

Who Mourns For Apollo?

-- Or --

Was It Really Only a Paper Moon?

by
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With

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In the last few years, we have become increasingly alarmed as a particularly silly and damaging "urban myth" has begun to take hold. Promoted by a few well known authors such as David Percy and the late James Collier, this latest twist on the current "conspiracy nation" fad is based on a simple, if unbelievably naive and absurd notion -- that the Apollo Missions and subsequent Moon landings were faked. Admittedly, we thought this whole issue was put quite nicely to rest in August 1997, when Enterprise Mission principal investigator Richard C. Hoagland "debated" Collier on Art Bell's "Coast to Coast AM" radio program. The results of that debate can only be described as an unmitigated humiliation for Collier, who turned out to be totally out of his element and misinformed on the general subjects of space travel, physics, engineering, NASA, and Apollo itself.

Yet still, it rears its ugly head today. Even after Percy's Fortean Times article was pretty much taken apart by readers, references to the "fake" landings began to creep into popular culture, springing up in such diverse places as Jay Leno's "Tonight Show" monologue and commercials featuring ESPN's Chris Berman. Usually, the references were tongue-in-cheek, but when we heard that the Fox network was planning a full scale special on the issue, we decided the time had come to say something.

Let us be clear; we are all uniformly, unabashedly, "conspiracy theorists" here. We are 100-percent convinced that there has been a cover up by NASA of some extraordinary discoveries made in the course of the agency's 40-year history. That said, one thing they did not do, unquestionably, was fake the Moon landings. In fact, most of the charges made, not just by Collier and Percy, but by others who have picked up the mantle of their assertions, are so absurd, so easily discredited, so lacking in any kind of scientific analysis and just plain common sense that they give legitimate conspiracy theories -- like ours -- a bad name. Frankly, we suspect that may ultimately be the point of this whole thing after all.

Almost from the moment that Neil Armstrong and Buzz Aldrin set foot upon the Moon at Tranquility Base, the rumors began that the whole thing was faked. We have always felt that there was something a little more to this than simple stupidity or naïveté. Something a bit insidious about the whole thing. We assumed that as time went by, the notion would weaken and falter, rather than gain momentum as it has recently. We have come to wonder, given our own stance on the whole question of what the Moon program

was really about and what the astronauts really found, if there wasn't perhaps something a bit "conspiratorial" about the promotion of this patently absurd and demonstrably false conspiracy theory.

As you will see, some of these charges can actually be more easily explained not just by a complete rejection of the Moon Hoax theory, but a combination of conventional explanations and our own "glass ruins" model of the Moon. The way light scatters on the Lunar surface; the size of solar reflections in the visors of the astronauts (which are way out of proportion to their counterparts on modern day Space Shuttle missions); the sometimes secretive stance taken by the astronauts and the Agency; the very peculiar qualities of the film in the cameras taken to the Moon by the astronauts, all point to something bigger and more interesting than we have been led to believe by NASA itself. But, we suspect that the promotion of this particular idea -- that the Apollo astronauts never went there at all! -- which is so easily discredited (as we will do below), is designed to lessen the blow when revelations regarding what NASA has really found across the Solar System begin to happen ... later this very year.

If NASA is eventually forced to admit that there was more to the Face on Mars than meets the Eye, that maybe they missed something "the first three times around," or that there is truly something "ancient and extraordinary on the Moon" ... then it will be crucial to have thoroughly discredited the "conspiracy theorists" out there (read: us). Remember, it is our position (and has been for some time), that this millennium cycle, the 2000-2001 period, is the beginning of an ongoing pattern of disclosure. Up to now, we had assumed that this would come in a series of significant revelations; of outright announcements that things are not quite what we had been led to believe. But now, we suspect that there will simply be a series of much smaller releases -- like simply taking a new image of the Face on Mars and releasing it without comment -- and pretending that the "Eye" isn't there staring back at them. If enough people can be convinced by this deliberate disinformation campaign that "there are no NASA conspiracies" -- by the deliberate promotion and then effective debunking of obviously bad conspiracy theories like "We Never Went To The Moon" -- then it will be much easier to sell the idea that NASA "just missed a couple of things" on those Mars pics all those years ago. And certain people, deeply implicated in the cover-up, will neatly escape the consequences for their theft over more than forty years of our entire space program!

So this then appears to be the political agenda. We plan to "scotch this thing once and for all" -- as a JPL spokesman was heard to say about the "Catbox" image of the Face on Mars -- in order that we might make clear the differences between what we have alleged, and the way that the powers-that-be would like you think about all things conspiratorial.

In this article, we will try to sort out the most common claims being made, highlight the rebuttal evidence, and show that the Moon landings were something quite extraordinary after all. Some of the details concerning these issues are beyond the scope of this article, however, and we plan to follow up with more specifics at a later date.

There are three major thrusts used by the fake landing advocates to bolster their claim: first, that the radiation exposure suffered by the astronauts was not survivable; second, that the photographic evidence "proves" that the landings were staged in a Disney movie studio somewhere; and third, that the mechanical aspects of the mission -- the pure mechanics and physics of the journey -- are not as claimed and therefore must be faked.

As you will see, each of these is based on misinterpretations, misrepresentations, or just plain ignorance of the realities of space travel. It is not a coincidence that many of the "believers" in this myth are too young to literally remember the Moon landings. If they had been old enough to watch the actual missions, especially on live TV, they would have known that most of these claims are poppycock. For this article, we will deal with each of these claims in separate sections, and try to directly address the key sub-claims being made.

