

# ASTEROIDS in the Context of Human Exploration: *A Sustainable Path*

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# House Subcommittee on Space

AMENDMENT IN THE NATURE OF A SUBSTITUTE

TO H.R. 4412

OFFERED BY MR. PALAZZO OF MISSISSIPPI AND

MS. EDWARDS OF MARYLAND

## 9 SEC. 601. ASTEROID RETRIEVAL MISSION.

10 (a) ASTEROID RETRIEVAL REPORT.—Not later than  
11 180 days after the date of enactment of this Act, the Ad-  
12 ministrator shall provide to the Committee on Science,  
13 Space, and Technology of the House of Representatives  
14 and the Committee on Commerce, Science, and Transpor-  
15 tation of the Senate a report on the proposed Asteroid  
16 Retrieval Mission. Such report shall include—

17 (1) a detailed budget profile, including cost esti-  
18 mates for the development of all necessary tech-  
19 nologies and spacecraft required for the mission;

20 (2) a detailed technical plan that includes mile-  
21 stones and a specific schedule;

22 (3) a description of the technologies and capa-  
23 bilities anticipated to be gained from the proposed  
24 mission that will enable future human missions to  
25 Mars which could not be gained by lunar missions;



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### Squyres, Pace, Not Convinced of Asteroid Return Strategy

Marcia S. Smith  
Posted: 24-Apr-2013  
Updated: 24-Apr-2013 11:49 AM

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NASA's new asteroid retrieval mission has not won over two influential voices in space policy debates. Cornell University's Steve Squyres and George Washington University's Scott Pace told the National Research Council (NRC) on Monday that it is not necessarily the best next step for the U.S. human spaceflight program.

The NRC's Committee on Human Spaceflight met Monday and Tuesday in Washington, DC. The committee is tasked with describing the value proposition of the human spaceflight program – what do taxpayers see as its value for the money spent – and providing advice on future planning for that program. Among the topics discussed was NASA's new [asteroid retrieval strategy](#) to capture an asteroid, redirect it into a retrograde lunar orbit, and send astronauts to retrieve a sample.

Squyres chairs the NASA Advisory Council (NAC) and is perhaps best known as the principal investigator for the twin Mars rovers Spirit and Opportunity. He also chaired the NRC's 2011 Decadal Survey for planetary science. In addition to talking about NAC's view of NASA's human exploration program, he shared his personal views on topics NAC had not yet considered, including the new asteroid retrieval strategy.

