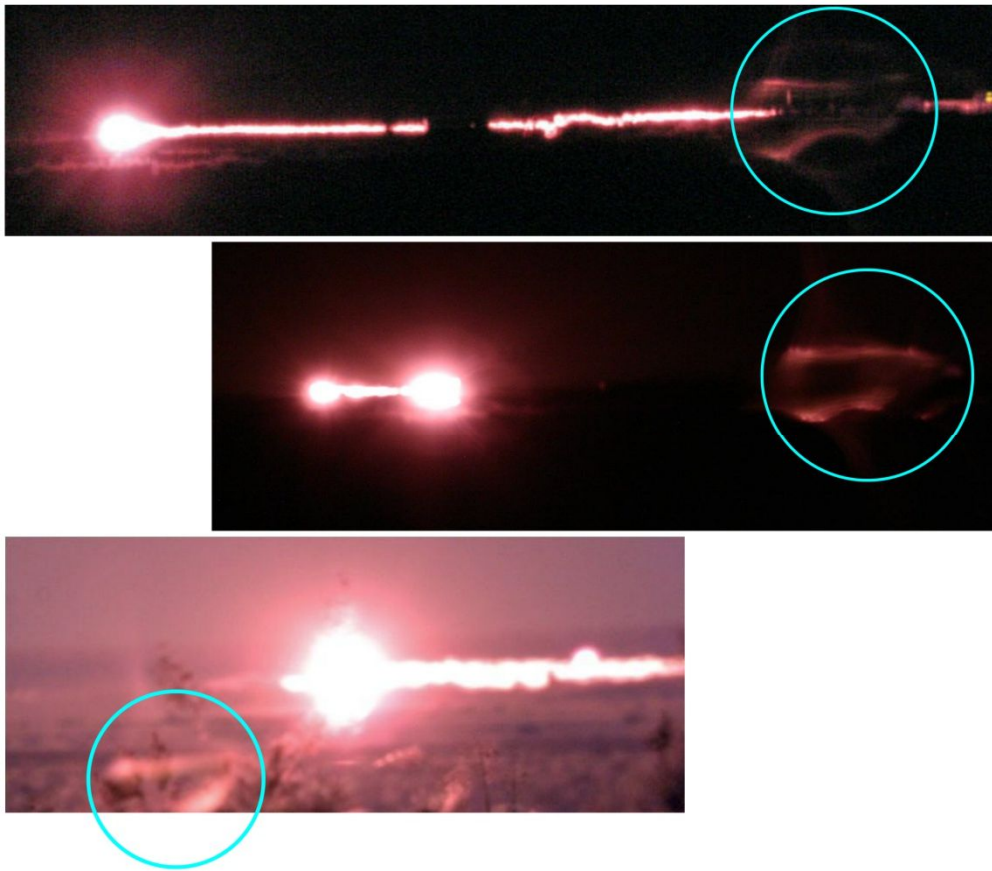


Figure 95. More photographic artifacts (circled in blue) similar to the patterns appearing in the photographs of October 19, 2006. We do not have any information about these images, which we reproduce here as they appear at:

Top: <http://web.archive.org/web/20080131150315/http://www.nightorbs.net/index.html> (old Bunnell's website).

Center and bottom:

https://www.researchgate.net/publication/278523084_The_Recurrence_of_Anomalous_Aerial_Phenomena_and_Laboratory_Areas_for_a_Scientific_Investigation

("The Recurrence of Anomalous Aerial Phenomena and Laboratory Areas for a Scientific Investigation", Power Point presentation by Massimo Teodorani, 2010.)

(Photos: © James Bunnell.)

Event dated July 23, 2007

A ML which appeared at 21:26:10 (CDT) and lasted 22 minutes 38 seconds was captured in a series of 62 or 63 photographs (as for the exact number, see the discussion below) with exposure times of up to 5 seconds. The camera was located at the SW plaque of the MLVC. The reported initial and final magnetic bearings were 152.4° and 215°, respectively (corresponding to true north azimuths of 160.4° and 223°, considering a magnetic declination of 8.0° East at the time). The ML was not recorded by any of the automated night cameras. Therefore, the actual distance to the MLVC could not be estimated.

Bunnell's book provides a very useful composite image of the first ten photos (his figure 47) as well as a select collection of 29 additional photos (his figures 48 to 50), which turns out to be of little or no use since they are reproduced severely cropped. Fortunately, a far less cropped version of some of the latter can be found in a PDF file he uploaded in 2013 to a former website.²⁹ We have built a table in **Figure 96** to show the correspondence between both sets of images. The photos in the book are labeled with a three-digit number (listed in the second column) while those reproduced in the PDF file are identified by its time (listed in the third column) and a plain ordinal number (listed in the first column) which we have adopted, for practical reasons, to refer to any of the photos onward. As only selected images are shown in these sources, "for brevity," there are missing images for 16 of the photos.

Bunnell's book states that "the complete photo sequence is 63 images long" whereas the PDF file indicates "62 images long" and refers to photo #62 as the "last slide." Another numbering inconsistency has to do with the "first ten photographs" gathered in the book's composite figure 47. Only two of them are included in the PDF file, the first and the last ones, but they are numbered as #1 and #12, not #1 and #10 as we would expect, a mess that hinders a proper evaluation.

