The Scientific Importance of China's Lunar Far Side Mission

by Benjamin Deniston

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The clearest counterpoint to Obama shutting down and destroying our space-faring capabilities is China—over the same time period—establishing itself as one of the leading nations in space exploration. China is clearly vectored towards becoming the number one nation in space exploration, given the current trajectories: The United States has been heading down; China is on a rapid path upwards. In the last few years, this reality grabbed the attention of the world with a key breakthrough in China's lunar exploration program. In December 2013, China made the first soft landing of a rover on the Moon in decades—since the mid-1970s—with its Chang'e-3 mission, deploying the Yutu rover as part of the mission. This captured the attention—and the imagination—of the world.

China's Lunar Exploration Program

Deployment of the Yutu rover was just one part of China's lunar exploration program, the Chang'e program, which has three phases: The first phase, now complete, was to put orbiters around the Moon and investigate it from orbit. The second phase, now ongoing, uses landers and rovers, including the brilliant success of the 2013 Chang'e-3 mission and its Yutu rover (see **Figure 1**). China has just released more high-resolution images of this mission.[1]

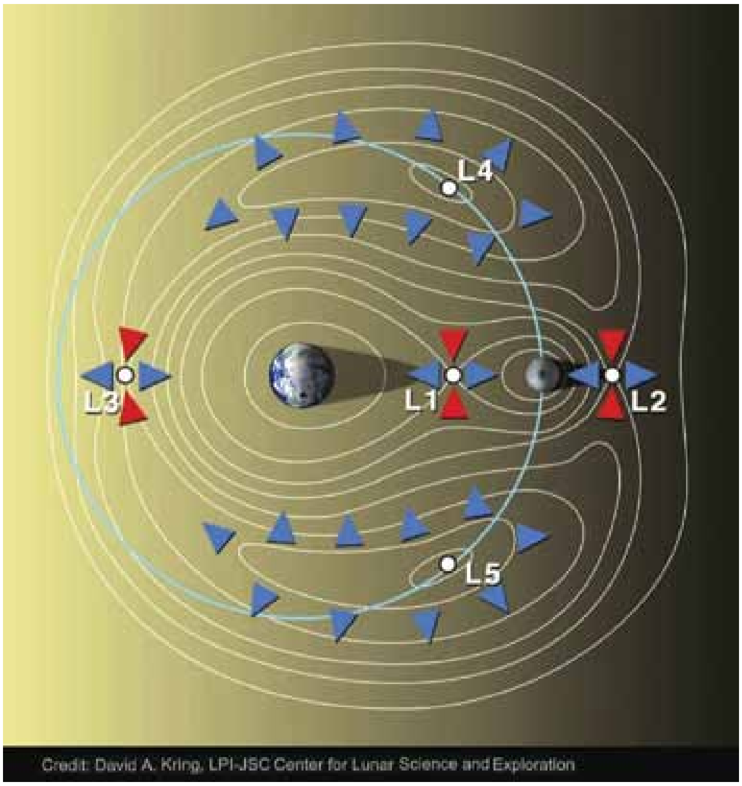
1. Available on a website of the National Astronomical Observatories of the Chinese Academy of Sciences titled "Science and Application

FIGURE 1

CNSA/Chinanews/Ken Kremer/Marco Di Lorenzo

A segment of the first 360-degree color panorama taken by the Chang'e-3 lander, showing the rover after its disembarkation from the lander. The Chang'e-3 rover is the first to travel on the Moon's surface in 40 years. Exciting video of the Dec. 16, 2013 disembarkation is published [here](#) by On Demand News.

FIGURE 2



David A. Kring, LPI-JSC Center for Lunar Science and Exploration

The five stable and near-stable locations created by the gravitational interaction of the Earth and the Moon, called Lagrange points or L-points, after the Italian mathematician and astronomer Joseph-Louis Lagrange (Giuseppe Lodovico Lagrangia) who first defined them. He died in 1813, long before the first spaceflight. The Chang'e-4 relay satellite will be parked at L2. The contour lines represent gravitational field strength and show why the L-points are where they are.