Section One – The Photographic Evidence

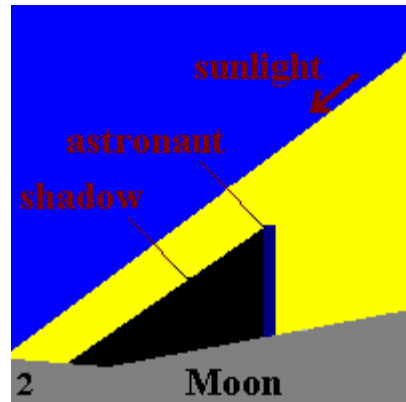
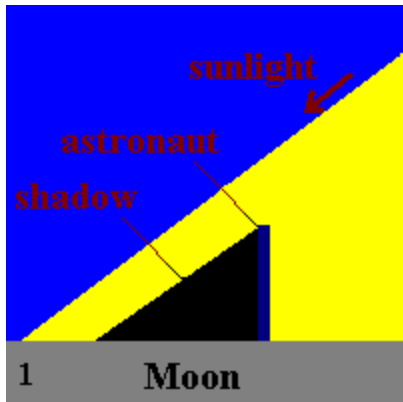
Percy is one of the primary drivers of this particular set of claims, but Collier and others have added to it. Let's list a few of the claims one-by-one and address them.

Issue 1 - The shadows don't fall right in images taken on the Lunar surface, proving that there are multiple light sources, like professional stage lighting using high-powered lamps. Since the Moon has only one light source, the Sun, these images (these people claim) "have to have been shot on a sound stage somewhere."



This one is usually based on images like the one above (taken from an Apollo 17 TV transmission), that seem to show the shadows of the astronauts coming from different lighting sources. However, a logical approach to this problem reveals that there is nothing at all mysterious about either the shadows or the light sources. If, in fact, the shadows were cast by different light sources, wouldn't each astronaut have two shadows, instead of just the one each we see here? Of course they would. Yet, in the images that the "Moon Hoaxers" cite, there is consistently only one shadow being cast, indicating that the Sun is (as it should be) the dominant light source.

So, how to explain the seemingly divergent shadows in this image? If you look closely, you will see that the astronaut on the right is on a slight rise above the astronaut on the left. This has not only the effect of lengthening his shadow, but also if the slope is greater in one direction, say to the left of the astronaut on the right, it will tend to flow and elongate in that direction.



It's important to keep in mind that the Moon has a very rough and uneven surface, with lots of slopes, rises and potholes. As a result, many of the shadows will appear to be non-parallel. Invariably, the Moon Hoax advocates will compare these lunar images to flat, smooth terrestrial landscapes, like this one below from David Percy.



In a sense, the Moon Hoax advocates are correct here; there is no comparison to be made from Lunar landscapes and terrestrial ones. But, it is because the surface of the Moon is so uneven, not because there are multiple light sources, i.e. lamps, casting the "wrong" shadows.

Also at issue is the photographic equipment used by the astronauts on the lunar surface. Shortened wide-angle lenses, like the ones on the hand-held Hasselblad 70mm cameras used by the astronauts, will distort otherwise parallel shadows. Simply pull some outdoor photos from your own personal collection and see for yourself.



Apollo 12 astronaut Alan Bean with Hasselblad camera on the surface of the Moon.

Issue 2 - The foreground of many images of the astronauts on the Moon are filled in with light, while the shadows remain absolutely black, again proving that there are multiple light sources.



In this one, the argument is that with his back to the sun, the astronaut's suit should be as dark as his own shadow stretching out in front of him (see Apollo 16 image, above). Since there is no light diffusion in an absolute vacuum, NASA "must" have used reflectors or "fill-in lamps" to illuminate the astronaut for this photograph. The truth is, there is evidence of a "reflector" in this image -- but it is the lunar surface itself! Obviously, the lunar surface is a fairly bright gray color. It is known, from the Apollo samples brought back and analyzed in Houston, to contain a LOT of glass beads, with a lot of reflective and refractive minerals in it. All of these materials tend to kick light directly back toward the source of illumination with very high efficiency, in this case the sun. This is one reason why the Full Moon is so much brighter (than other phases) in the night sky; the sun is "behind" the Earth. The effect of the sunlight hitting the lunar surface and being reflected back toward the sun itself creates a "backscatter" that fills in the astronaut's bright white shadowed suit with excellent "fill-light." And the fact that the shadow is so dark on the ground in front of him is proof of exactly the opposite of the claim being made by the "Moon Hoaxer" crowd. It shows that indeed, the astronaut is standing upright in a harsh vacuum, where his suit can "see" the illumination from the surrounding lunar landscape. By stark contrast (pun intended ...), almost no light at all has seeped into the shadow -- because it's lying flat on the ground and cannot "see" anything but black space overhead! It is, as it should be, extremely dark and sharp.

Interestingly, as to the question of multiple light sources, some of the leading debunkers of the Moon Hoax theory have also made a very significant mistake. It is flat wrong, as many of them have stated, that the Earth is a "very significant" light source on the Moon. When full, the Earth is on the order of 68.4 times brighter than a full Moon as

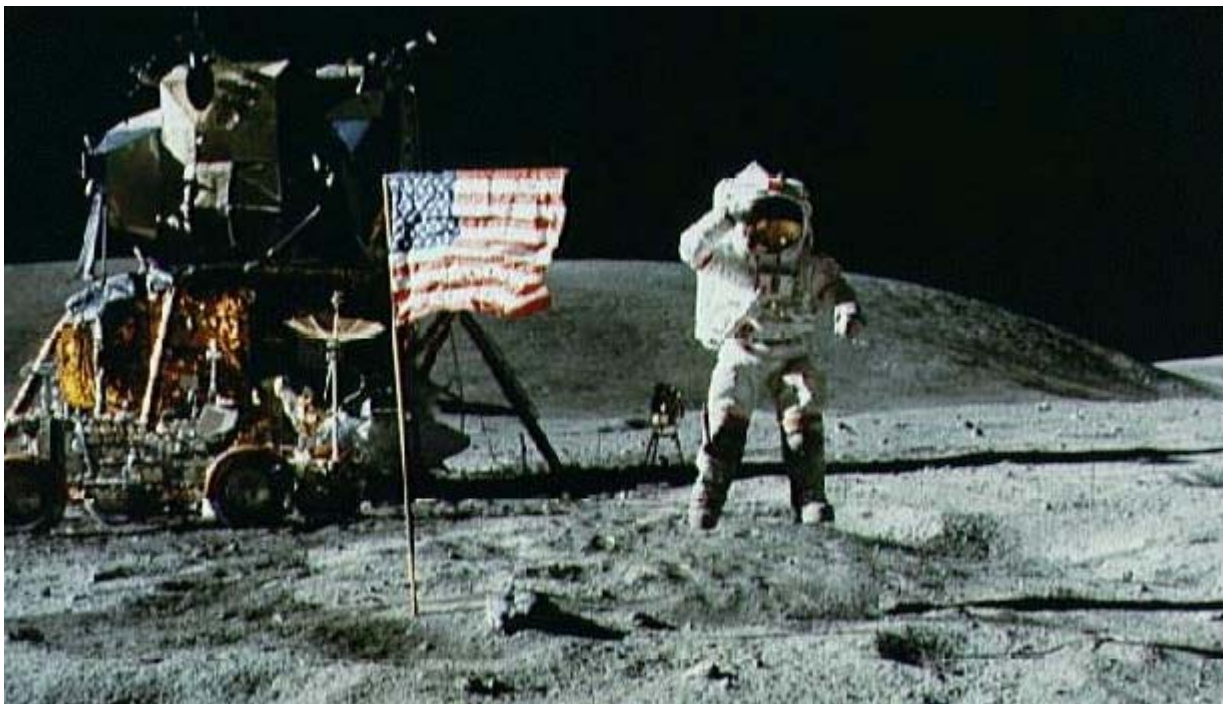
seen from Earth. It also takes up something like 13.5 times as much sky. But, that's not the whole story.

