

And Finally... Yes, We Did Go to the Moon.

By Duncan Lunan

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During the Extra-Vehicular Activity on the Apollo 17 mission, the astronauts had difficulty with lunar dust being thrown up by the wheels of the Lunar Rover. One of the dust guards which should have prevented it was broken, and the astronauts had to improvise a repair using maps and sticky tape. The Public Affairs Officer at the Johnson Space Centre, Houston, remarked, "As you can see, it's only a paper fender, but the Moon is real."¹

However, Channel 5 recently re-broadcast a documentary entitled *Conspiracy Theory: Did We Land on the Moon?*, made in 2001 by Nash Entertainment and also shown in the USA, purporting to show that the Project Apollo astronauts might never have gone to the Moon. I haven't met anyone who was completely swayed by it, but a lot of people have asked me about it and most of them said they'd found the arguments convincing. For people who don't know the facts about Apollo, I dare say they might have been; and even among astronomy and space enthusiasts, there are many people now who weren't even born when the Moon landings took place and may find those arguments difficult to answer. One counter-approach is the one taken by the NASA spokesman in the programme, who simply refused to discuss the specific arguments, but that method can easily backfire – critics will say that NASA doesn't answer because it has no answers. In response to the US screening, the Lunar and Planetary Information Bulletin, published by the Lunar and Planetary Institute in Houston, has taken the line of answering other questions about the Moon instead.² But since the allegations can be answered in detail, I think it's worth doing and in what follows I'm going to address them all, though in logical order which isn't always that of the programme. So don't panic, because we are here to help you.

"NASA could have faked it."

In the opening titles, I was surprised to hear that statement from my old friend Brian O'Leary, who was credited as a former astronaut "unafraid to speak out". Technically Brian was never an astronaut, because he never flew above fifty miles' altitude, but he was a trainee in the scientist astronaut programme. He resigned partly because the prolonged training in the engineering aspects of the programme was beginning to harm his scientific career, and he felt (rightly, as it turned out) that he had little chance of eventually flying in space. Only one of the scientist astronauts ever went to the Moon, though a few more had extended missions on Skylab.

But in 1971 he was quite sure that the astronauts were going to the Moon, and in his book about his experiences he was critical about the lack of scientific knowledge which they sometimes showed in their commentaries.³ He felt that opportunities were being wasted, but he never doubted that they were up there, and I imagine that his more recent remarks have been taken out of context. When I last met Brian, he

was still a committed advocate of the Space Station programme and of manned missions to Mars.

Many would-be astronauts died in training – was it because they knew too much?

The astronauts were required to put in long flying hours on top of their other training. Commonly they flew themselves around the country in T-38 trainers, to cut out the delays of commercial flights and also to keep their hours up. When Brian O’Leary joined the programme, four of the first fifty astronaut trainees had been killed in flying accidents. He investigated the statistics of fatalities in noncombatant US military jets, particularly the T-38, and concluded that the chances of a skilled pilot being killed in astronaut training were as high as one in six: for a beginner like himself, more like one in four or one in five. As a married man he felt the risk was unacceptable and resigned with the famous quotation, “Flying just isn’t my cup of tea”. But in his 1971 book he specifically stated, “it comes as no surprise that during nearly 100,000 hours flown collectively by all the astronauts, while in the programme, there have been four deaths. Therefore, I became gravely concerned that the statistics on the astronauts are not anomalously grim but are to be expected.”

The Apollo 1 fire was staged to kill Virgil Grissom because he knew they weren’t going to the Moon.

Apollo 1 was a ‘Block 1’ spacecraft of a design which had been severely criticised by experts and by the astronauts.⁴ In particular Walter Schirra was urging that manned flights should be suspended until the Block 2 version was ready. NASA’s Malfunctions Investigation section was running spot checks on the spacecraft and was well aware that the fire hazard was acute, but NASA management insisted on trusting the contractors. In retrospect, many of the decisions taken with regard to the fatal test seem extraordinary, but more realistically they can be related to the idea, perhaps not yet abandoned, that the Moon landing could be achieved as early as the end of 1967.