The table in **Figure 96** also shows the photographic timeline (according to the times given in the PDF file) and actual information regarding the successive positions of the camera. We have deduced it from the changing landscape visible in the images from the PDF file, that we subjected to a contrast-enhancing process. Different cell colors in the third column of the table imply different camera positions (a blank cell simply means that the photo is not reproduced in the PDF file). On the other hand, different colors also reflect our interpretation in terms of three basic sequences of photographed lights, as follows:

(29) <http://nightorb.ipower.com/www.marfalightsresearch.com/49201.html>

- Blue cells refer to photos of traveling lights, possibly the same source of lights in all the instances. It was photographed in three different moments.³⁰ We are convinced that these were the headlights of a vehicle driving northward all along Nopal/Escondido Road. We call this sequence B.

- Yellow cells refer to photos of a stationary light that we have been able to identify as the central mercury vapor ranch light (CMV). In the PDF file, Bunnell drew attention to its “greenish hue,” not present in the rest of the lights. In fact, clear mercury lamps produce white light with a bluish-green tint. We call this sequence Y.

- Finally, the two subsets of orange cells refer to photos of another stationary light, unrelated to the above lights. It was photographed around minute 7 and then again around minute 19.5—as shown in the timeline—remaining at the same place on or near Nopal Road. We can easily formulate a conventional explanation consistent with the general scenario of the non-mysterious Marfa Lights: a car with lights on, for example, stopped by the road for a quarter of an hour. Though that hypothesis is extremely difficult to confirm, the bottom line is that a prosaic, non-anomalous alternative can be possible. We call this sequence O.

The table we have designed for [Figure 96](#) also gives, at the right end, the accurate location of the photographed lights. The map in [Figure 97](#) illustrates where the lights were when each of the released photographs was taken, according to our analysis. With regard to the traveling lights of sequence B (highlighted in blue), assuming it was a single vehicle, it traveled at an average speed of ~35-40km/h, which is within reasonable limits for a vehicle.

We have deduced the true location of the lights by comparing the background on the photographic images with a Google Earth simulated view of the landscape—as seen from the SW plaque of the MLVC. And we have found a good match! Three figures display the match found for the main sequence of photographs, that of the traveling lights we call sequence B (a car moving through Nopal Road): [Figure 98](#), [Figure 99](#), and [Figure 100](#). On the other hand, [Figure 101](#) illustrates the location of the first stationary light (sequence Y, ranch’s mercury vapor light), and [Figure 102](#) proposes a possible match of the landscape behind the second stationary light (sequence O, possibly a stopped car along Nopal Road).

(30) Actually four, if we consider photo #49 separately (an isolated image of the traveling lights that do not belong to their “third” and last appearance).