The Earth is -- maximum -- 100 times the brightness of a Full Moon (we're going to overestimate a bit to prove the point). The apparent magnitude (brightness) of a Full Moon is about -13. The equivalent magnitude of the Sun is about -27. Subtracting, that's a difference of 14 magnitudes. Since each 5 magnitudes corresponds to a factor of 100 in brightness, a difference of 14 magnitudes corresponds to almost $100 \times 100 \times 100$, or a factor of a million! Allowing for the ~ 100 times greater reflected brightness of the Earth (at "Full Earth"), the direct lunar sunlight is still $\sim 100,000$ times brighter than the Earth's illumination.

There is NO WAY that the slide films used by the crews (even the "super film" developed by EG&G, see below) could have detected that feeble "Earthlight" on the lunar surface, even in the shadows, with exposures set for the sunlit view.

Of course, we have our own thoughts on this. Some of the debunkers must be realizing that backscatter is insufficient to account for some of what we are seeing on the lunar surface photography. To come up with an explanation, they have resorted to the (obviously incorrect) "Earth light" angle; but it is of course, more interesting than that. Read on.

Issue 3 - There are no stars in the background from pictures taken on the Moon.



This one keeps coming up, but the answer, while obvious, is somewhat complicated by our own lunar conspiracy theory. Usually, Moon Hoax advocates cite any number of pictures of the lunar surface showing an absolute black background, but this one above of John Young saluting the flag in front of the LM "Orion" is quite prevalent. Anyone with the slightest knowledge of photography can easily put this one to rest. Any

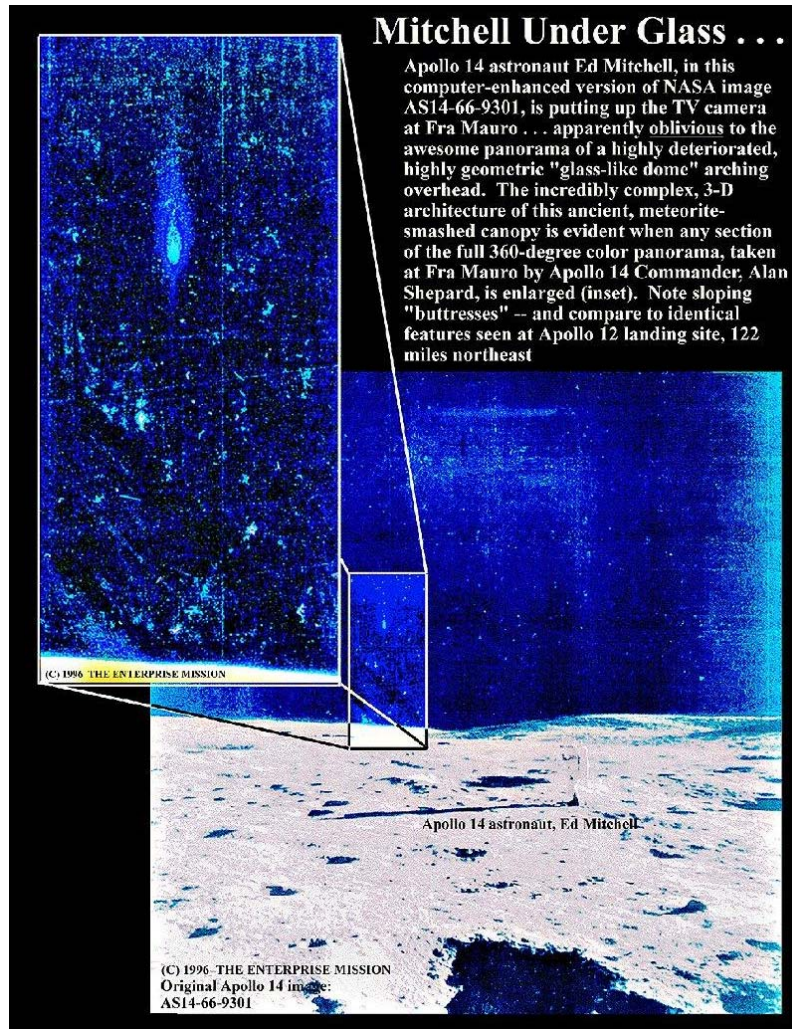
brightly lit foreground object must be photographed with a very short exposure time. Otherwise, the image will be badly overexposed. Any background pinpoint light sources - like, say, stars that are literally trillions of miles further away -- will not show up at all. Likewise, if the photographer wants to capture the background stars, he is going to have to use a very long exposure time, which means that the foreground will be totally washed out in one blob of overexposed light. Obviously, there would be no real benefit to taking such an image, since the point of the lunar surface photography was to document the activities of the EVA's on the lunar surface -- not to stargaze.