The Chang'e-4 mission is part of this second, landing-and-rover phase. It was initially reserved as a backup, in case something went wrong with Chang'e-3. Since Chang'e-3 was a success, it wasn't needed as a backup. Now it has been announced that Chang'e-4 has a new objective, *landing on the far side of the Moon*. That will conclude the second phase. The third phase involves landing, acquiring a sample from the lunar surface, and returning it to Earth.

Initially the Chang'e-4 lunar far side landing was planned for 2020; now the National Space Administration has announced it for late 2018. So China has also accelerated the timeframe. It will be the first time ever that mankind has landed anything on the far side of the Moon. All of the Apollo missions were to the near side; all of the Soviet unmanned missions were to the near side. We have sent orbiters around the Moon that have imaged the far side, imaged all of the Moon. But this will be the first time that mankind has ever landed any device on the far side.

Sometimes the far side is referred to as the "dark side" of the Moon. It is not really so. In every 28-day orbit of the Moon around Earth, the Moon will show both its face and its far side to the Sun, so the far side is dark only part of the time. You *could* say "dark side" in reference to mankind's knowledge of it, which is a fair expression, because it is always facing away from us. However, this does create some problems.

The difficulty is that the far side is in a state of constant radio blackout with respect to communications with Earth, because the mass of the Moon is always between the far side and the Earth. So part of this Chang'e-4 mission is to send a relay satellite out to what's called the Earth-Moon L2 point, an interesting, stable position in the gravitational interaction between the Earth and the Moon. The L2 point is one of a few "L-points," which are very advantageous for space agencies as parking spots, so to speak, in different orbital locations, where we can park satellites without much drift. For the Chang'e-4 mission, China will use the L2 point, which is beyond the Moon—along a straight line extending from Earth through the Moon, a line that therefore moves with the Moon as it orbits the Earth (see **Figure 2**).

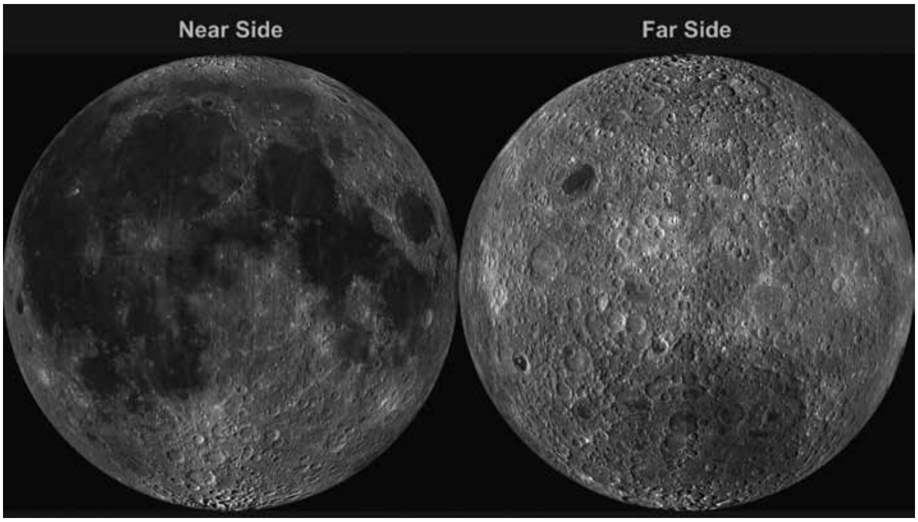
The intention is to send a relay satellite to this L2 location; there, it will always have a line of sight to Earth for communications. And it will always have a line of sight for communications with the Chang'e-4 lander on the lunar far side. With this configuration, China will be positioned to have the first-ever landing on, and direct investigation of the lunar far side. This is a first, a first for mankind.

Why the Far Side?