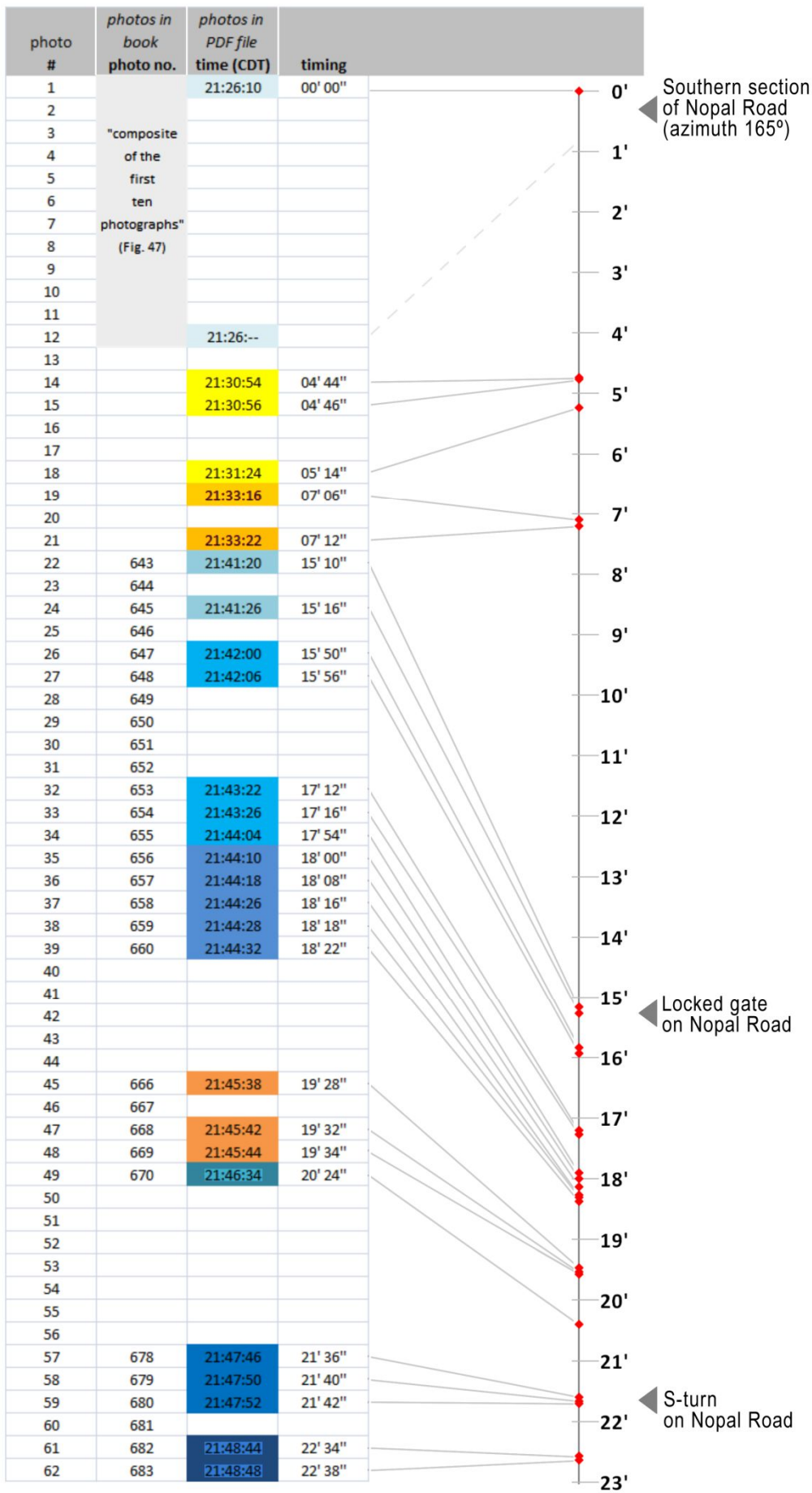


Figure 96. Event dated July 23, 2007: summary table of the photographic evidence (see description in text).

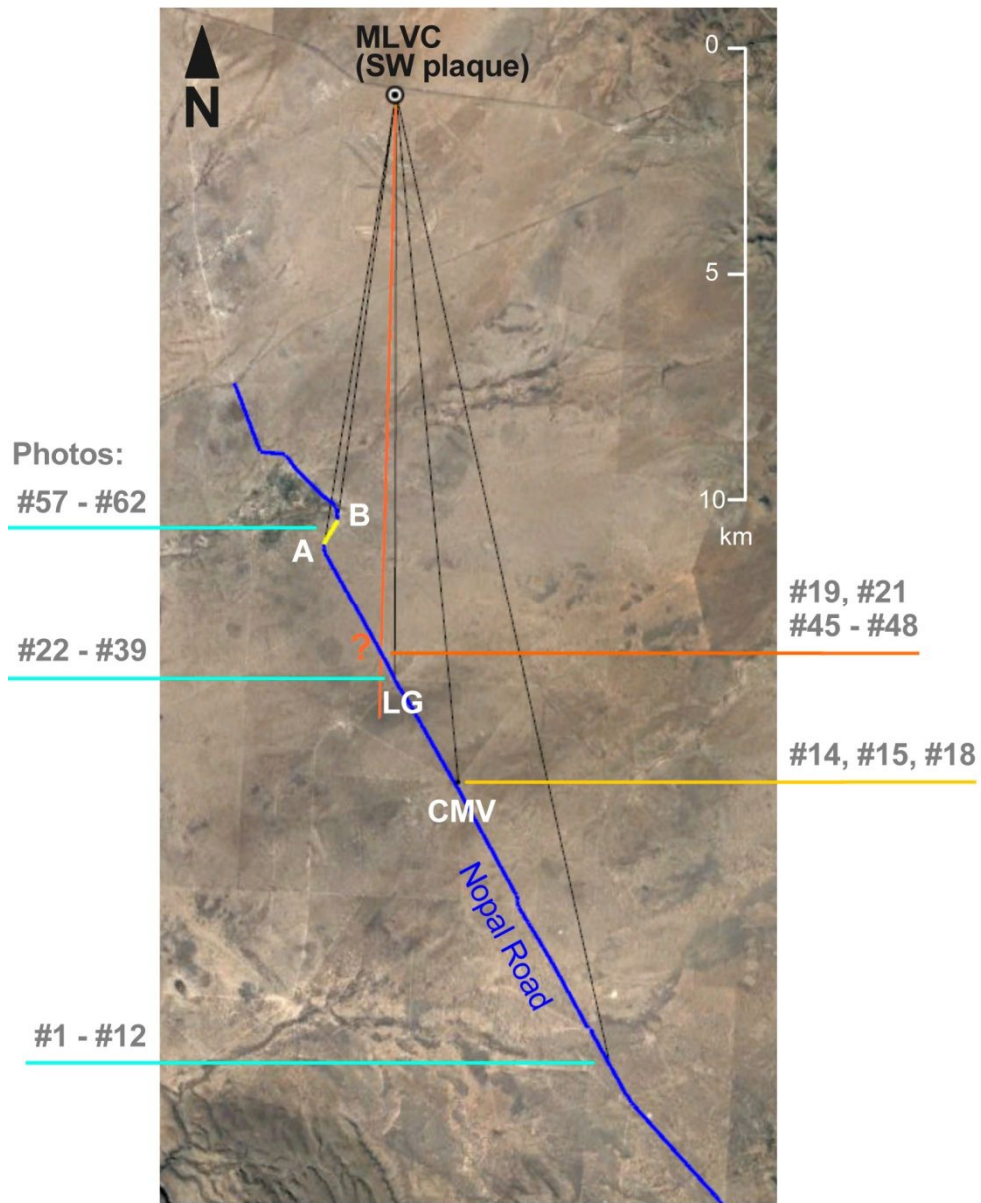


Figure 97. Event dated July 23, 2007: map showing the location of the lights captured in each photo (image: Google, Landsat/Copernicus).