Repeated comparisons were made in the programme with the 1978 movie *Capricorn One*. But in the film, it’s the astronauts who faked the mission who are the targets for assassination. If NASA was rubbing out people who refused to go along with the supposed Apollo deception, it’s remarkable that many of the lunar astronauts are still alive and those who aren’t have died of completely natural causes.

The spacecraft never left orbit around the Earth.

If that were so, at least two objects would have appeared in Earth orbit each time: the Command and Service Module combination (which stayed together until just before re-entry), and the S-IVB stage which had performed orbital insertion and was to perform Trans-Lunar Injection. The Lunar Module (Ascent and Descent stages combined) was stored in an adaptor on the forward end of the S-IVB, and the CSM mounted forward of that. The S-IVB with CSM attached would have been brighter than a first magnitude star (the Skylab space station was a converted S-IVB), so it would have been necessary to separate them as soon as possible. In theory, the S-IVB/LM combinations could have been deorbited over the Indian Ocean or the

Pacific, but the risk of someone seeing them would be very high, given that it would have happened nine times, for Apollos 8, 10 and 13 as well as the six landings

But even the CSM's would be the brightest things in Low Earth Orbit, for up to a fortnight at a time, and would have been reported by both amateur and professional observers. At that range, radio traffic with the ground could be picked up by amateur groups such as the famous one at Kettering Grammar School, which located the secret Soviet launch complex at Plesetsk. And the Soviets had a large seagoing fleet of tracking ships, which would have located the spacecraft and had no reason at all to keep the finding quiet.

Most conclusively, the Apollo missions were tracked on the way to the Moon by both amateur and professional observers, because they knew where the spacecraft were supposed to be.⁵ The spacecraft themselves rapidly passed out of optical range, but several course correction burns were observed within the Earth's shadow (see comments on rocket flames below). In particular the gas cloud released in the Apollo 13 explosion was captured by multiple observers.⁶ Returns to Earth were also monitored and again Apollo 13 came in for particular attention, because the plutonium powerplant for the Apollo Lunar Scientific Experiment Package was still in its storage cylinder on the Descent Stage of the Lunar Module, and the Pacific nations were very concerned about contamination. All the evidence (and lack of contamination) indicated that the capsule had reached the seabed unbroken; but it was definitely on return-to-Earth trajectory from the Moon, a full two miles per second faster than descent from orbit.

Then again, there are people who say that Project Apollo was never cancelled: after spending all that money on it, of course the USA wouldn't abandon it. You can hear a Saturn V launch fifty miles away, and see a night launch from hundreds of miles, so I'd love to know where they've supposedly been firing them in secret for the last thirty years.

The Apollo 1 fire proves that the spacecraft was too dangerous to fly to the Moon.

In that case, it would have been too dangerous to use in orbit either. But it was the Block 2 spacecraft, and later models, which actually performed the lunar missions.

Why weren't the astronauts killed by the Van Allen radiation belts? All other space missions have stayed below them.

Untrue. The inner Van Allen Belt extends towards the Earth in a region called the South Atlantic Anomaly, which was flown through by Skylab and is sometimes penetrated by the Space Shuttle. In his autobiography "Off the Planet", astronaut Jerry Linenger states that when the Mir station went through the Anomaly, the flashes in the eyes generated by high-energy particles were too intense and frequent to allow sleep.⁷

As its name implies, it's not over the Earth's magnetic equator, where the radiation belt is most intense; and neither is Kennedy Space Centre. The nearer a launch site is to the true equator, the more boost the spacecraft gets from the Earth's rotation, but

KSC is at the furthest north from which you can launch to the Moon without making an orbital plane change, which uses a great deal of fuel unless you do it at the Moon itself (see below). From there, Apollo missions could skim through the less intense regions of the inner Van Allen Belt; but it has left US commercial launchers at a disadvantage compared with ESA's Kourou, which is much nearer the equator. The outer Van Allen Belt consists of trapped electrons, which are far less penetrating than the protons of the inner one.

Apollo photographs of the Earth taken on the Moon and back demonstrate the main point. The Apollo 10 and 11 photographs of the Earth taken on the way to the Moon show North America or the Sahara in the centre of the disc, demonstrating that the spacecraft is well above the equator, while the Apollo 17 one of the full Earth disc shows Lake Victoria (on the equator) well above the centre, and the whole of Antarctica, sunlit because it was December 1972.