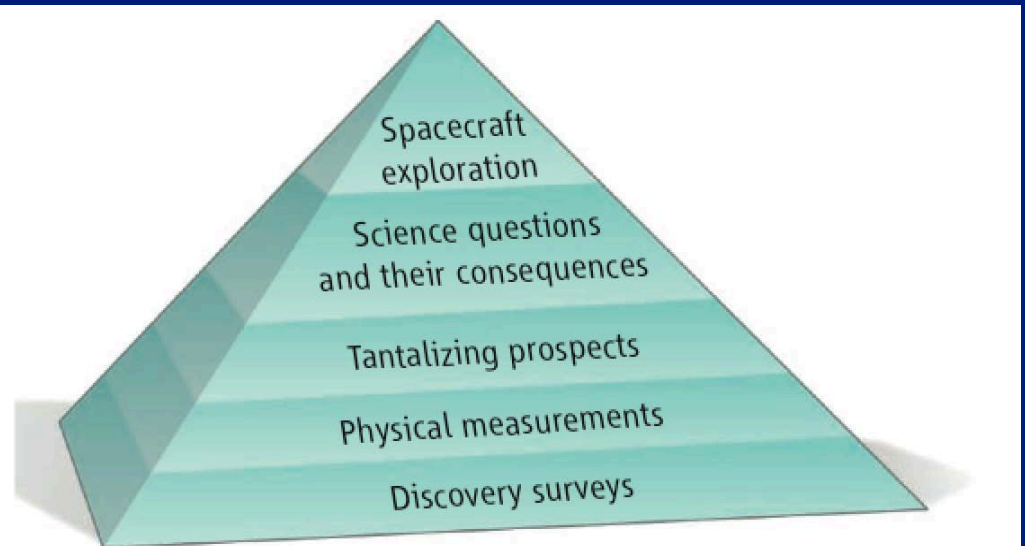
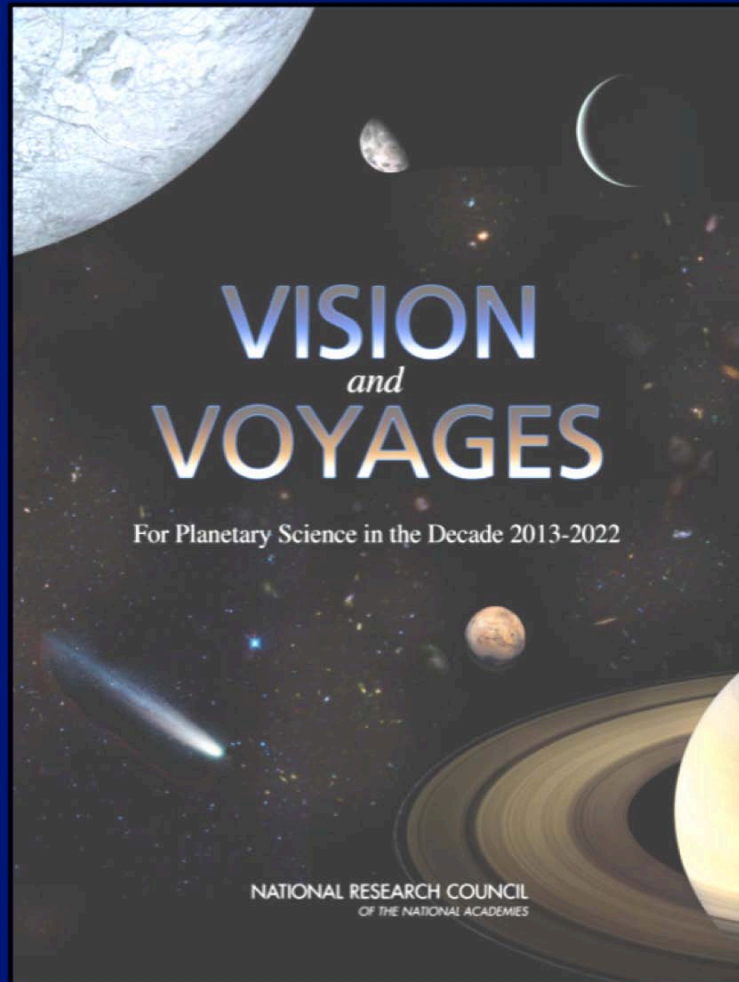
His personal recommendation is that NASA not attempt to sell the asteroid retrieval mission either on the basis of exploring asteroids or that it is a more effective way to satisfy President Obama's goal of using an asteroid mission as a step towards Mars. Quoting the President's April 15, 2010 [speech](#) at Kennedy Space Center, Squyres reminded the committee that the President's goal was to build "new spacecraft designed for long journeys ... beyond the Moon into deep space," which is not what the new strategy entails. He agrees that understanding asteroids is an important scientific goal, but not one that requires humans on-site. Humans and robots work effectively together in exploring complex environments like Mars where Earth-bound scientists cannot anticipate the many surprises that lie ahead. Comparatively straightforward environments like that of an asteroid can be effectively explored with robotic spacecraft alone, he believes.

in·cre·du·li·ty  **noun** \,in-kri-'dū-lə-tē, -'dyü-\

: a feeling that you do not or cannot believe or accept that something is true or real