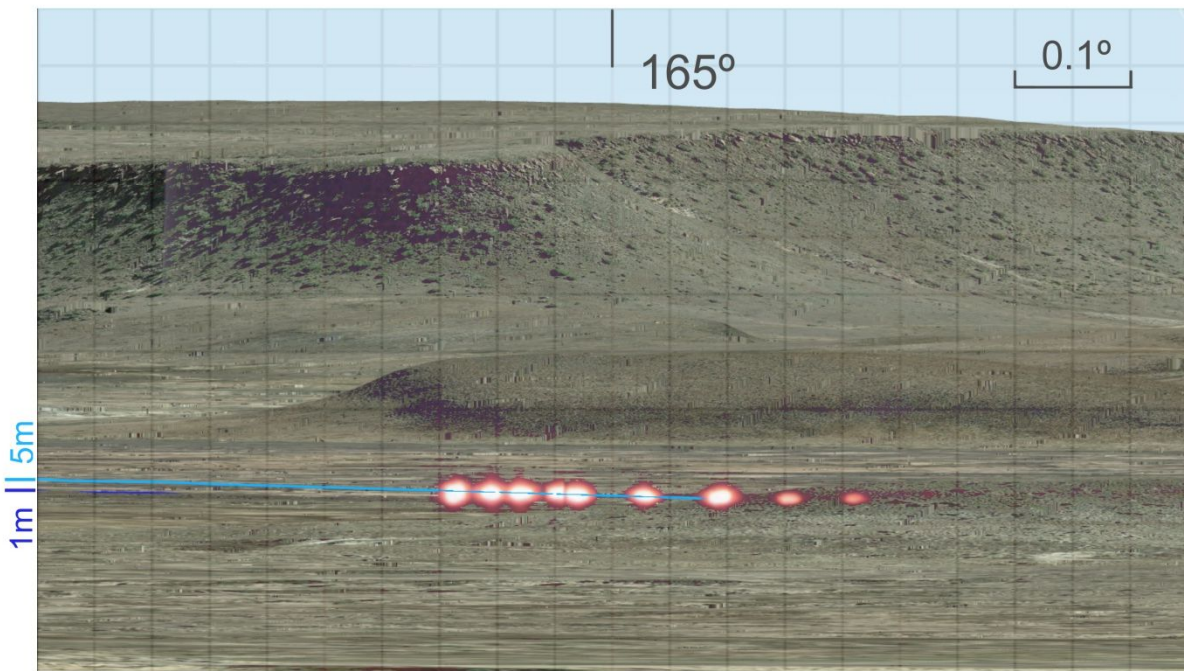
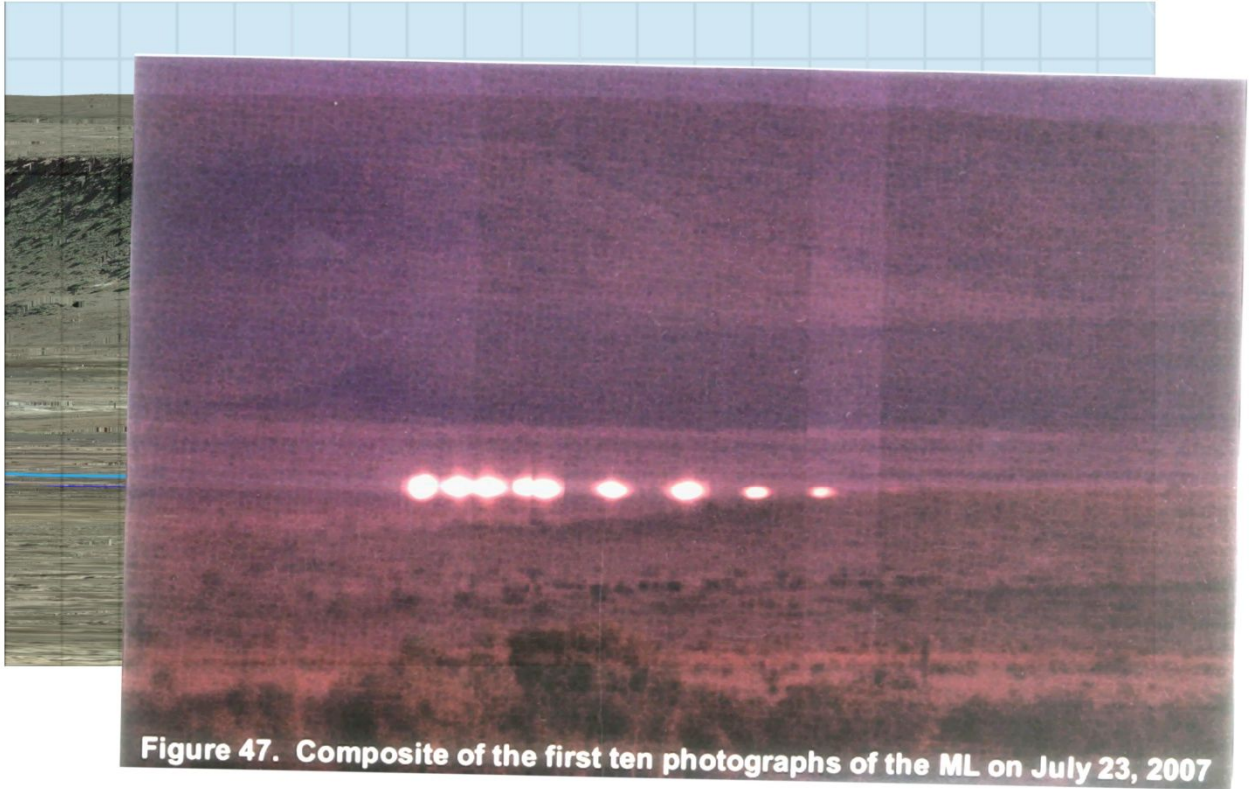


Figure 98. Event dated July 23, 2007: sequence B (first part) of traveling lights. Comparison of a composite of the first ten photographs of the ML (figure 47 in Bunnell's book) with a Google Earth image showing a southern section of Nopal/Escondido Road as seen from the SW plaque in the MLVC (paths 1m and 5m above the road are shown—purple and blue lines—to help visualize a possible raising effect due to atmospheric refraction). (Composite: © James Bunnell. Landscape image : Google, Landsat/Copernicus.)