What's so interesting about the far side of the Moon? This must be considered in light of what Kesha Rogers has recently emphasized as Krafft Ehricke's insightful understanding of the *necessity* for mankind to develop into a species of the Solar System, so to speak. The far side of the Moon offers certain unique and critical points of investigation for mankind.

Center for Moon and Deepspace Exploration." Exciting video of the rover's disembarkation is here.

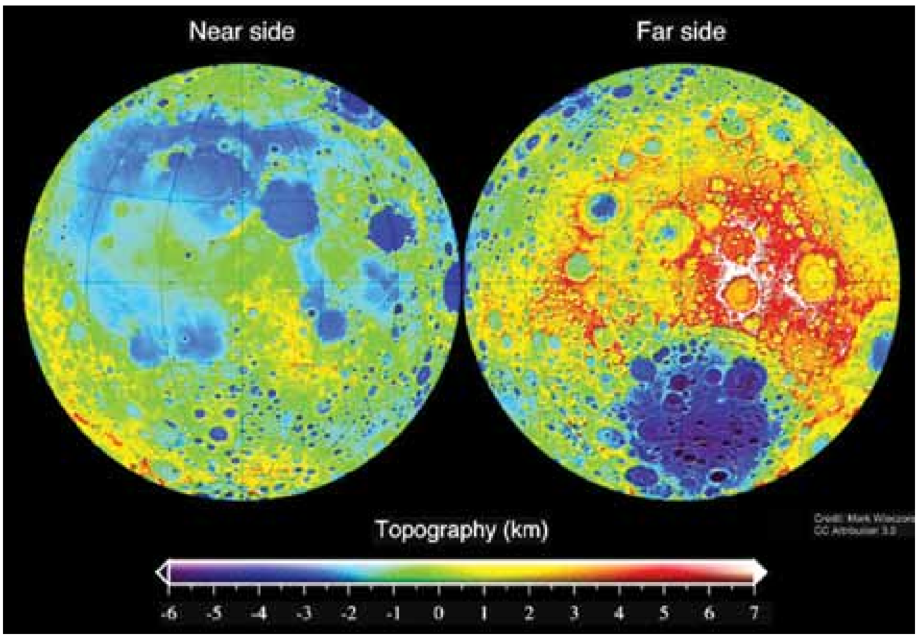
FIGURE 3



NASA

The near and far sides of the Moon, imaged by NASA's Lunar Reconnaissance Orbiter launched in 2009. Dramatic, close-up video of features on both sides is found here.

FIGURE 4



Mark Wieczorek; CC Attribution 3.0

A topographical (elevation) map of the Moon. The deep purple near the South Pole on the far side is the Aitken Basin, about six kilometers deep and 2,500 kilometers in diameter.

For example, the far side may have a higher concentration of helium-3, which we've discussed.[2] It is thought that because the near side is often shielded from the Sun by the Earth, the Earth has blocked some of the deposition of helium-3 by the solar wind on the lunar near side. The far side, always facing away from Earth, is thought to have a higher concentration of this helium-3, probably the best fusion fuel known to us. The Sun has been creating this unique isotope and pumping it out into the Solar System. It has been embedding itself on the lunar surface for a few billion years, so you've got quite a build-up there.

Geophysical Anomalies

Second, the lunar far side also has a unique geology. In the high resolution images from NASA's Lunar Reconnaissance Orbiter you can clearly see that the far side has a dramatically different look. The near side is largely covered by dark patches; these *maria*[3] were produced by volcanic flows. The far side has less of that, making it a more direct representation of the earlier stages of the Moon, less affected by the volcanic activity which occurred later. So, if we want to answer some basic questions about the Moon, its formation, its interaction with the Solar System, and even the interaction of the Solar System with the galaxy—looking for places where we can get long, deep records about what experiences different parts of planets have had over the past billions of years—this is really crucial stuff. And there are other interesting features you can see on the far side.