This whole process is complicated by the fact that in a vacuum, the problem is made even worse, the light far more intense, and the exposure must be even shorter. The Moon Hoax advocates also seem to have forgotten that they are basing most of their "analysis" on press release photos, which are invariably cleaned up before release to the press. So of course, these sanitized press kit images would reflect what we all would expect to see, an absolute black background.

Which brings us to our own thoughts on the Moon and lunar photography.

Contrary to what the Moon Hoax advocates have been saying, the sky above the astronauts should be absolutely black. And in fact, on most of the prints that they have been looking at, web based images, press release photos, and even new prints from the archives, it is. The problem is that while the sky should be absolute black, and does appear that way in images presented by the Moon Hoax advocates, it most demonstrably is not absolute black in the images examined by Enterprise Mission investigators.

As you know, a few years ago Enterprise principal investigator Richard C. Hoagland was approached by former NASA flight instructor Ken Johnston, Jr., and supplied with a set of extraordinary first generation prints of Apollo lunar photography which had remained untouched for nearly thirty years since he obtained them from inside NASA. What these prints showed was quite another story -- that the sky above the astronauts was far from blank -- it was in fact filled with a strange, bluish, geometric set of ruins.

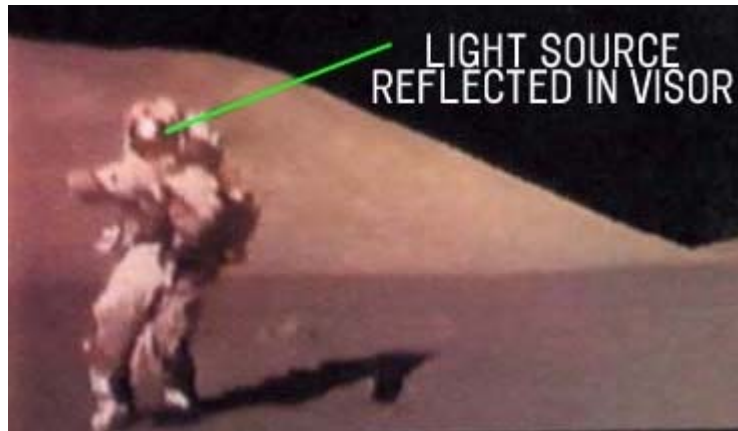


So the problem is exactly the opposite of how it is stated by the Moon Hoax advocates. The sky should be black, but it isn't.

One amusing sidelight of this Apollo 16 photograph is that it is used on several web sites as "proof" that many of the pictures taken on the Moon are fake, since John Young "... is casting no shadow at all!" on the lunar surface. In fact, all it really shows is how dumb most of the Moon Hoax advocates really are. If you actually look at the picture, you will see that Young is casting a shadow to the right side of the picture a few feet away. How can this be? Why is the shadow not "attached" to young's feet?! Well, because in this famous sequence, John Young is leaping into the air as he is saluting, while Charley Duke snaps the photo. Many Moon Hoax advocates, too young to have actually watched this all on live television, look at this picture and mistakenly believe that Young is standing on the slight dome shaped rise in the background, when in fact he is in midair (well, OK, mid-vacuum). This famous sequence is also a good way to show that the astronauts are indeed in the one-sixth gravity of the Moon, since in order to get this kind of elevation on Earth (especially with the bulky, several-hundred-pound spacesuit and backpack on), Young would have to have the leaping ability of Michael

Jordan! For those interested, I can highly recommend the excellent NASA video series "Apollo - Mission to the Moon" which shows film of this famous live TV sequence.

Issue 4 - In some images, a huge light source can be seen reflected in the astronaut's visors. This has to be a very bright, nearby source.



Apollo17



Apollo 1

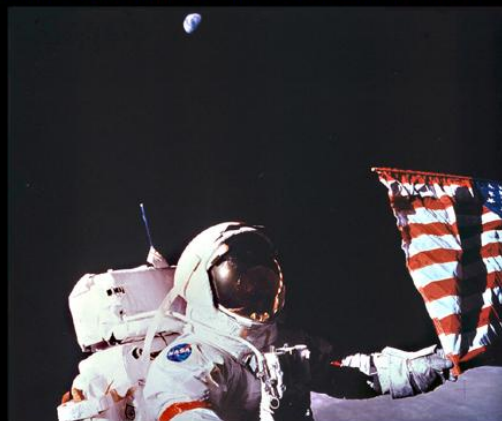
This argument is essentially a variation of the first argument. Occasional images, like the ones above (taken from the Apollo 17 EVA TV transmissions and Apollo 14), seem to show a very bright, huge light source taking up almost 25% of the astronaut's visor. Moon Hoax advocates argue that this is proof of a large light source (a stage flood or a spot, again) positioned very close to the astronauts. What they are missing here is essentially the same geometric problem they missed with the "bent shadows" argument. As you can see from the previous image of Alan Bean (above), the gold-covered helmet visors that the astronauts wore were very convex shapes -- similar to automotive wide-angle side mirrors included on many current models ("Warning: objects may be closer than they appear ..."). Like the surface shadows in the earlier images above, this curved helmet has the effect of severely distorting the reflections, making them appear much smaller (and thus farther away) than they actually are.

The problem: the sun, in the lunar helmet reflection pictured here, appears much larger (and therefore closer!) than it possibly could. Our explanation for this remarkable observation is firmly grounded in our investigation of the REAL conspiracy that NASA has worked so hard, for over 40 years, to cover-up: the presence of ancient, glass-like ruins on the Moon. It is these ruins, sticking up above the lunar horizon and physically intervening between the low-angle sun and the Apollo astronauts roaming across the surface, which create the magnified halo of scattered light seen in the gold visors. Since this area of "forward scattering" is much larger than the optical size of the sun itself, it makes the "reflection" appear disproportionately larger -- even in the curved gold visors -- than the view of a similar reflection of the sun from Ed White's helmet, photographed in Earth orbit on the Gemini 4 mission in 1965 (photographic comparison, below).