# *REAL* Science and Exploration in the National Interest

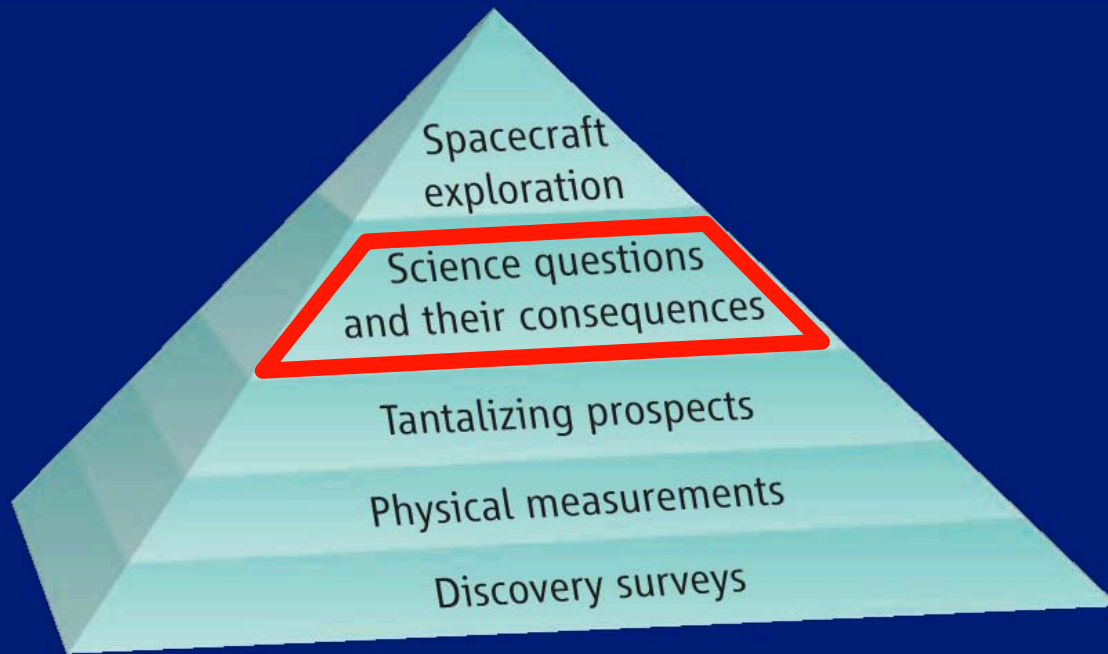


**Pyramid building.** Planetary exploration begins with discovery, often in the course of surveys. Physical measurements, with increasing precision, bring to focus particularly tantalizing objects. Science questions become refined through both observation and theory, often to their limit. Spacecraft exploration capable of delivering consequential breakthroughs forms the capstone.

**SCIENCE** VOL 338 12 OCTOBER 2012

*Published by AAAS*

# *REAL* Science and Exploration



Pyramid of planetary exploration.  
*Science* **338**, 203 (2012)

## Stunt







# *Buzzword Pyramid*



# Far Away Robotic SandCastle Experiment (FARCE)



Concept Study: Robotic spacecraft (A) arrives at target. Builds sandcastle (B).  
(Some technical and budget details omitted. But we are very smart. Trust us.)

## Develop Key Technologies For Human Spaceflight

- Overcome challenges of precision low-g operations.
- Flexible mission options: Moon, Mars, asteroids.
- Applicable to Planetary Defense and Space Resources.

## Science Community Involvement

- Site selection and instrument platform development.
- Opportunities for international partners.

## Public Engagement & Stakeholder Benefits

- Educational: Popular Earth activity translated to space.
- Sandcastle design contest. Fun for the whole family!
- Commercial opportunities, including space tourism.
- Future selfies with iconic space castle.