The Russians abandoned the Moon race because they knew they couldn't get to the Moon.

The Soviet launch site at Baikonur is still further north than KSC, requiring more powerful boosters for direct launch to the Moon, but plane change manoeuvres had been performed around the Moon by Soviet lunar probes since Luna III in 1959. The Van Allen radiation belts would however have been even less of a problem. Variants of the Soyuz spacecraft designated Zond had been flown round the Moon many times and late in 1968 that the Soviets were preparing for a manned lunar flyby. The call-sign 'Diamond' was assigned to the mission, and cosmonauts Belyayev and Bykovsky were the intended crew.⁸ The Apollo Lunar Module was not ready for testing and NASA took the decision to put the CSM alone into lunar orbit as Apollo 8. This was an extremely risky mission, as there had been no previous manned flights on Saturn V, and if the CSM had failed as it did on Apollo 13, the astronauts would not have survived. In the event it proved to be a serious mistake, because if the Soviets had put a man round the Moon then they could not have claimed later that they never intended to go there; western scientists like Sir Bernard Lovell would not have backed them; there would have been no congressional attempt to imprison the NASA Director and the Apollo programme might not have been cancelled.

However the Soviets did not immediately abandon the competition after Apollo 8. Their N-1 'Lenin' booster and a manned Zond spacecraft on a Proton booster were on pads on July 4th, 1969. It appears that Cosmonauts Filipchenko, Kubason and Shonin were in the Zond and the Lenin was carrying a lunar lander.⁸ But it exploded immediately after launch, damaging a second one which was also preparing for launch, and ending the remote chance of beating Apollo 11 to the Moon.

Even then, there was a Soviet spacecraft in orbit around the Moon with Apollo 11. Luna 15 went into orbit ahead of Apollo 11, and the media were full of speculation that it was a last-ditch attempt to get a lunar sample ahead of the Americans. But a last-minute sample grab seemed both petty and pointless, so it just might have been a rescue vehicle. Whatever it was, it was deorbited two hours before the Apollo 11 liftoff and crashed into Mare Crisium. The sample return explanation is still officially accepted, but in 1990 it was revealed that the 'Luna 15' designation had been applied, at least temporarily, to a one-man lunar landing module which was to be

placed in lunar orbit ahead of a manned Zond;⁹ and the lander on the Lenin booster was lifted clear of the explosion by an escape tower.⁴ That doesn't guarantee that the Luna 15 we know was the same craft, but if it was a rescue vehicle, the history of lunar exploration might have taken a very different course.

The crash of the lunar trainer flown by Neil Armstrong proves that the astronauts couldn't do a landing even on Earth, in atmosphere.

The lunar landing trainer in question was a 'flying bedstead' vehicle, held up by a downward-pointing jet engine. The first vehicle of that type was built in the UK in the 1950's and led to the development of the Short SC-1 vertical takeoff and landing aircraft. That proved so difficult to control that it could only be flown tethered in a cage until a fly-by-wire control system was developed. The Soviets developed a similar VTOL aircraft for submarine and carrier use, but the vectored thrust system of the Harrier is more controllable and effective than separate downward-pointing engines, and after Britain's success with it Soviet designers also moved on to the vectored thrust principle. But even the Harrier is hard to fly vertically, which is why carrier pilots prefer to operate off a 'ski-ramp' on the bows of the ship. As for James Bond style jet-packs, notwithstanding Paul Merton's enthusiasm for them on *Have I Got News for You*, they're not in use with any armed forces in the world.

But the bedstead used for lunar landing practise was even harder to control, because the idea was to throttle back the jet until it was cancelling only five-sixth of the vehicle's weight. The rest of its weight had to be supported by the rocket engine, which was then throttled in turn (see below), to try to achieve a controlled descent. A little thought will reveal how hard it was to get both thrust vectors balanced around the vehicle's centre of mass, and when it tipped on its side, as Neil Armstrong's did, recovery was almost impossible. No mechanical failure was found and the most likely explanations are pilot error, or just a gust of wind. Either way, in true one-sixth gravity, with no air to confuse matters, the Lunar Module was much easier to control and the intended period of hover above the landing site was eliminated – Armstrong actually flew the *Eagle* in like a helicopter.