Helmet Reflection Comparisons

Ed White in Earth Orbit and Gene Cernan on the Moon

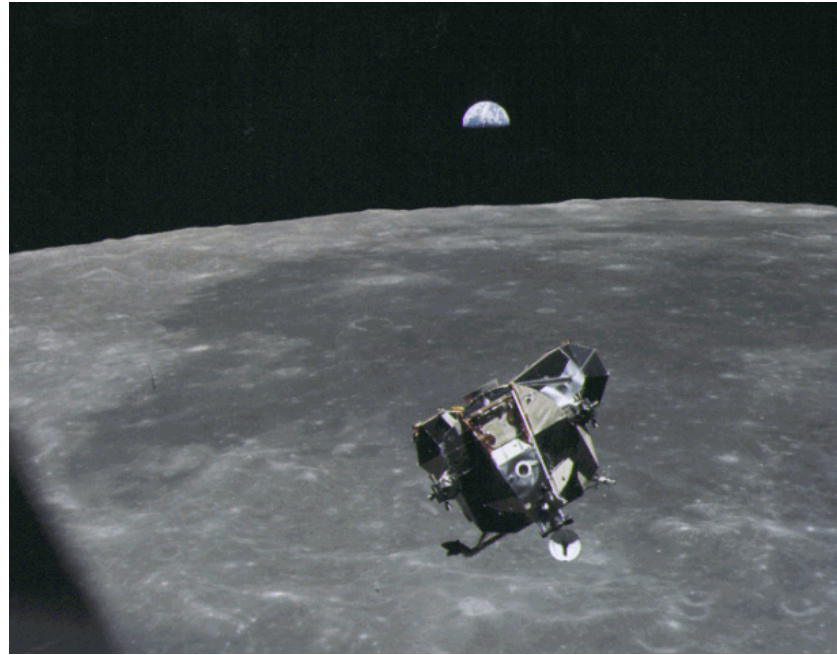
What's Wrong with the Sun's Reflection Compared to the Size of the Earth in Cernan's Helmet?



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Issue 5 - There are no views of the Earth in pictures taken from the Moon.

This one also is just plain wrong. Collier was among the most enthusiastic promoters of this mistaken notion, based on studying only a few press release photographs from NASA. Below is an Apollo 17 picture (on the left) of a large boulder, with the Earth in the background, taken by an astronaut with a hand held Hasselblad 70mm camera (the same camera which took the photograph of Gene Cernan, with the flag and Earth, above). Below right is a hand-held 70mm Hasselblad picture taken by Apollo 11 astronaut Michael Collins, as the Eagle approached the CSM for the return trip home. Since all the non hand-held pictures taken on or at the Moon were using something other than 70mm transparency film, these photos had to have been taken by a human being -- an Apollo astronaut -- physically present either on the Lunar surface or in space around the Moon.



Issue 6 - How could NASA take TV images of the LM ascending on Apollo 15, 16, and 17 if there was no one on the Lunar surface to man the camera?



Now, most of these charges are pretty dumb, but this one really has to take the cake. As you can see from the collection of images above (from two different missions) on the later Apollo missions (15-17) the astronauts left the TV camera pointed at the LM so that viewers on Earth could watch the liftoff. Initially, the camera was unable to track the ascent stage as it rose into space, but by Apollo 17, NASA had figured a way to get the camera to track upward and follow the spacecraft. So the answer to this one is also simple and obvious -- the camera was remotely controlled from Earth.

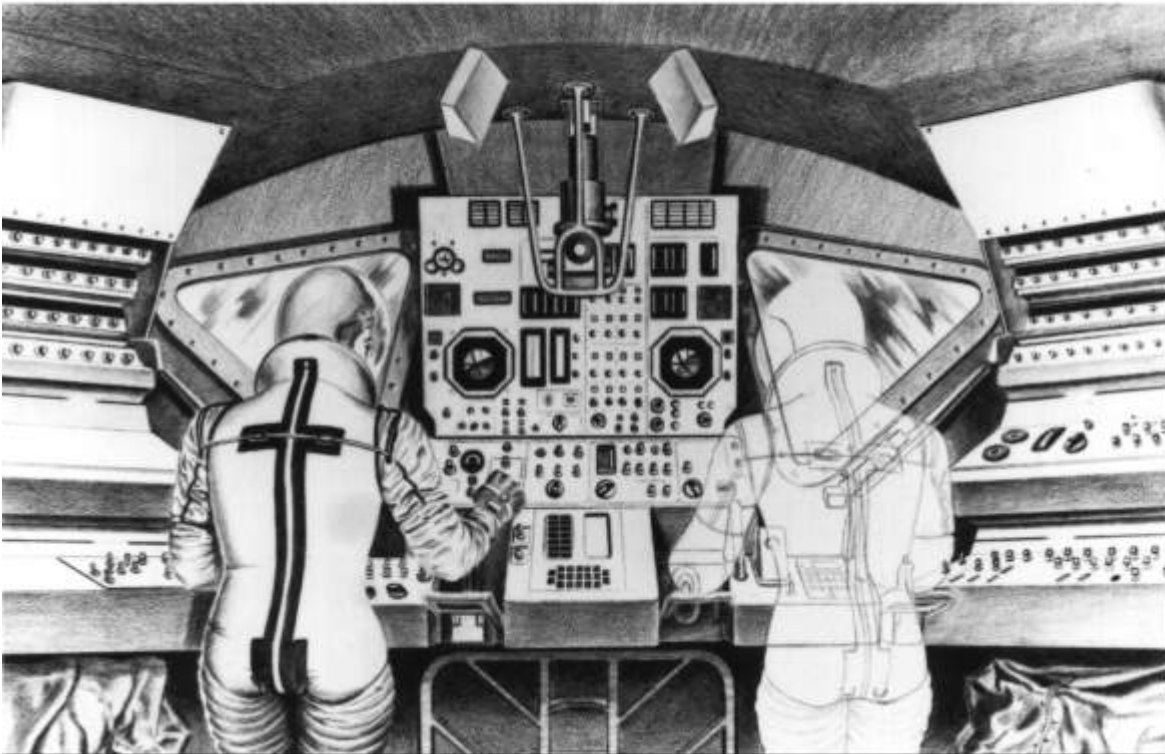
Section Two – The Mechanical Arguments

Most of these claims come from James Collier's "Was it only a paper Moon?"

Issue 1 - The astronauts could not have egressed and ingressed the LM because they could not fit through the hatch and there was no room to even open the hatch in the LM.