## Not a science mission, but clear science benefits

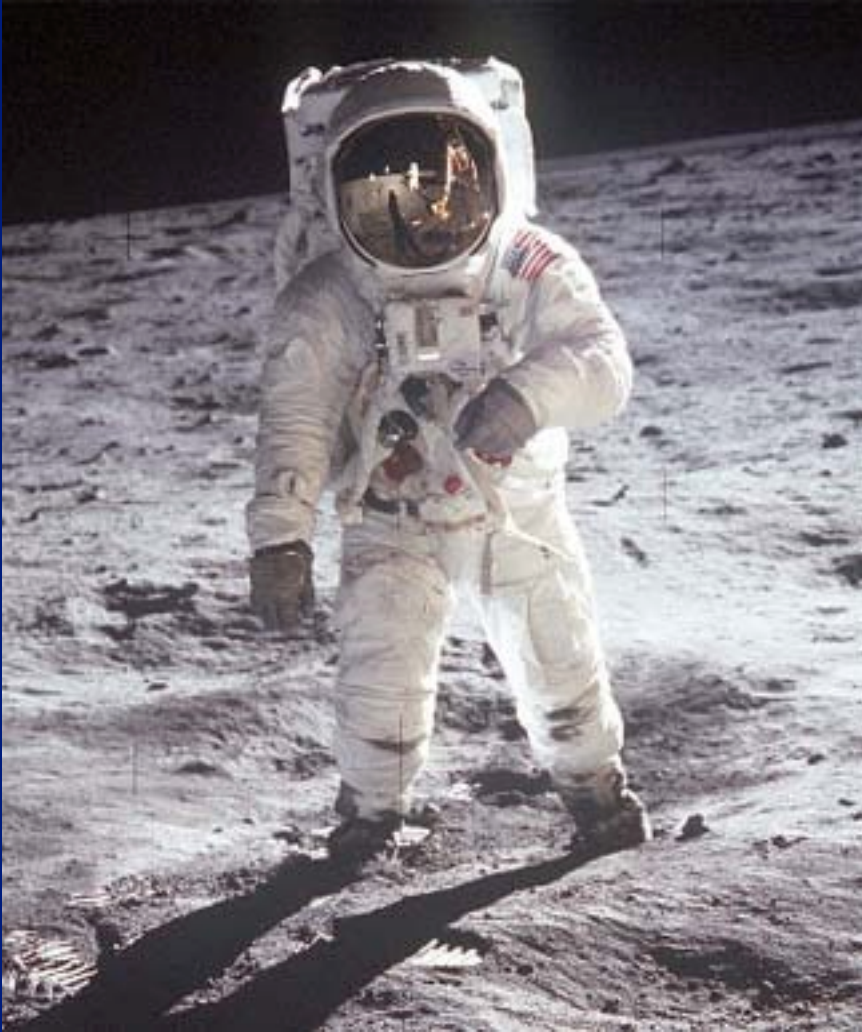
- Understanding regolith properties on diverse worlds, including depth, cohesion, particle size distribution.
- Significant advances in sample science capabilities.
- Opportunity to study subsurface thermal properties.
- Castle stability as a measure of seismic environment.
- Castle erosion reveals local weathering environment.

## Supports Ongoing Innovation:

We'll keep making slides until *somebody* likes *something*.

**Alternatively:** Advocate a *sustainable* path with *compelling* objectives serving the national interest through broadly developed and meaningfully *prioritized* goals.

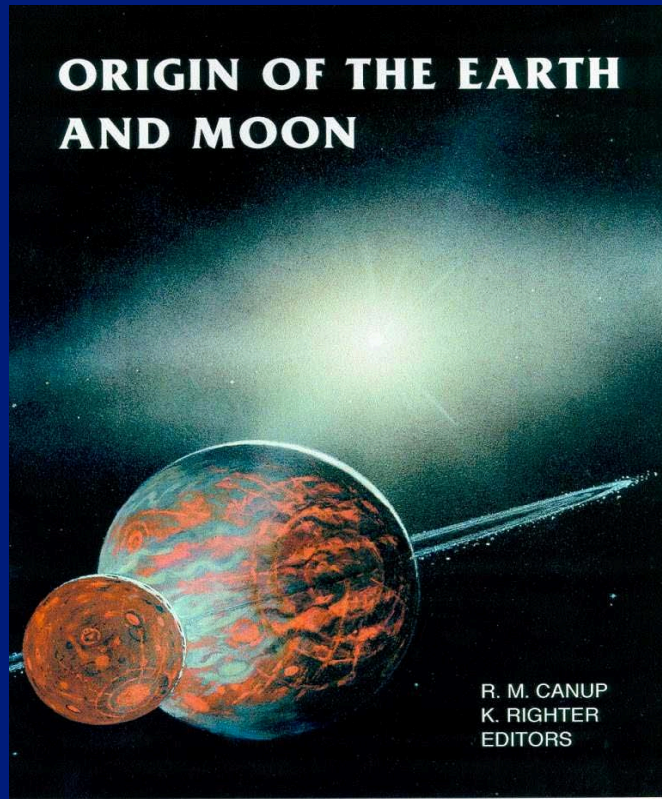
**“But... Apollo was  
not about science”**



# **Different Era**



“But... Many scientists also decried Apollo. But look at how the *science* advanced !”



