

26 Feb 2015

Senator Ted Cruz, Chair  
Senator Tom Udall, Ranking Member  
Subcommittee on Science, Space and Competiveness  
Committee on Commerce, Science and Transportation  
United States Senate  
Washington DC 20510

Dear Senators Cruz and Udall,

I am writing you about the future of U.S. human space exploration. I appreciate the attention you are giving to this as evidenced in your first Subcommittee Hearing. As the Executive Director Emeritus and Co-Founder of The Planetary Society I have had many opportunities over the past forty years to be involved in the technical, scientific and policy sides of our space program. I have several times testified to your Subcommittee (and even was once a Congressional Science Fellow on its staff). Most recently I have been the co-leader of the Asteroid Redirect Mission study at the Keck Institute for Space Studies. I am particularly writing you about that mission.

Moving a celestial body from one part of the solar system to allow humans to take their first step beyond the Moon is the exciting goal of the Asteroid Redirect Mission. That it is feasible and far less costly than any other proposed human space outpost is a hallmark of American space ingenuity and leadership and an opportunity for a unique achievement in both human and robotic space development. Placing the asteroid in a Distant Retrograde Orbit around the Moon supports a crew visit and astronaut operations in deep space before 2025 while advancing the technology and mission capability that leads to deeper and longer space missions, eventually to Mars.

This is the essence of the Asteroid Redirect Mission proposal (ARM). The mission is lower cost than any other suggested human space exploration outpost beyond low Earth orbit and enables humans to once again conduct science and exploration in space as they did nearly 50 years ago at the Moon. One would think that asteroid scientists would welcome humans exploring asteroids. Instead their community has been critical of the proposal, motivated it seems by fear that the human space program will attack their parochial science funding. This fear by scientists and their human vs. robotic arguments are as old as the space program, and has always been found to be unwarranted.

Prof. Richard Binzel of MIT articulated the science criticism<sup>i</sup> proposing his own plan of waiting until a "proper" science survey of asteroids could be made and a target

found in a “native orbit” that would be reachable for humans. This has the merits of creating a new program for the asteroid science discipline just as it delays human exploration in space. Scientists almost always want to do their programs first. If the point of the Asteroid Redirect Mission was to enhance asteroid science studies then many alternatives for asteroid investigations (e.g. robotic and human; deep space or Near-Earth; different types and compositions) should be considered. But the point isn’t asteroid science – that is only an added benefit of the human space development which is the prime purpose of the mission. It is a mighty big benefit in my opinion: to have humans again doing worthwhile exploration on a celestial body. But it is secondary to creating a place for human exploration.

The alternative program has even a bigger weakness – it rests on three things we don’t have and don’t have the money for. A robotic asteroid survey mission will certainly take many years to yield results and cost hundreds of millions of dollars; a long duration habitation module to enable astronauts to get to and from the native orbit is not yet in development and it would cost even more – billions of dollars. The third missing piece is launch capacity to take a crew on that long a voyage (even to a theoretically to be found nearer one). The time scale for its accomplishment would be at least 15, more likely 20, years.

Originally going to the asteroid meant going to one in its native orbit between Earth and Mars. But, round-trip times to near-Earth asteroids in their native orbits are at least six months, whereas to the redirected asteroid in the lunar orbit it is a couple of weeks – the absolute limit of the SLS/Orion in its present development. So either we wait 5-10 years for more NASA programs to get started (and more money) or we start now to revitalize the human program with exciting ventures in space for the current space generation, not only for some future one.