Why can't you hear the rocket motor during descent on the Moon?

In supersonic aircraft, including Concorde, the cabin goes quiet when the aircraft passes the speed of sound. That's because the engine noise carried by the air outside is much more than the sound transmitted through the structure. Not only was there no air outside the Lunar Module to carry sound, but inside it was pressurised with pure oxygen to a mere five pounds per square inch, which doesn't carry sound very well (it was a real problem in the larger internal volume of Skylab). But in addition, the astronauts were in full spacesuits, sealed, and their microphones were on the inside.

However, what you could hear from the Moon provides strong evidence that they really were up there. When the Apollo 10 Lunar Module Ascent Stage separated from the Descent Stage, ten miles above the lunar surface, a mis-set switch caused it to make a sudden ninety-degree gyration in yaw. Gene Cernan, taken by surprise, uttered the first swearword to be broadcast in the history of the space programme. Thereafter Houston imposed a seven-second delay on the retransmission of capsule

communications, to allow judicious editing if necessary. But if you listened closely to the TV, you could still faintly hear the incoming sound in real time, ahead of the sound synchronised with the pictures. Are we supposed to believe that the pictures were pre-recorded but the sound was in real time? If so, presumably the astronauts weren't even in orbit but somewhere in a studio, in which case they would have been hard put to fake the timelag – a discrepancy which only one person notices in *Capricorn One*.

Why are there no blast craters under the descent stage engines, and why weren't the Lunar Modules covered with dust?

The shape of a rocket flame in vacuum is quite different from the one it takes in air, spreading out much more widely. The entire category of 'Jellyfish UFO's', seen over the Soviet Union and South America, was a piece of disinformation invented to cover night launches of spy satellites from Plesetsk.¹⁰ The programme showed some NASA artwork which mistakenly portrayed spearlike flames from the Lunar Module, but it wasn't accurate. As mentioned above, the engine was throttled back in the final stages of descent in any case.

Nevertheless, there was serious concern about the amount of dust which might be raised during the landing, because it would be in one-sixth gravity and vacuum and had never been done before. The results from the Surveyor unmanned landings were encouraging, suggesting that blast damage would be minimal, but nevertheless the Descent Stage motor was to be cut before touchdown. In shots of the Lunar Module in orbit you can see probes extending from the landing pads, and after landing they can be seen bent upwards. When they touched the ground, the co-pilot called "Contact Light!" and the pilot was then to shut down the engine. The Module dropped the last couple of feet, as was clearly shown in Tom Hanks's television series dramatising the Apollo programme. On Apollo 12 the object of the flightplan was to achieve a pinpoint landing at the site of Surveyor III in Oceanus Procellarum, and having seen it on approach, Alan Bean was so excited that he forgot to cut the power, with the result that the Surveyor suffered more sandblasting from the touchdown than it had in its entire stay on the Moon. In Apollo 12 photos the blast marks under the Descent Stage are more pronounced than in the others, but the light patch of disturbed soil around the Apollo 17 Lunar Module was photographed from the Command Module in orbit.¹¹ Because there was no air, all the dust flew radially outwards, every grain on its own ballistic trajectory, so none of it fell back on the module. The effects of the blast on takeoff were also very obvious – see below.

Why can you see the astronauts backlit, when they're coming down the ladder in shadow?

All the Moon landings occurred just after sunrise, to make sure the pilot had plenty of contrast to judge heights by. Lighting conditions on the surface are very different from those on Earth: the lunar soil has a 'fairy castle' structure, uncompacted by Earth gravity or moisture, so every surface facing the Sun acts a miniature reflector.¹² The soil is shot through with beads of glass formed by impacts, so when the Sun is low on the horizon, the ground throws a lot of light back towards the Sun and also scatters it to the sides, so the shadowed side of the Lunar Module was by no means in total darkness.

Why do the shadows run in different directions?