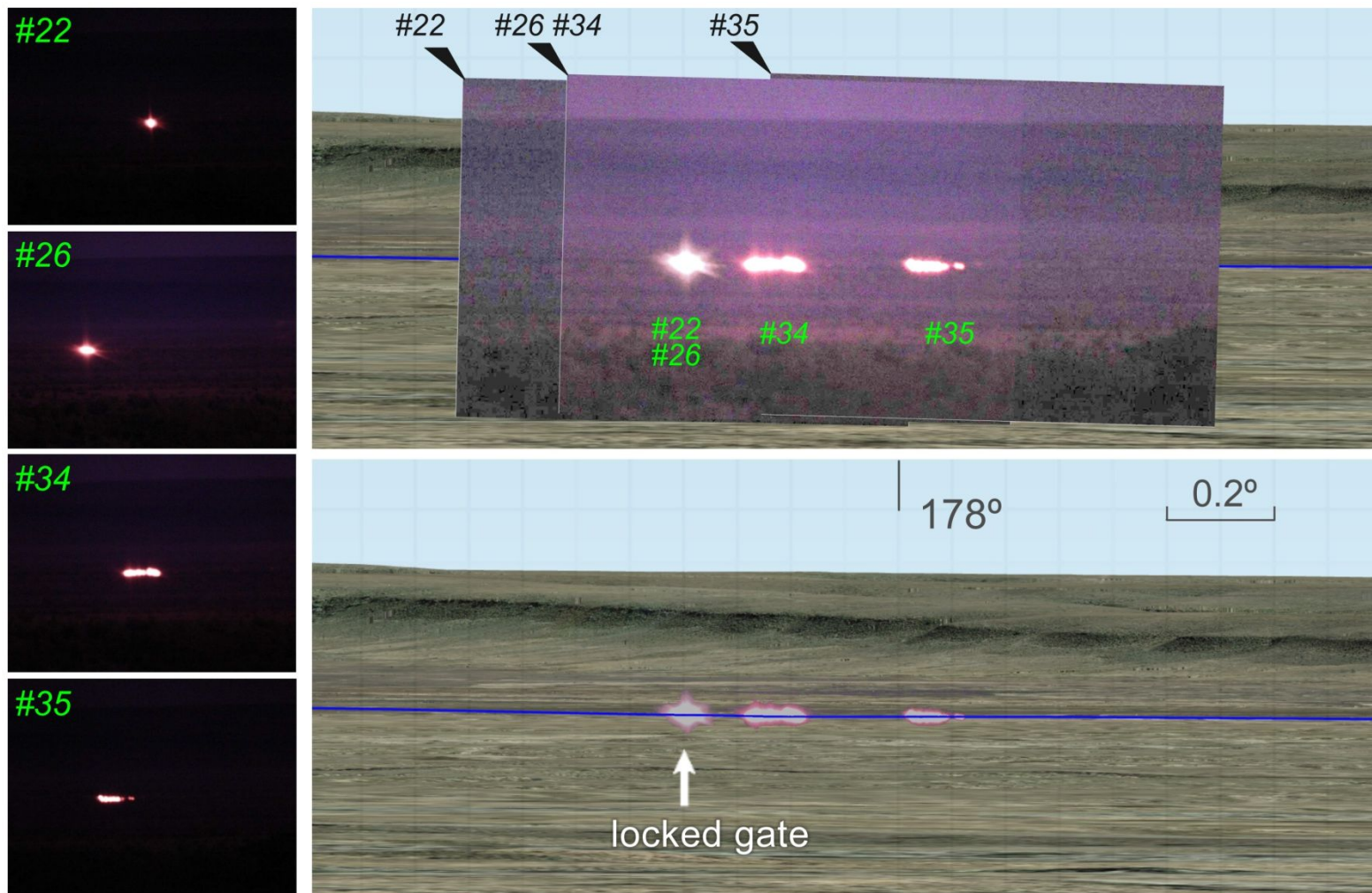


Figure 99. Event dated July 23, 2007: sequence B (second part) of traveling lights.
 Left: original version of four of the photos in the sequence.
 Right: comparison of a contrast-enhanced version of the photos with a Google Earth image showing the locked gate on Nopal Road as seen from the SW plaque in the MLVC.
 The camera was repositioned just before taking photo #26, and once again between shots #34 and #35 (this latter change is misinterpreted by Bunnell as a course reversal of the ML).
 The photographs show that the light was stopped at the locked gate before moving to the right.
 (Photos: © James Bunnell. Landscape image : Google, Landsat/Copernicus.)

