

Lunar Exploration: Expanding the Human Range of Action

Remarks

to the

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by

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Good evening, and thank you for inviting me to be here with you tonight.

My topic tonight touches on a very old debate in the space community, the relative merit of human and robotic space activities. When I was a child, interested even then in everything about space, this debate was already in full voice. It has continued for five decades. In my judgment there has been no winner, and the contentious nature of the argument has made losers of us all.

The conflict is between those who pursue two goals which ought to be complementary: scientific discovery, and expanding the range of human action. I have simply never seen a valid reason for such conflict, but it exists, and so tonight I would like to delve into some of the reasons, as I see them, why this is so, and at the same time offer a more unifying view for our space community.

As I see it, the issue at its core is one of mutual respect as much as it is any rational accounting of costs and benefits. Though it most certainly has not always been so, we live today in an era in which the merits of vigorous national programs of scientific discovery are well accepted. Scientists, the science community, and the scientific method are highly respected in all modern societies. (This being so, one wonders why there is not a more rigorously logical approach applied to political decisions!)

But if, as Shakespeare put it, “all of life’s a stage”, then the value of enlarging the very stage upon which we humans put forth our play, of expanding the scope and range of human activity, is not as well recognized. So, I would like to make the case as I see it for the value of human space exploration, beginning with a return to the Moon.

In point of fact, scientific discovery itself is a basic element of the rationale for human exploration of the Solar System. The entire history of science is intimately bound up with the observation of the world from new vantage points, both physical and mental. Quite often, it requires a change of physical venue to accomplish a needed shift in a scientific paradigm, or to gather new information not available in the old places. So our reasons for exploring beyond the frontier certainly include the ability to enable scientific discovery. Exploration offers new capabilities to do exciting new science in new ways from new places, and about

those new places. And because of this, the rationale for exploration would inevitably be weaker without a component of scientific discovery.

But we go too far when we say, as some have, that the *only* acceptable reason for manned spaceflight is to enable and conduct new and better science, or when we say, as some in my country have, that “exploration without science is tourism”.

The opposing view has been, in my opinion, best and most tersely captured by our President’s Science Advisor, Dr. John Marburger, in a speech at the American Astronautical Society’s Goddard Symposium in March 2006. Jack noted that space exploration is not fundamentally *about* scientific discovery; rather, it is fundamentally about bringing the resources of the solar system within the economic sphere of mankind.

To me, this is precisely right. The issue is a simple one. We live here on Earth, in – relatively speaking – a concentrated region of matter and energy around a rather nondescript star. There is an enormous gap of time, energy, and technological capability separating us physically from other star systems. I am not one of those who believe that travel to other stars is forever beyond our capability, but I do believe that it will not happen soon. For perspective, I would remind us all that two millennia of human endeavor separated the Queen Elizabeth II from the

Roman Triremes paddling about in the Mediterranean. Our spacefaring capability has not yet reached even the Trireme stage. We have a ways to go.

So for the foreseeable future we can sense but not interact with the realm beyond our own Solar System. But within the Solar System, even with our present rudimentary capability, we have already shown the ability to interact with our environment by means of our people and our tools. This presents us with a very simple choice. We can choose to incorporate the Solar System and its resources into the reach of our civilization, or not.

The President and Congress of the United States have chosen to do so. From the 2005 Authorization Act for NASA, “The Administrator shall establish a program to develop a sustained human presence on the Moon, including a robust precursor program, to promote exploration, science, commerce, and United States preeminence in space, and as a stepping-stone to future exploration of Mars and other destinations.”

The wording of the Act is significant. It requires us to promote the goal of “exploration”, but to do so *together with* economic, scientific, and leadership objectives, and in a way that encourages and allows further progress. Stated this way, the Act promotes U.S. leadership on the space frontier, but recognizes implicitly that leadership without a worthy purpose has no point. Thus, the goal is not solely to explore our Solar System, but to *use* accessible space for the benefit

of mankind. It is not a goal that can be accomplished in a decade, nor one that is restricted to a single destination for the purpose of planting a flag. The goal is to begin now to incorporate our Solar System into our way of life.

So a key point must be made: Exploration without science *is not* "tourism". It is far more than that. It is about the expansion of human activity beyond the Earth. Exactly this point has been made by no less than Stephen Hawking, who joins others in pointing out a basic truth: The history of life on Earth is the history of extinction events, and human expansion into the Solar System is, in the end, fundamentally about the survival of the species. So to me exploration is, *in and of itself*, a human endeavor fully as noble as that of scientific discovery.

Now, I have learned that portions of the broader scientific community feel deeply disrespected – I can think of no other word – when I, or anyone, says or implies that “space exploration” is *not* primarily about “science”. I believe that response is misguided. The space exploration enterprise stands, and should stand, on a much broader base.

With all of that said, when the International Space Station is completed, the Moon is the proper next step in this enterprise, and science will be one of the early beneficiaries. This is because scientific exploration of the Moon is fundamentally important to Solar System science. Many key questions remain to be answered.

Our best current theory states that today's Earth-Moon system was formed by the impact on a proto-Earth of a Mars-sized body; thus, the histories of Earth and Moon are intimately linked. The outer layers of the Moon were once an entirely molten "magma ocean", and later differentiated to form the earliest crust and mantle. But why is there a dramatic chemical difference between the compositions on the nearside and farside of the so-called KREEP elements? Additionally, the size, composition, and nature of the lunar core remain almost unknown, but are fundamental to understanding the origin and evolution of the Moon.

The absolute chronology of impacts on the Moon is critical to understanding the history of the inner solar system; however, the impact history of both Earth and Moon remain poorly understood for the first 600 million years after the proto-Earth formed, and for the last 3000 million years. It is believed, but not confirmed, that there was a terminal cataclysm, an intense peak in the rate of large impacts on the Moon, and therefore also on the Earth, about 3.8 to 3.9 billion years ago. If so, is it a coincidence that the end of this period of heavy bombardment of Earth and Moon roughly coincides with the emergence of life on Earth?

Numerous specific investigations into certain aspects of the lunar environment are interesting as well. Why are the lunar poles rich in hydrogen? Are there significant deposits of water ice in permanently shadowed polar regions?

Are the poles significant cold traps for other volatiles? Why does there remain a tenuous lunar atmosphere, and why do we see dust lofted to high altitudes?

The characteristics of the lunar regolith and the plasma and radiation environment near the Moon are both scientifically important and critical to future human exploration. Can ancient regolith be found, which may record past radiation and plasma environments, as well as a history of past solar activity?

The Moon is a unique and important platform for future astronomical observations. In particular, it offers radio-quiet sites that do not look through a thick ionosphere, allowing the use of low frequency radio astronomy to access a new window into the early universe.

But, just as with space exploration generally, exploration of the Moon is about more than just scientific discovery. It is the first and closest location where we can begin to learn how to extract, process, and use extra-terrestrial materials, something we must do if there is ever to be a significant human presence carrying out important activities in space. The Moon is another world, a place three days from home where we can begin to learn the techniques necessary to live off-planet, the techniques necessary for longer voyages, to Mars and beyond. Once we set out for Mars, the first crew to try it will be gone for years. When that happens, it will be essential to have behind us the experience of living for months at a time on the International Space Station, and on the Moon.

Space exploration is an enterprise for the ages. We will be doing it for as long as we are human beings. We in the United States are committed to it, and we want you to join in it with us. As President Bush has said, we “invite other nations to share the challenges and opportunities of this new era of discovery. The vision I outline today is a journey, not a race, and I call on other nations to join us on this journey, in a spirit of cooperation and friendship.”

I am here with you tonight to precisely that end.

Thank you.