Even on Earth, human perception is easily fooled as to depth of view, especially when studying photographs. Dr. Jack Cohen is fond of demonstrating, with a photo of shafts of light from the setting Sun, that the Sun can't be more than ten miles up and a few yards across. In vacuum, there's none of the blurring of detail with distance which we unconsciously use as a guide, even although it's unreliable. In the Apollo 15 photographs, for example, the mountains are much higher and much further away than they look. (That's why the programme was able to show a shot of mountains with the LM in view, and an apparently identical one without it.) All the Moon landings occurred just after sunrise, to make sure the pilot had plenty of contrast to judge heights by, so the shadows are very long. Since the lunar surface is uneven, it's quite easy for them to look as if they're going different ways. But in some cases there really are multiple shadows because of the lighting effects mentioned above: the spacesuits themselves were white and reflected a lot of light, as well as heat, and in some photographs you can see halos round them because they've overexposed. One of the experiments deployed on the lunar surface was even a polished aluminium sheet facing the Sun, to trap particles from the Solar Wind.

The astronauts couldn't have worked the cameras while wearing spacesuits.

Spacesuited US astronauts had been taking Hasselblad pictures of each other and of other spacecraft, in vacuum, during the Gemini programme and on Apollo 9. If the cameras worked in Earth orbit, there was no reason why they shouldn't work on the Moon.

Why are all the pictures so perfect?

Because the imperfect ones weren't released to the press. The catalogues of lunar photographs contain lots of shots which were spoiled in one way or another – lens flare was the most frequent problem, but some were fogged by cosmic rays. The entire archive of about 9000 photos has now been released and is available online, so it's easy to check how many poor ones there are.

Why can't you see the stars?

“This may be a good point at which to correct an almost universal fallacy – the idea that one would see the stars during the daytime on the Moon. (I am indebted to Dr. W.H. Steavenson for pointing this out.) They would be there all right, because there is no atmosphere to swamp them with scattered sunlight. But the eye would not see them, because the intense glare from the brilliantly illuminated landscape would have made it too insensitive. To observe them, one would have to stand in shadow, shield the eyes completely from all sources of light, and wait a few minutes. Then they would become visible, first in tens and then in thousands – but they would vanish again as soon as one re-entered the sunlight.”¹³

Arthur C. Clarke published that as long ago as 1951! The light level above the Earth's atmosphere, or on the Moon, is 10% higher than it is at ground level here. Even at the distances of the outer planets, where the light level is 99% or more lower,

stars don't show in the Voyager photographs unless they're deliberately over-exposed to show them for navigational purposes (that was how the volcanic plumes on the edge of Io were discovered).

Why does the flag wave as it's erected?

Again, as far back as school in the 1950's, I designed a British mission to the Moon. I realised that the Union Jack wouldn't fly on the Moon but just droop at the mast, and my solution was to put it in a plastic bubble with a solar-powered propeller inside. The US solution was to run a spring along the top of the flag, with a deliberate kink in it to make it look realistic. But with every ounce of weight at a premium, both that spar and the supporting mast were extremely light. As the Apollo 17 astronauts were struggling with their flag, Harrison Schmitt was heard to say, "Did you ever see a vibrator like that?", to which Gene Cernan replied, "No, I've never put a flag up on the Moon before."¹ During one of the liftoffs the entire mast can be seen whipping violently, bending like a fir tree in a nuclear blast as the exhaust reaches it. In all the film shots in the programme where the flag is waving, one of the astronauts is moving it at the time.

Why are some of the features apparently in front of the reference marks on the camera lenses?

The roseau marks on the camera lenses are sometimes washed out by the brightness of sunlit objects behind them. In the examples shown they're being swamped by the bright edges of sunlit objects, but the full archive contains many examples of marks partly blotted out by this effect. I'm obliged to Prof. Martin Hendry for the answer to this question, which was the only one which I couldn't immediately provide from my own knowledge.

The moonwalks must have been faked because their spacesuits couldn't have coped with the heat of the Sun or the cold in shadow.