If we examine the Moon's topographical characteristics, one of the places of great interest is the Aitken Basin, a very large, deep impact crater near the South Pole on the far side (see **Figure 4**). China may decide

2. See the material on the LaRouche PAC page, "The Lunar Helium-3 Fusion Driver."

3. The plural of Latin *mare* (sea). Formerly, astronomers thought these volcanic plains were actually seas.

to bring its Chang'e-4 lander down here. It is of great geological interest because it is one of the largest known impact craters in the Solar System; it is so deep (about 6 km) that it reaches into some lower layers of the lunar surface, making them accessible for investigation.

Some people might think, "Lunar geology, how interesting can that be? This is just a giant, cold, dead rock up there; how much can you learn from that?" But we are constantly being humbled by our realization of how little we know about the Solar System, about planetary bodies. When the Apollo astronauts went to the Moon, they brought seismometers to measure seismic activity. They thought they might measure seismic activity from thermal expansion due to differential solar heating of the Moon, and seismic activity from meteorite impacts. They measured those phenomena, but they also measured deep, earthquake-like seismic activity in the Moon (moonquakes), something they didn't think could happen. They didn't expect it; we still don't really have an explanation for why the Moon is still seismically active.

Radio Astronomy at Very Low Frequencies

The following scientific areas are among those identified as potentially benefitting from very low frequency radio observations of the universe.[1]

The unexpected unknown. First and foremost: *things we don't know and can't foresee!* Every time we open up a new window on the universe, we find things we didn't expect. This is perhaps the most important potential of the entire effort.

Magnetic fields. Magnetic fields can be hard to detect and measure from afar, but because they are often associated with plasma structures, and because plasma structures radiate at very low frequencies, some new investigations of magnetic fields on various scales may become possible.

Large-scale plasma structures. On planetary, stellar, interstellar, and galactic scales, there are large, coherent plasma structures that can be investigated because they radiate in very low frequencies.

Solar activity. We may obtain a new picture of solar activity, potentially shedding light on the nature of the energetic, explosive events underlying solar flares and coronal mass ejections—processes that are not currently fully understood.

1. Unless otherwise noted, these are some scientific potentials summarized in the 1997 ESA report, "Very Low Frequency Array On The Lunar Far Side."

Planetary imaging. Images of the radio activity (including that resulting from lightning) of the outer planets—Jupiter, Saturn, Uranus, and Neptune. Some very limited, low-frequency radio measurements were done by the Voyager spacecraft decades ago, but there is much to learn.

Asteroid and comet detection. Observations at very low frequencies may provide a new way to detect asteroids and comets. As they travel through the interplanetary medium, asteroids and comets excite the solar wind (a plasma), causing it to radiate in these very low frequencies.[2]

Low-energy cosmic rays. Cosmic rays below a certain energy cannot penetrate the Sun's heliosphere, so we currently know nothing about them, but they can radiate in very low frequencies.

Supernovae remnants. Certain parts of supernovae remnants are expected to radiate in the very low frequencies.

Structure of the Milky Way Galaxy. Certain features of the Galaxy's magnetic fields and the interstellar medium can be investigated.