## Lunar Samples: Transformative Science

- Planetary scale
- Geology, geophysics
- Early formation processes
- No previous samples

## ARM Samples:

- Incremental science, at best
- Irrational for human risk

Moon:	3475 km	$7.4 \times 10^{22}$ kg
ARM Target:	10 m	$1.6 \times 10^6$ kg
<b>RATIO:</b>	<b><math>3 \times 10^{-6}</math></b>	<b><math>2 \times 10^{-17}</math></b>

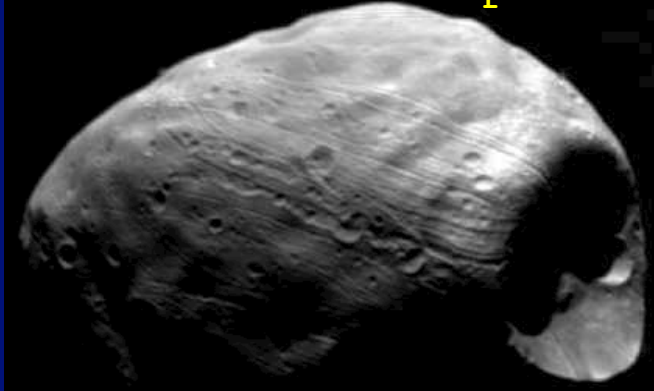
*"It's not a science mission, so . . ."*  
*"It's still pre-formative, so . . ."*

**What does this**

**have to do with  
humans on Mars ???**



10 meters = 0.1 pixel



**The impact hazard ???**

10m ARM target  
is 1/100<sup>th</sup> mass  
of Chelyabinsk.

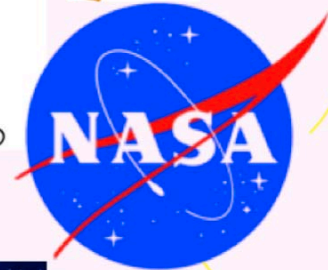
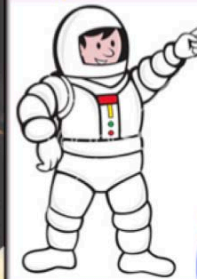
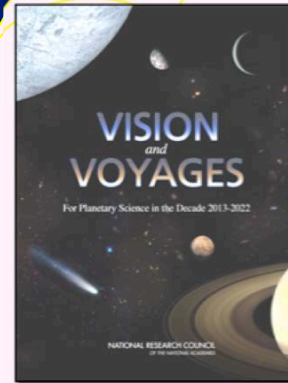
4-6 tons  
delivered "free"



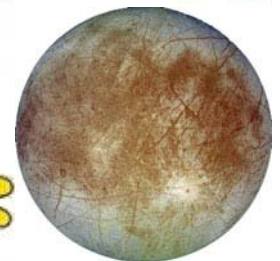
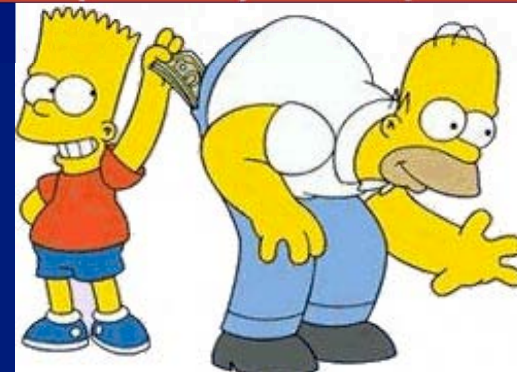


# “It’s not our money, it’s HEO MD.”

## Zero sum game



R&A  
Europa  
Titan



# Converging To a *Sustainable* Path



**Just say no:**  
*“One-and-done” stunt  
will irreparably damage  
small body exploration.*





# Converging To a *Sustainable* Path



- There are alternative *non-retrieval* paths that move the overall program forward.

# Converging To a *Sustainable* Path



- Not sustainable, one-and-done “stunt”.
- No benefit to astronauts.
- Science not compelling.
- Impact hazard relevance??
- Path to Mars relevance???