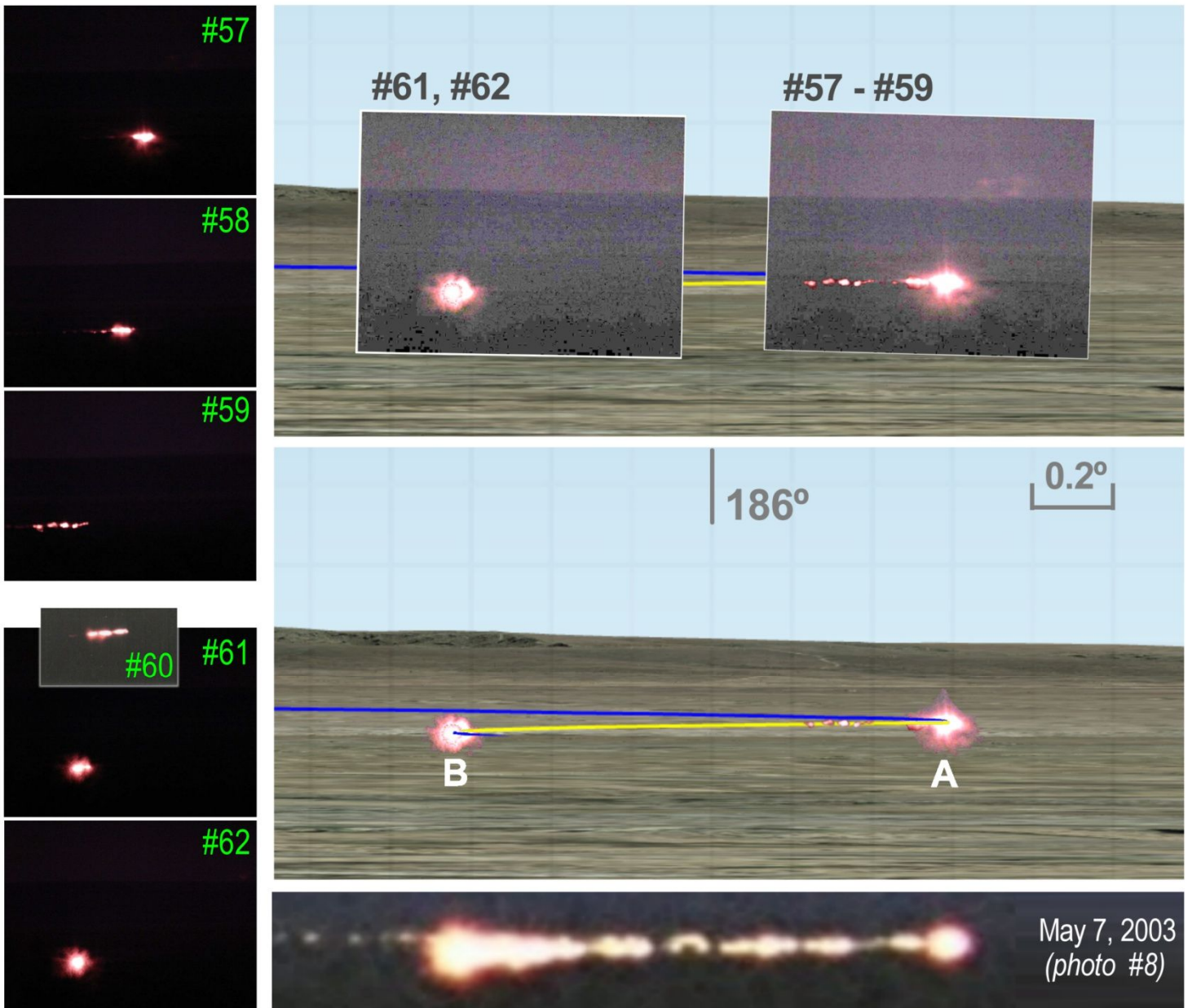


Figure 100. Event dated July 23, 2007: sequence B (final part) of traveling lights.

Left: original version of the photos in the sequence (we have been unable to verify the relative position of the light in photo #60, since there is only a cropped image available).

Right (top and center): Comparison of a contrast-enhanced version of the photos (displayed as two composite images) with a Google Earth image showing the S-turn on Nopal Road as seen from the SW plaque in the MLVC. Although, in this case, lack of detail in the available images precludes a precise comparison, they appear to be consistent with the proposed location.

Right (bottom): vehicle lights traveling through the S-turn as they appear in a time-exposure of May 7, 2003 (photo #8 reviewed in the chapter Events Analyzed). They are reproduced here at the same angular scale than the images above, for the sake of comparison.

(Photos: © James Bunnell. Landscape image : Google, Landsat/Copernicus.)