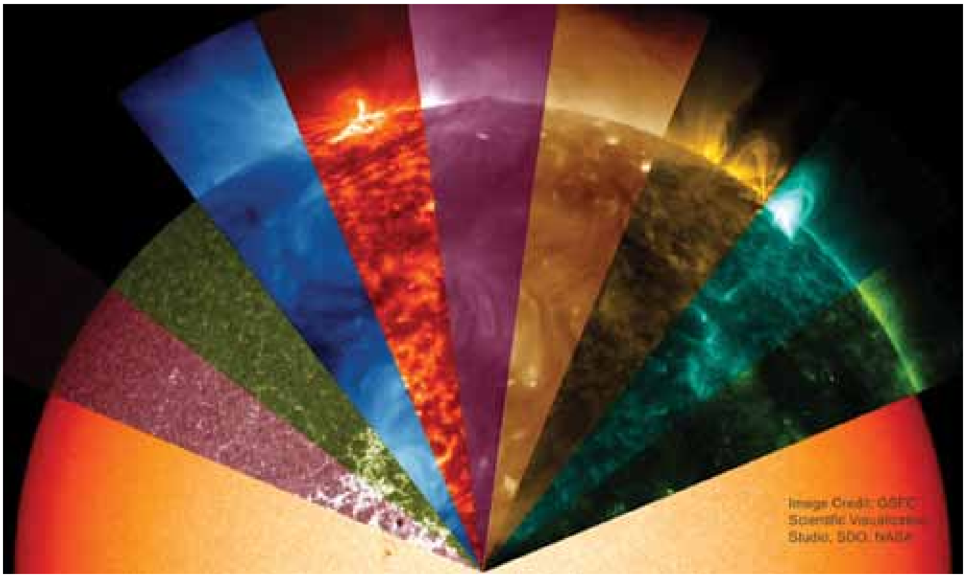
Radio galaxies and other active galaxies. The mysterious phenomena of active galactic nuclei can be illuminated in a completely new way, which may shed some light on one of the most interesting mysteries of galactic astronomy.

2. Proposed at the 1992 Los Alamos National Laboratory planetary defense conference. See "Space Optical and Low-Frequency Radio Searches for Earth-Crossing Asteroids and Comets" by J. G. Hills in *Proceedings of the Near-Earth Object Interception Workshop*, LANL, Los Alamos, New Mexico, Jan. 14-16, 1992.

Or take a more recent discovery. Just in the last couple of years, we've found evidence that the Moon was still volcanically active within the last 100 million years. Earlier, experts had thought it hadn't been volcanically active for billions of years; they thought it was just a cold, dead body up there. Now, speaking in terms of geological time scales, we find that it has been volcanically active in the relatively recent past.[4]

Not only that, but these recent periods of lunar volcanic activity correspond to times when the Earth has experienced very intense volcanic activity.[5] Is that a coincidence? Maybe. Is it an indication of some process on a larger scale, affecting the Solar System as a whole? It could be.

FIGURE 5



GSFC Scientific Visualization Studio, SDO, NASA

Different frequencies of the electromagnetic spectrum disclose different phenomena. This is a montage of the Sun imaged at different frequencies, some showing the solar "granulation," some disclosing magnetic field organization, and others showing flare activity. The electromagnetic spectrum extends from gamma rays (high frequency) through X-rays, ultraviolet, visible light (violet to red), infrared, microwaves, and radio waves (low frequency).

These kinds of things direct our attention to the larger system of the galaxy.[6] It's amazing how little we know about the fundamentals of the Solar System, of planetary bodies. So it is crucial to get up there and actually investigate.

The (Radio) Dark Side

Third, the lunar far side offers an entirely new window for our investigation of the universe as a whole: It will enable us to observe cosmic phenomena in the very low frequency part of the radio spectrum for the first time. Very low frequency radio astronomy from the far side is under consideration as a part of the new Chang'e-4 mission.

Why is this important? We don't observe the universe just in one part of the electromagnetic spectrum. Our eyes enable us to see light from the red to the violet, which we call the visible range of the spectrum. But we know that this is just a tiny fraction of the entire spectrum in which processes in the universe radiate. As we have discovered more and more of the electromagnetic spectrum, we have also developed instruments to detect and image phenomena in the universe at those wavelengths. And we have been surprised every time we have done it, finding things we didn't expect.

The image of the Sun in **Figure 5** illustrates the point. It is a montage of images taken at the same time, but with a variety of instruments, each sensitive to a different window of the electromagnetic spectrum, giving a sense of what different processes we see when we look in the different parts of the spectrum.