If so, then all the EVA's ever, in both the Russian and American programmes, would have to be faked as well – the heat and cold are the same in space, at this distance from the Sun, whether or not you're on the Moon. That would mean that none of the satellite rescues took place, including the repairs and refurbishments of the Hubble Space Telescope; nor external repairs to Skylab and Mir; nor the work currently being done on the outside of the International Space Station.

NASA could easily have faked the lunar sequences. If you speed up the film, it looks as if the astronauts are moving naturally on Earth.

It depends which sequences you use. Some of the things the astronauts did would be well-nigh impossible under Earth gravity, particularly moving at speed or leaping, as John Young did on an Apollo 16 EVA, while wearing spacesuits. Before the landings there were fears that walking in one-sixth gravity would be almost impossible, and the late Chris Boyce considered that people were moving much too freely in the lunar sequences of *2001, A Space Odyssey*. But a natural walking pace on the Moon turned out to be 60% faster than on Earth, and the most comfortable way to move was in a lope of 10 feet per second, as compared with four fps on Earth.¹⁴

The astronauts quickly adjusted to it. But they still had their full mass and inertia, and in order to slow down or stop, they had to develop a technique of kicking their feet out in front of them. Try doing that on Earth when walking fast and see what happens to you! Furthermore, when they did it, they raised sprays of dust which immediately fell back and vanished, as did the dust kicked up by the wheels of the Lunar Rover. So either it was very *heavy* dust, or they really were in vacuum, not in a hangar at Area 51.

Even at the time, even before Apollo 11, there were rumours that the whole programme was being faked. I quoted one disbeliever in my story 'With Time Comes Concord':¹⁵ at Christmas 1968 a friend called Mike Adams, watching a live broadcast from Apollo 8, suddenly declared, "That's not possible. Up till now I thought they were idiots, those people who say it's all being done in a TV studio. But I can't believe that."

"Of course they're up there," I said, "They've been in zero-g for over five minutes on-screen. Why, what's wrong with it?"

"That demonstration he's just given of the onboard computer. You know I'm a Systems Analyst, I trained with IBM. He's got it a box there the size of a small typewriter, and he's saying he can get performance out of it that I can't get from my company's mainframe!"

But of course, the microchip revolution was coming, and they really were going to the Moon. On the final EVA of Apollo 15, Dave Scott undertook to prove that it wasn't a fake, and he did it by reproducing Galileo's apocryphal experiment with the falling cannonballs. Scott produced a falcon feather (their Lunar Module was named *Falcon*), and he let it drop along with a geological hammer. Both fell together, in vacuum, and slowly, at one-sixth gravity. To underline the point, in the BBC's studio coverage, James Burke hastily obtained a hammer and a feather from the Props department, climbed up on his desk and let them go – of course, the hammer crashed to the floor and the feather floated. Although the impromptu demonstration was easy to stage on the Moon, it would have been very hard to fake even on film, still less with real-time dialogue. Zero-g would be even harder: even in 2001 Stanley Kubrick couldn't get it completely right, and couldn't keep Poole's arms and legs stationary as he turned end over end in space – so leading some critics to think, incorrectly, that he was still struggling although his air supply had been cut off for a long time by then.

Some of the film sequences are wrongly labelled.

Surprise, surprise! Working in spacesuits, under pressure and in unfamiliar conditions, the astronauts made many mistakes with labelling films and in some cases, including Apollo 12, actually left films behind on the Moon. As the pictures shown showed both astronauts they were probably TV footage from the Lunar Rover. But it wouldn't be the first time NASA got the editing wrong, especially with Rover footage: at our 1971 International Space Exhibition, where we showed the Apollo 15 information film to multiple school classes, it was obvious that some of the EVA film from the Rover was out of sequence.

There are bomb craters in Area 51 which look like ones on the Moon.

In the 1950's and 60's, there was a great deal of argument over whether lunar craters were meteoritic or volcanic. Opinion in the USA generally favoured impacts, and one of the arguments for them was that there was an unbroken sequence of sizes and diameters from shell and bomb craters on Earth up to the smallest craters visible on the Moon. However all the craters in Area 51 are much smaller than the ones photographed from lunar orbit, and markedly fresher than the ones photographed on the lunar surface.

Why is there no flame from the Ascent Stage engine on liftoff?