It's hard to know just how to respond to this one beyond simply stating that it is wrong. As you can see from the artist's concept below, the astronauts were positioned on either side of the central cockpit panel, with the main EVA door between them. There was in fact plenty of room to open the hatch. On Apollo 11, Armstrong would have been manning the left position in this view and Aldrin the right. The door was latched to Aldrin's side, necessitating that the door be swung open inward, and effectively "trapping" Aldrin momentarily on his side of the LM. In fact, this is the main reason that Armstrong egressed first. Once he was out, Aldrin was able to close the hatch, move over to Armstrong's position, and exit himself.

LEM COCKPIT INTERIOR



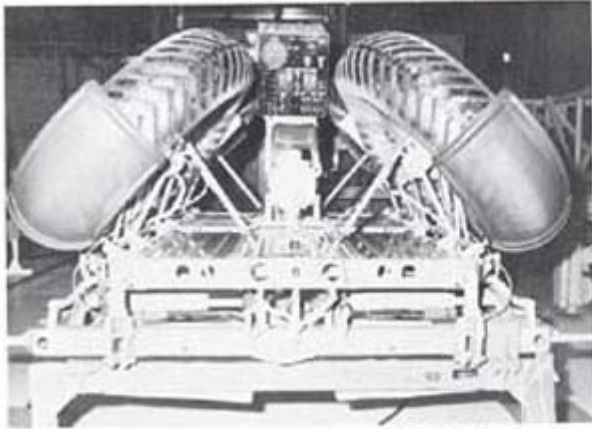
As to the issue of whether the astronauts could fit through the hatch, as you can see below, they must have. This is an image taken from a film shot by Armstrong of Aldrin egressing the Lunar Module. The entire sequence is available from the NASA archives, and shows the whole procedure from start to finish, including Aldrin opening the hatch and crawling through it.



Furthermore, if it turns out that the astronauts could not fit through the hatch, this will come as quite a shock to our friend and contributor Ken Johnston, Jr. He spent many hours in the vacuum chamber at Houston, fully suited up including the backpack, crawling in and out of the full scale mockup of the LM, to test exactly that. He'll be very upset to learn that he wasted all that sweat for nothing.

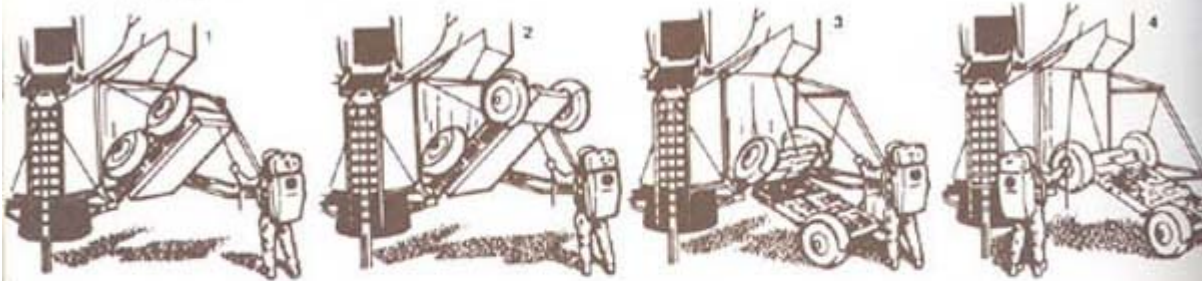
Issue 2 - The Lunar Rover was too big to fit in the LM.

Well, this is strictly true if you take the measurements of the Rover when it was fully deployed and assembled. However, the Rover came packed into a very tight little package which fit neatly into the space provided in the LM.



Folded up to fit within its storage bay in the LM descent stage, the little car was designed so that it almost assembled itself.

Deploying the Lunar Rover



Carried to the Moon in a nose-down, floorpan-out position, the Rover could be deployed by an astronaut paying out two nylon tapes. In the first stage the car swings out from its storage bay. Then the rear part of the chassis unfolds and locks, and the rear wheels unfold. In the third stage the front chassis and wheels snap out.

Finally, the astronaut lowers it to the surface, and unfolds the seats and footrests. Torsion-bar springs and latches made assembly semiautomatic. Power for the Rover came from two 36-volt silver-zinc batteries driving an independent $\frac{1}{4}$ -hp motor in each wheel. A navigation system kept track of the bearing and range to the LM.

Touring the Moon

Encumbered by a spacesuit, an astronaut on foot could not venture very far from the LM; carrying tools and samples made his forays more difficult. On the last three lunar missions a lightweight electric car greatly increased the productivity of the scientific traverses. Mission rules restricted us from going more than 6 miles from the LM—the distance we could walk back in a pinch—but even so the area that could be investigated was ten times greater than before. The Rover's mobility was quite high; it could climb and descend slopes above 25° . Crossing a steep slope was uneasy for the man on the downhill side, but there were no rollovers. On the level we averaged close to our top speed of 7 mph. Once, going down the Lee-Lincoln scarp, we set an informal lunar speed record for four-wheeled vehicles of 11 mph.

When the astronauts got the Rover out, all they had to do was pull on two nylon cords and the Rover popped right out of its berth and down to the lunar surface. As it did so, the wheels, which were folded over (as you can see in the photograph above) deployed outward and were then locked into position. The main purveyor of this claim that the Rover was too big to fit into the LM is Collier, who took his measurements by going to the Johnson Space Center (where there is a full scale mockup of the Rover in it's deployed configuration) and then compared those numbers to the containment bay on the LM. Anybody with a rudimentary knowledge of engineering could have figured this one out -- simply by looking at the hinges which allowed the wheels to fold out when deployed (there are no "tires" -- they are very cool wire mesh construction). This whole aspect of the controversy could have been avoided by a trip to the film archives or viewing the video series mentioned before, Apollo - Mission to the Moon. Both have footage from the Apollo missions showing the astronauts actually deploying the unfolding Rover on the Moon.

Issue 3 - The astronauts could not get from the Command module to the Lunar module with their space suits and pack on.