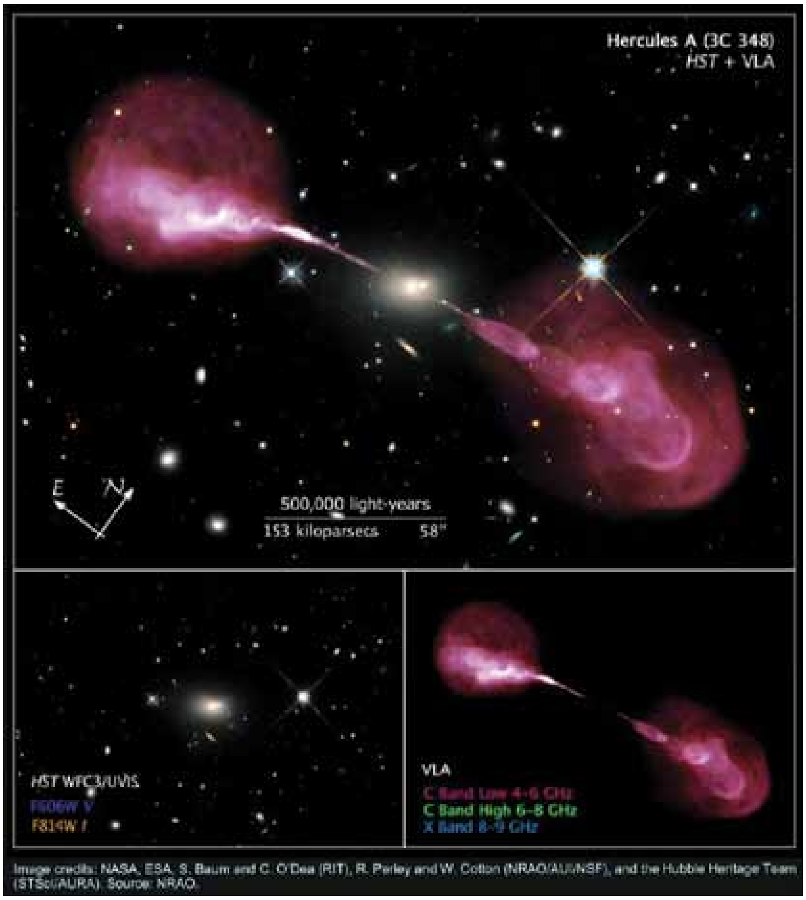
The same principle can be impressively demonstrated when looking at galaxies. If we look in the optical—what we're used to seeing with backyard tele-

4. S.E. Braden et al., "Evidence for Basaltic Volcanism on the Moon within the Past 100 Million Years," *Nature Geoscience* 7, 787-791. Published online Oct. 12, 2014.

5. See Benjamin Deniston, "Earth-Moon Comparative Planetology," *EIR*, July 17, 2015; and Benjamin Deniston, "Near Simultaneous Multi-Planet Volcanism on Geological Timescales as Evidence for a Cosmic Driver of Planetary Geophysical Activity?" *New Concepts in Global Tectonics*, 4:1 (March 2016), in press.

6. See "Toward a Galactic Science Driver," Benjamin Deniston, *EIR*, July 17, 2015.

FIGURE 6



NASA, ESA, S. Baum and C. O'Dea (RIT), R. Perley and W. Cotton (NRAO/AUI/NSF), and the Hubble Heritage Team (STScI/AURA). Source: NRAO

The Hercules A galaxy in radio and optical wavelengths. Lower left, the galaxy as captured by the Hubble Space Telescope in visible and ultraviolet light, showing galaxies but no plasma jets. Lower right, the same location captured in radio waves with the Very Large Array, showing plasma jets but no galaxy. Above, the two images are combined.

scopes, and the Hubble Space Telescope has an optical capability—we might see a spiral disk, or the form of an elliptical galaxy. If we look using radio frequencies, at the known locations of certain galaxies we see something completely different, something we would otherwise never know was there. Sometimes you see massive structures of plasma in the radio part of the spectrum. So an entire, critical phenomenon, central to what is going on in the fundamental physical properties of these galactic systems, is completely invisible in the optical. It's only when we look in certain other wavelengths that we get a completely new window (see **Figure 6**).