There is also criticism by some who consider ARM a diversion in the development of human space flight. How it can be a diversion from a program which has not moved out of Earth orbit in 40 years is perplexing. Human space exploration is at a standstill now, getting it going again should not be viewed as a diversion. Human missions to Mars, the Nation’s stated long-term objective, require solving a host of major technological problems. One of these is the propulsion technology needed to affordably move huge quantities of equipment and supplies to Mars. Only since NASA initiated studies into the feasibility of an Asteroid Redirect Mission did the Agency gain a full understanding of the extraordinary capability of solar electric propulsion (SEP) to significantly lower the cost of Mars exploration. This understanding is so new, and the capabilities of high-power SEP so impressive and so near-term that they weren’t recognized by the 2014 NRC report<sup>ii</sup>. The NRC Committee characterized SEP “dead-end,” and instead called for nuclear propulsion – very unrealistic and certainly very long-term. Far from being dead-end, SEP is now recognized as enabling for human flight support to Mars. ARM will flight test a

SEP system at least 20 times more powerful than the one successfully used on NASA's Dawn mission to explore Vesta and Ceres. Just as Dawn gave NASA two science missions for the price of one, ARM affordably accomplishes two high-value objectives on the path to Mars—providing human exploration experience beyond low Earth orbit, and flight testing high-power SEP, for the price of one.

Space enthusiasts have many things they like better than ARM – building a lunar base (as was tried on Constellation), flying around Mars (with unspecified human habitation and heavy life support), and even a one-way trip to Mars. They all cost a lot more – in time and in money. They also rely on things we do not have and would cost many extra billions of dollars. I personally am a Mars man, a long-time advocate of human exploration there. I have even written a book urging that. But none of our Mars dreams can be accomplished in a single step, nor quickly. We examined the ARM concept in some detail in our study at the Keck Institute for Space Studies and showed how it supports and accelerates the development of human Mars exploration capability.<sup>iii</sup> This is called in NASA bureaucratese, “extensibility.” It applies to other extensions of the ARM technology – to enhance planetary defense options and to build up commercial and science capabilities. These extensions of ARM benefits have been misinterpreted by some as substitute rationale for the mission. That the mission and technology has the added benefits is excellent, but nothing should divert us from understanding the purpose of ARM: to serve as a stepping stone for human exploration into the solar system.

We could develop solar electric propulsion and we could send humans to lunar orbit without the redirected asteroid; that would, however, delay human missions from conducting operations on a celestial body for at least another decade. Worse than that, the human program would then be boring – with no technological or physical destinations in the near-term. I personally fear this will undermine public support for all space ventures. Does anyone have a proposal for humans to explore anything else before 2025, or for that matter before 2030, or with a lower cost and more expansionary benefit? The non-critical path, but exciting aspect of ARM has another advantage – if there is a snag during the capture or while redirecting the asteroid, nothing too bad happens. No lives are lost, technology still advances, and the crew mission can go ahead with a back-up plan to the distant retrograde lunar orbit.

There is a public perception that NASA is aimless and has lost both its purpose and its verve – that is its “can-do” spirit and willingness to take risks. Ironically, the with the Asteroid Redirection proposal the shoe seems to be on the other foot. A bold and innovative proposal from NASA now has various advisory committees and policy wonks criticizing the supposed risk and objecting to NASA's direction by coming up with their own different directions without practical alternatives. NASA has made clear that its human exploration goal is Mars, but that they can't jump

the chasm of cost, technology, energy and life support that it now requires. They need a stepping stone; there is no better one than a small asteroid placed into a distant retrograde lunar orbit, awaiting humans' first step beyond the Moon.

Thank you very much for considering this letter and for your stated support for space exploration. Please know I would be happy to further discuss it with you or your staffs.

Sincerely,

A handwritten signature in black ink, appearing to read "Louis Friedman", is centered on a light yellow rectangular background.

Dr. Louis Friedman  
Executive Director Emeritus and Co-Founder  
The Planetary Society

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#### References

<sup>i</sup> Binzel, "Human spaceflight: Find asteroids to get to Mars," **Nature**, **514**, 20 Oct. 2014

<sup>ii</sup> National Research Council *Pathways to Exploration: Rationales and Approaches for a U.S. Program of Human Space Exploration* (National Academies Press, 2014)

<sup>iii</sup> Brophy, et. al., "Synergies of Asteroid Redirection Technology and Human Space Exploration," **International Astronautical Congress-2014 A5.3-6.7, x26388**