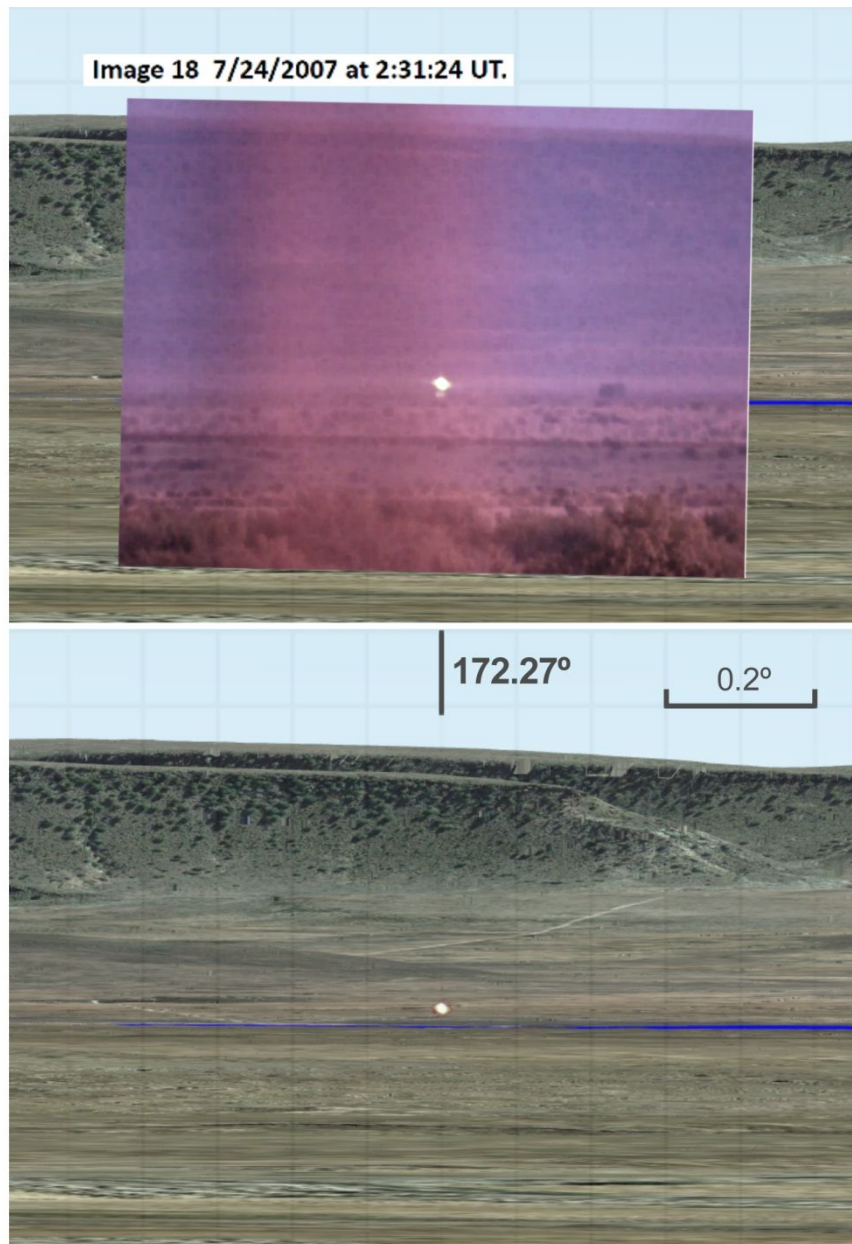


Figure 101. Event dated July 23, 2007: stationary light in sequence Y. Comparison of a contrast-enhanced version of photo #18 with a Google Earth image showing the central mercury vapor ranch light (CMV) on the vicinity of Nopal Road, visible at an azimuth of 172.27° from the SW plaque in the MLVC.

(Photograph: © James Bunnell. Landscape image : Google, Landsat/Copernicus.)