Mankind has been doing this for decades. We have been putting up satellites to look in more intense energy ranges, that is, using higher frequencies—in the ultraviolet, the X-ray, and the gamma ray. We have also been going in the other direction, using infrared and longer wavelengths, that is, at lower energies, down into the radio range. And there is still a lot to be done; we're constantly looking with higher resolution, we're looking farther, we're getting clearer pictures.

But there is one large chunk of the spectrum that we have not utilized in looking into the universe; we have never been able to image the universe in very low frequency radio waves,[7] that is, very long wavelength radio waves. We have never done it because we cannot do it from the Earth. Many of the longer radio wavelength ranges simply do not penetrate to Earth's surface; they bounce off of the ionosphere structure of the atmosphere. We also use long radio wavelengths massively for communications, so the Earth environment is very noisy in these regions. And the Earth itself emits very strong signals in these regions. For these reasons, even Earth-orbiting satellites can't do the job. It is impossible from Earth, even from Earth orbit, to observe the universe in this entire low-frequency range of the spectrum in a fruitful way.

For decades, scientists have realized that the perfect location for making such observations is the far side of the Moon.[8] Being the far side, always facing away from the Earth, it is always shielded from all the radio noise from the Earth (natural and manmade) by the mass of the Moon itself. The Moon has an incredibly thin atmosphere, so the very low frequency signals from the universe can penetrate down to the lunar surface. So we have a unique window from the Moon to begin looking at the universe in a completely new part of the spectrum.

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7. For the astronomers, very low frequency (VLF) refers to a low of a few hundred kilohertz to a high in the tens of megahertz. This differs from the definition of very low frequency used by the electrical engineer, which is significantly lower.

8. In the United States, the 2007 National Research Council report on the general scientific importance of returning to the Moon (*The Scientific Context for Exploration of the Moon*) emphasizes the unique importance of lunar far side very low frequency astronomy (Section 6).

It has been discussed since the 1960s;[9] it has been studied in detail by numerous teams in terms of the importance of accessing this part of the spectrum and of demonstrating that the Moon's far side is really the only nearby place we are going to be able to do this.[10]

There is some discussion about what we might find by using this region of the spectrum. In the very large, certain fundamental processes of galaxies are thought to radiate only in this region. On the smaller scale of our Solar System, some basic processes of our Sun are thought to only radiate in this region (see box, p. 13). For example, we still don't know why there are explosive events on the surface of the Sun—the solar flares and coronal mass ejections—which pose a threat to our astronauts out in space and to our satellite grid and electrical systems. We still don't understand the basic physics of how these explosive solar events occur, and this part of the spectrum has been posited as crucial to understanding it.

But on all scales—and perhaps most importantly—beyond what we think we might find, there is also what we don't think we might find—the unknown unknowns, waiting to be discovered.

Some very preliminary test observations in this low-frequency window are being proposed as a possible part of the Chang'e-4 far side mission. It could mean the opening up of an entire new window on the universe, showing us new features and processes in the activity of our Sun, our Solar System, our Galaxy, and in the galaxies beyond.

The proposal for such observations and the Chang'e program more broadly stand in critical contrast to what Kesha Rogers has emphasized about the course the United States is taking. China is taking clear, decisive steps, establishing itself as a world leader in space exploration, and now positioning itself to take fundamental first steps into new domains that mankind has never entered before. That is the direction that mankind should be taking; that is the direction China is going in. And you contrast that with where we have gone under Obama, in the exact same period, and I think you get a very clear picture of what the challenge is.

9. As discussed in Section 2.1 of *New Astronomy from the Moon: A Lunar Based Very Low Frequency Radio Array* by Yuki David Takahashi (2003).

10. In 1997—following multiple, in-depth studies—a 70-page European Space Agency report was dedicated to the subject, "Very Low Frequency Array on The Lunar Far Side."