Again, strictly true. They never did go from the CSM to the LM and back with their packs on for one very good reason -- they didn't have to. The packs were stored in the LM the whole time. Beyond that, they did not wear their packs at all until they actually went out on their EVA's. As you can see from the LM cockpit interior concept above, this was always the intention. In fact, an image taken by Armstrong of Aldrin right after touchdown shows this was indeed the case.



Issue 4 - There can't be any pictures taken on the Moon because the film would melt in the 250° temperatures.

Any normal film exposed to 250° would indeed melt at that temperature. There are only two problems with this Moon Hoax claim -- this was no ordinary "Ektachrome" film, and it was never exposed to those kind of temperatures in the cameras.

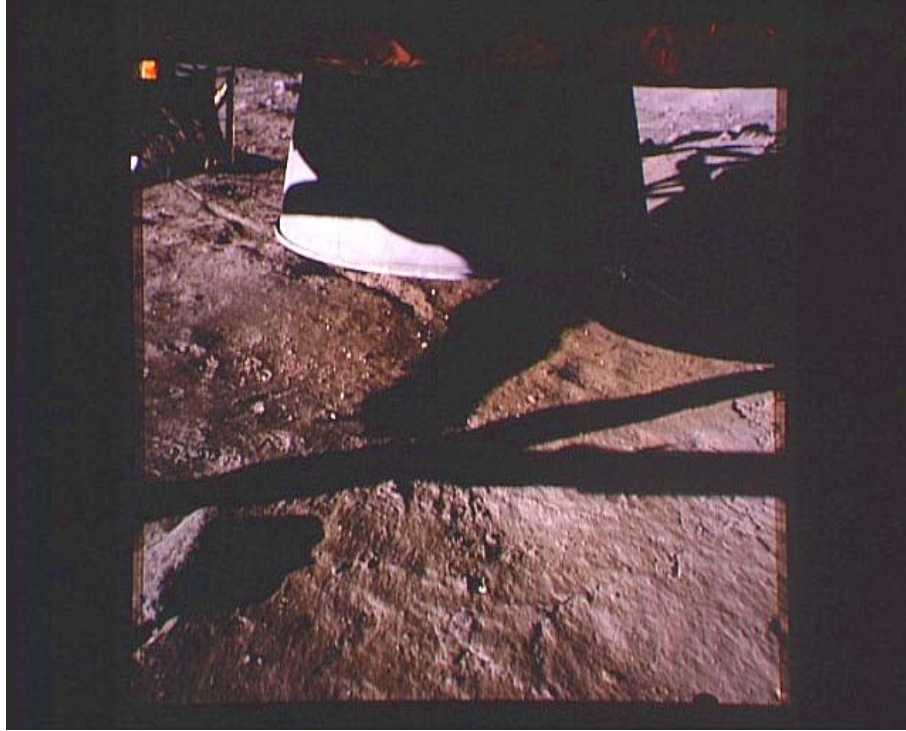
The 70mm film used in the Hasselblad cameras the astronauts carried was a very special transparency film designed specifically (under a NASA contract) for hostile environments like the Moon. According to Peter Vimislik at Kodak, the film would at worst begin to soften at 200° F, and would not melt until it reached at least 500° F. So, a worst case scenario of 250-280° F for a totally uninsulated, non-reflective camera would still be well within the film's operational parameters. The film itself, in terms of its light-gathering abilities, was also quite amazing (in striking contrast to the uninformed claims of the debunkers). It was a special "extended range color slide film" called "XRC," that allowed the astronauts to take perfect "National Geographic" quality pictures on the lunar surface, even though they were hardly experienced photographers. This has truly opened

up whole web pages of controversy -- with the Moon Hoaxers claiming that such a film simply doesn't exist! In fact, Enterprise Principal investigator Richard C. Hoagland actually used many rolls of this "super lunar film," back when he was advising Walter Cronkite at CBS. His personal story of the film's development, its inventor, and how NASA cleverly hid its very development from everyone, will be detailed in a future segment of this series. Suffice it to say that more than thirty years after the first manned lunar mission, many of the features of this amazing film are only now finding their way into the commercially-available color emulsions used in today's modern day 35mm and 70mm non-digital cameras

As you can see from the image of Alan Bean above, the cameras were also protected inside a special case designed to keep them cool. Although it is true that in the direct, airless sunlight the temperature can reach upwards of 250° - 280° Fahrenheit, precisely because there is no air, it's fairly easy to keep cool. The situation is a lot different than in your oven, for instance. With no convection or conduction, the only type of heat that is of concern is radiative. The best way to reflect radiative heat is to wrap the object (like a camera or person) in layers designed to reflect as much heat as possible, usually by simply being white. As you can see from the images above, most all of the astronaut's clothing and the camera casing were indeed white, which very efficiently directed heat away from the both the astronauts and camera film.

Issue 5 - The LM engine was very powerful. How come it did not leave a crater below the spacecraft? Why didn't it kick up any dust when it landed?

The truth here is once again very straightforward. At all of the landing sites, the astronauts found that the Lunar surface had about a two inch layer of dust. Below that was pretty much hard pan. As you can see from the image below from Apollo 11, not only is the upper layer of dust blown away in a radial pattern (as if from a thruster?) there is also a small depression below the nozzle. Since the LM descent engine only made about 3,000 pounds of thrust (compared to a modern jet fighter which makes between 18,000 and 22,000 pounds of thrust), this is pretty much as any engineer or geologist would expect things to look.



And, as this picture from Apollo 12 shows (below), the LM did leave a strikingly clear, "discolored" ground track (when photographed at right angles to the sun) as it descended to its final resting place across the Lunar surface.



And what of the charge that no dust was kicked up by the LM as it descended? Again, we'd recommend any of the fine NASA videos on the Apollo program. They show that in each and every case, the LM did indeed create a literally blinding swirl of dust blown radially outward from under the descending LM, as it groped its way down, balanced on its 3000-lb thrust engine, to its final lunar resting place. You simply have to be willing to find the films and watch them.

Section Three – The Radiation Arguments

Issue 1 - The astronauts could not have survived the trip because of exposure to radiation from the Van Allen belts and other sources.