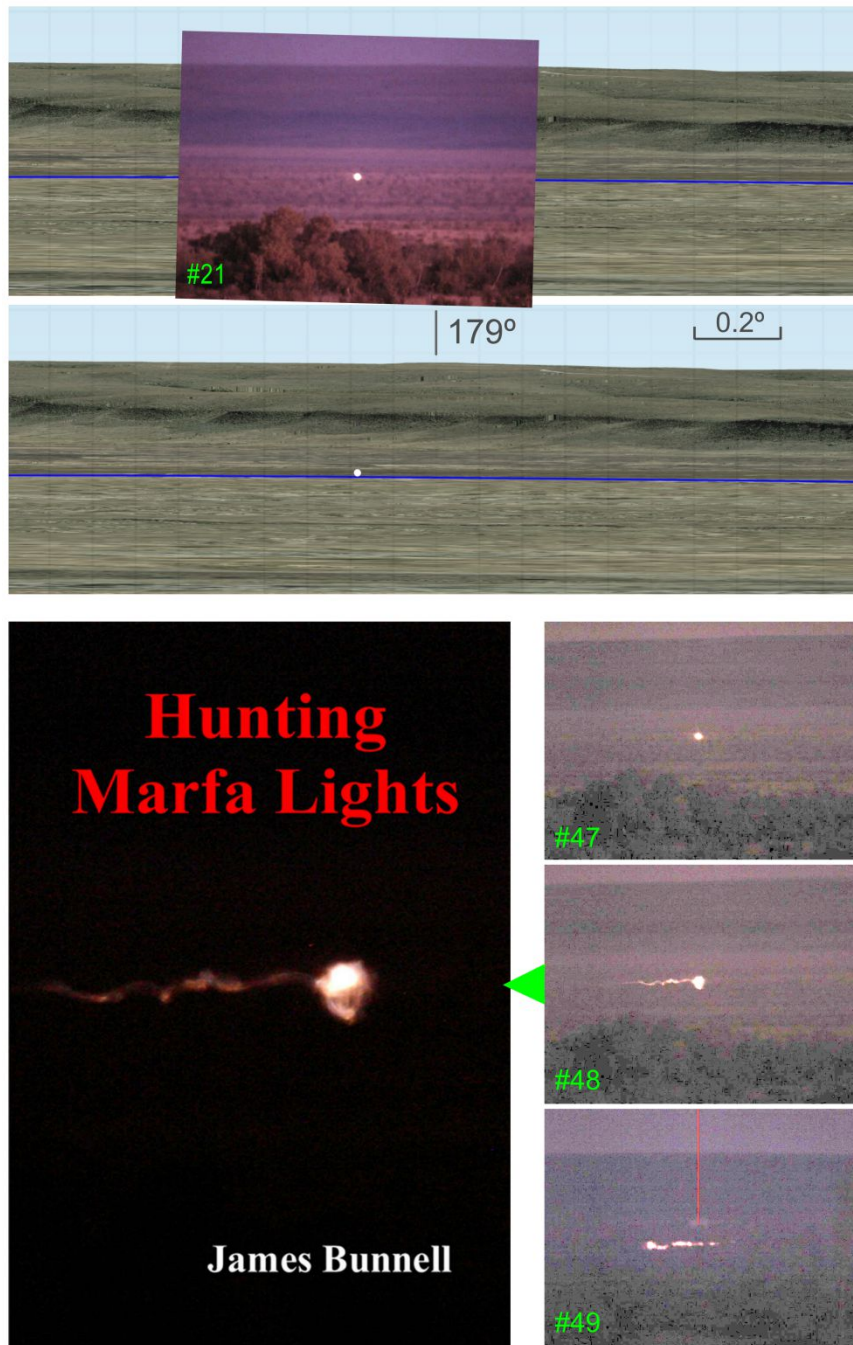


Figure 102. Event dated July 23, 2007: stationary light in sequence O.
 Top: comparison of a contrast-enhanced version of photo #21 with a Google Earth image showing a section of Nopal Road around azimuth 179°, as seen from the SW plaque in the MLVC. The background of the photo is too homogeneous to allow finding a precise match with the landscape. In any case, there is no ranch nor facility close to the road in this area.
 Bottom: cover of Bunnell's book *Hunting Marfa Lights* displaying the light in photo #48, which allegedly shows ejected material streaming out to the left. A contrast-enhanced version of the photo is shown at the right, accompanied by the previous and next photos (#47 and #49). See discussion in text.
 (Photos and book cover: © James Bunnell. Landscape image : Google, Landsat/Copernicus.)

Summarizing our findings on the July 23, 2007 ML series, the overall succession of photos appears to cover basically a vehicle's drive on Nopal/Escondido Road (main sequence, B). First photographed at a (true north) bearing of 164.85°, its lights reappeared at the locked gate some 15 minutes later. The last photos captured them at the S-turn, at a bearing of about 185.4° (by the way, not near the final azimuth of 223° indicated in the book). Note that the lights should have been unambiguously identified as vehicle headlights on Nopal Road since the photos show the stop at the locked gate and the flashing at the S-turn.

Bunnell remarks a midway "course reversal back to the left" in photo #35 (numbered as 656 in the book) for a short time. This would not be compatible with the vehicle explanation since the only reversal of the apparent motion is to be found later at the S-turn. Actually, we have verified that there was no reversal at all but a repositioning of the camera (see [Figure 99](#)).

As already stated, two other lights appear in this collection of photos, both of them motionless. While waiting for a second appearance of the traveling "ML" (in fact, the vehicle lights of the main sequence, B), Bunnell photographed the central mercury vapor ranch light around minute 5 (sequence Y) and, a couple of minutes later, an unidentified stationary light, but not necessarily anomalous (first part of sequence O). There was no follow-up, since the next photograph was taken eight minutes later and shows the "ML" stopped at the locked gate (that is, the second appearance of the vehicle lights). New photographs of that unidentified stationary light (second part of sequence O) were taken 12.5 minutes after its first appearance, followed by a shot of the traveling light after a time gap of almost one minute—as the timeline in [Figure 96](#) shows.

It is not clear if Bunnell regards these stationary lights as MLs. While he certainly did so in the 2013 PDF file ("ML is reacquired," he wrote in the caption of photo #14, which starts sequence Y) the early photos of the stationary lights have been neither reproduced nor mentioned in his 2015 book. Moreover, the ML is said to have reappeared "fifteen minutes after ML start" and been captured in photo #22 (numbered 643 by Bunnell), neglecting photos #14 to #21. In other words, the book skips sequence Y and first part of sequence O. Yet, paradoxically, it includes the second part of sequence O, which is reproduced in both references, presented as a return of the ML as a "stationary sphere."

On top of this, Bunnell considers the last photograph in sequence O (#48 or 669) "such a prime example of ML behaviors" that he "elected to use it as cover art for the second printing of *Hunting Marfa Lights*, in December 2009" (see [Figure 102](#)). Where he sees "ejected material [that] creates a twisted light trail streaming out to the left," we rather see a camera movement. We suspect that, actually, nothing remarkable was happening and, at the end of that exposure #48, the camera was being repositioned in search for another light. This would explain why the next shot (photo #49) did not follow immediately but came after a wait of 50 seconds, capturing a different light at a different place.

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From the star tracks we can deduce that these are two successive shots, with an exposure time of eight minutes (not four hours as indicated on the picture!) and three and a half minutes, respectively, with a time gap of about one and a half minute in between.

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OTHER FOTOCAT REPORTS RELEASED

Report #1 (Vicente-Juan Ballester Olmos)

The Year 1954 in Photos (Expanded)

Online access: <http://www.box.net/shared/y1mufymo8w>

El año 1954 en fotos (Versión Ampliada)

Online access: <http://www.box.net/shared/bg8v8enkso>

Report #2 (Vicente-Juan Ballester Olmos)

Argentina, The Year 1965 in Photos

Online access: <http://www.webcitation.org/6mx4rfU20>

Argentina, El año 1965 en fotos

Online access: <http://www.webcitation.org/6mx4oXV4n>

Report #3 (Vicente-Juan Ballester Olmos, Manuel Borraz Aymerich, Heriberto Janosch & Juan Carlos Victorio Uranga)

Avistamientos OVNI en la Antártida en 1965

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Report #4 (Vicente-Juan Ballester Olmos & Ole Jonny Brænne)

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Report #7 (Vicente-Juan Ballester Olmos & Wim van Utrecht)

Belgium in UFO Photographs. Volume 1 (1950-1988)

Online access:

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Book format: <http://www.upiar.com/index.cfm?language=en&artID=191&st=1>



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