As early as the 1950's, it was known that rocket flames are invisible in sunlight in vacuum; I remember the then Astronomer Royal denouncing science fiction films for that reason. (Burns in darkness are a different matter, as witness the 'Jellyfish UFO's' above.) Stanley Kubrick got it right with the Moon landing and 'Moon Bus' sequences in *2001*, as well as the pod manoeuvres, in none of which can you see the exhausts. The jets from the Space Shuttle's thrusters are visible in sunlight because they're emitting steam, not a chemical rocket flame. There were commentators who said they could see a blue flash as the Lunar Module Ascent Stage separated, but with so much gold and silver foil flying towards the camera I wasn't convinced.

Why weren't the Apollo 16 astronauts killed by radiation from a solar flare?

It's now thought that the particle streams from the Sun, which periodically overload the Van Allen Belts and cause auroral displays, are not generated directly by solar flares but by related processes. The streams are lethally intense, but highly unstable because they are held together by the magnetic fields they themselves generate: the paths they take through the interplanetary medium are often unpredictable. Since the SOHO probe was positioned at the Sun-Earth Lagrange 1 point there have been several false alarms when particle streams were thought to be on course for Earth but didn't arrive.

Had any of the Apollo missions been hit by one of those particle streams, the astronauts would undoubtedly have died. There was no way to fit adequate shielding into the lightweight Apollo spacecraft. The astronauts knew that, and accepted the risk. It's a pretty poor response to their courage, to say that they never went to the Moon at all. But here's a question for those who say they didn't:

Who did all the work?

Even the Preliminary Science Reports issued after the lunar missions are the size of large-city telephone books. Extremely detailed geological maps of the lunar equator were compiled by the Scientific Equipment Modules of Apollos 15, 16 and 17. Nearly a ton of moonrock was brought back, its composition is quite unlike terrestrial rocks – no carbon, nitrogen or hydrogen compounds, much more glass, etc - and from it we have learned an entirely new history of the Earth-Moon system and the Solar System as a whole, not to mention the history of the Galaxy as revealed by cosmic ray tracks, and of the Sun: we now know that it doesn't occasionally flare catastrophically, for life on Earth, as some scientists believed in the 1960's.

On each mission, a Scientific Experiment Package was deployed at the landing site. The Apollo 11 one was battery-powered and lasted only months, but the rest were powered by plutonium isotopes and all but one of them remained operational until 1977, when an unbelievably cheeseparing US Congress ordered them to be turned off. We saw the astronauts deploy them, we saw Dave Scott struggling to get his drill cores and John Young accidentally pull out a cable, we heard Gene Cernan declare, "Okay, nobody touch my Heat-Flow Experiment!" as he set up the replacement. From that and from seismic mapping of the Moon's interior we know that it has a semi-liquid core and is still geologically active. The solar wind collection experiments which the astronauts set up were repacked and brought back for analysis. The passive laser retroreflectors, which don't require power, are still there and still working; the Royal Greenwich Observatory is one of the sites using them to monitor the Moon's movements to an accuracy of centimetres, month after month.

Burton Sharpe, (co-author of "The Moon..."¹⁶) who worked on the Apollo Lunar Scientific Experiment Package, states, "I think the best empirical convincer is the Laser RetroReflector array. Whether one is a sceptic, agnostic or true believer, if you laze the Apollo 11, 14 and 15 sites from anywhere on Earth, BINGO you get a return. References to, and descriptions of ranging done from Hawaii and McDonald Observatory (U of TX) are various places on the internet - good overall description at -

http://cass.jsc.nasa.gov/pub/expmoon/Apollo14/A14_Experiments_LRRR.html

- but an interesting variation is at <http://janhaag.com/POmcd.html> - excellent reminder of the room that exists for, and the value of, the broad spectrum of human perception."

You might say that they were deposited by unmanned probes, but then, where were the launches? You might as well say that the work on the Moon was done for us by aliens. But then, the late Joseph Goodavage and others have claimed for years that the astronauts met aliens on the Moon and the authorities have hushed it up. James Oberg of NASA even wrote a book to disprove it,¹⁰ so that shows there must be a cover-up, right?

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