Actually, of all the issues put forth by the Moon Hoax advocates, this is the one that requires the most digging into. The Van Allen radiation belts are a pair of toroidal-shaped belts of high-energy electrons and ions trapped in the Earth's magnetic field. The inner region is centered at about 3000 km above Earth and has a thickness of about 5000 km. The outer region is centered at about 15,000 -- 20,000 km above the surface of the Earth and has a thickness of 6,000 -- 10,000 km. As you can see from the extract below, the radiation in the belts was of some concern to the scientists working on the problem. However, they actually considered a rogue solar flare to be a much bigger problem.

RADIATION PLAN FOR THE APOLLO LUNAR MISSION

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NASA Manned Spacecraft Center

Abstract

The radiation protection plan for the Apollo Program is based on real-time monitoring of solar activity and radiation in the spacecraft to provide data on which to base estimates of the radiation to be expected. The major radiation hazard is from solar flare particle events, which are unlikely to occur during any given mission. The monitoring system, consisting of onboard dosimeters and the Solar Particle Alert Network, provides early warning through observation of solar flares and the associated radio bursts and a continual updating of the radiation picture as particles arrive at the spacecraft. Prediction criteria have been developed which are progressively revised as more data are received, with a corresponding reduction in the error limits on the prediction of radiation dose.

The criteria are initially based on the energy in the radio burst, with flare classification, location on the sun, delay time between the flare and particle arrival at the spacecraft, and particle flux measurements factored in as data become available.

Introduction

Space radiation was brought to public attention as one of the unique problems of manned space flight when the Van Allen belts were discovered in 1958. At approximately the same time, researchers began to recognize that various ionospheric and solar disturbances which had been observed for many years were aspects of a greater phenomenon, the solar flare particle event. Although early conservative estimates indicated that radiation would be a major problem, observations from the ground and from spacecraft have demonstrated that the space radiation hazard is one of the lesser engineering problems to be overcome in spacecraft design and mission planning. Flux maps of the Van Allen belts have become available, solar flare particle events have been subjected to intensive statistical analyses, and techniques have been developed to calculate radiation doses behind complex spacecraft structures. Van Allen belt radiation doses can be kept small by use of low-altitude orbits or by rapid movement through the belts. Only the very large (and consequently very rare) solar flare particle events constitute a hazard for moderately shielded spacecraft. Also, secondary radiation is not significant for such spacecraft.

(See p. 3 of previous paper)

The radiation plan for the Apollo lunar mission calls for low-altitude earth orbits and rapid transit to the moon to keep the Van Allen belt radiation dose below 1 rad. Most of the radiation protection activity is directed towards providing protection against major solar flare particle events which might occur while astronauts are in the lunar module or on the lunar surface. The events, which start at the sun, are detected by ground-based instrumentation and are measured at the spacecraft by dosimeters and particle spectrometers. A prognosis of the radiation dose is prepared and continually updated.

a console in the Mission Control Center. Dose estimates are then provided for the use of the medical officer, who advises the Flight Director of the radiation effects to be expected.

Real-Time Data Systems

Onboard Radiation Monitors

The onboard radiation monitors measure both dose and particle flux and spectra. Each astronaut carries a personal dosimeter which measures the accumulated skin dose by integrating the current from a thinly shielded 10-cubic-centimeter ion chamber. The read-out is made by the astronaut from a digital register on the dosimeter (Fig. 1). Two additional ion chambers in the Apollo command module provide readings which are telemetered to the ground and fed into the data system at the Mission Control Center, where the data are available for video display. One ion chamber measures skin dose; the other is shielded so that it measures the dose that would be received at a body depth of 5 centimeters. The depth dose is significant only for the relatively hard spectrum of Van Allen belt particles; therefore, this dosimeter is called the Van Allen belt dosimeter (VABD) (Fig. 2). A portable dose rate meter (Fig. 3) is to be carried into the lunar module and onto the lunar surface.

Comparison of the dose behind the two different shield thicknesses of the VABD gives an indication of the particle spectrum. More detailed spectral information and discrimination between protons and alpha particles are provided by a solid-state spectrometer mounted on the Apollo service module. Data from the particle spectrometer (Fig. 4) are also telemetered to the Mission Control Center where the data are used for the calculation of doses in the command module, lunar module, and space suits. The dose calculations are made automatically and are read out on the video data display (Table 1). The relative biological effectiveness (RBE) of the protons and alpha particles as functions of energy is introduced into the dose calculations so that the doses are given in rem.

Solar Particle Alert Network

The Solar Particle Alert Network (SPAN) (Fig. 5) monitors solar flares and associated radio emissions on a 24-hour basis. The solar flares are observed with optical telescopes equipped with filters that transmit a 1/2-angstrom band about the H α line. Time of occurrence, area, and location of the flare are determined by SPAN observers and are teletyped to the Mission Control Center where the data are incorporated into the estimate of the particle event size. Radio emissions associated with the flares are observed at 1420, 2695, and 4995 megahertz. The radio burst profile for each frequency is also teletyped to the Mission Control Center. In approximately 2 years of operation, SPAN has observed several hundred flares and radio bursts. Data from SPAN are augmented by data from the solar and ionospheric monitoring systems operated by the Environmental Science Services Administration and the Air Weather Service.

In fact, as stated in this official government report, the scientists working on the problem of Van Allen radiation considered it to be minor compared to other design hurdles to be conquered. Their solution was simple -- avoid exposure by keeping the spacecraft at low Earth orbit altitudes while in parking orbits and then send it through the

belts at high speed. The eventual escape speed, some 25,000 miles per hour, would have passed them through the belts in less than an hour, keeping their dose well below 1 rad. There was a modicum of shielding from the equipment, but in the end this was not necessary as the extraordinary transition speed kept the dose below harmful limits -- both going to and returning from the Moon.

As to the issue of solar flares and the danger they presented, there simply weren't any major ones during any of the Apollo missions. So the biggest reason that none of the astronauts died from their radiation exposure was that they simply did not get a bad dose to speak of. Readers wanting more information on this issue should read NASA Technical Notes - NASA TN D-7080, Apollo Experience Report - Protection Against Radiation by Robt. English, Richard E. Benson, J. Bailey, and C. Brown, --Manned Spacecraft Center, Houston, March, 1973.