- SEP delivers supply module to cis-lunar space. “Boring?”
- Rendezvous benefits astronauts, crew health and safety.
- Enables extended missions. “True” path to Mars.

# So, how do asteroids fit in ?

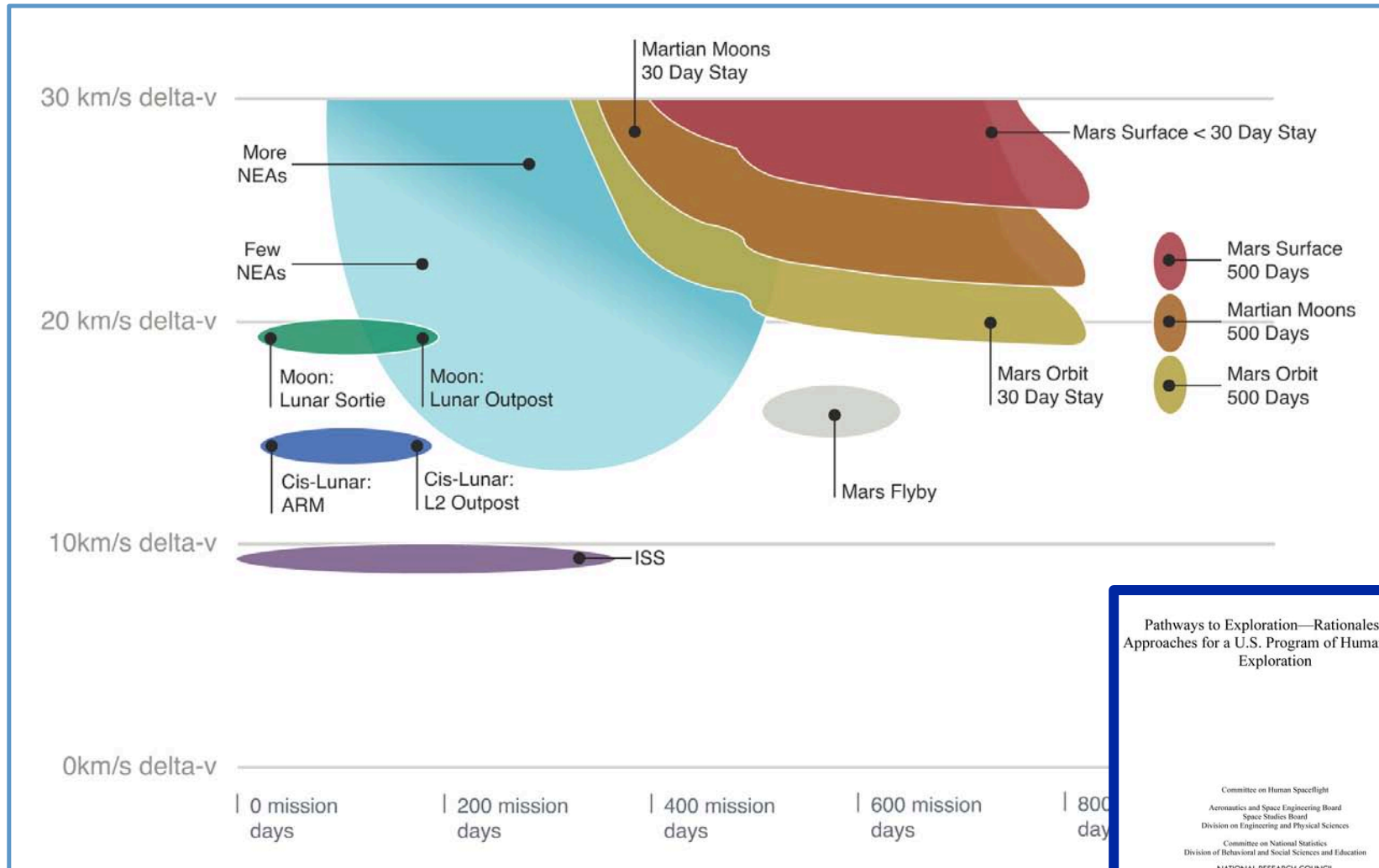
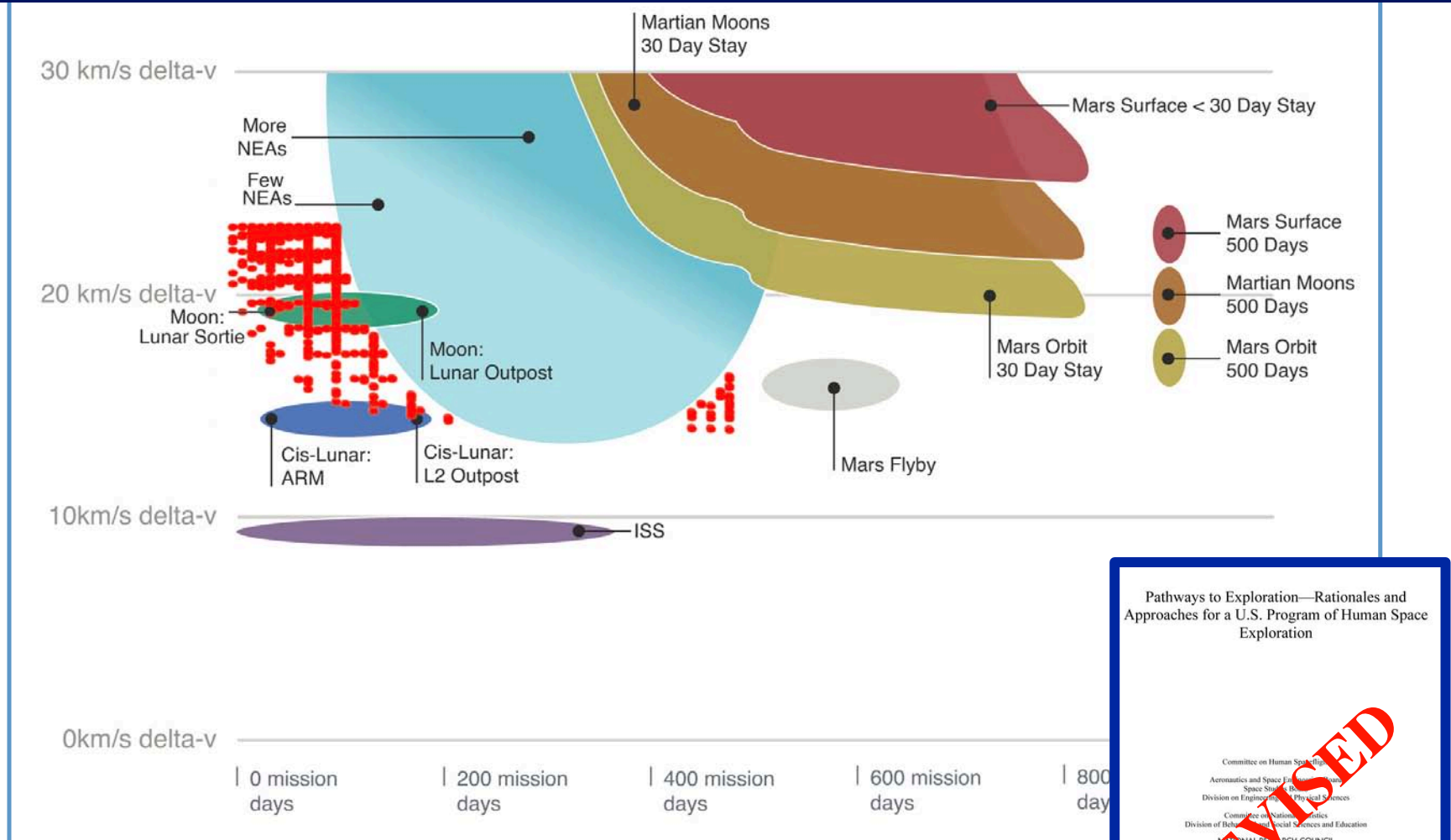


Figure 1.9

# Asteroids in their native orbits are abundant on the path to Mars



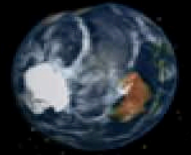
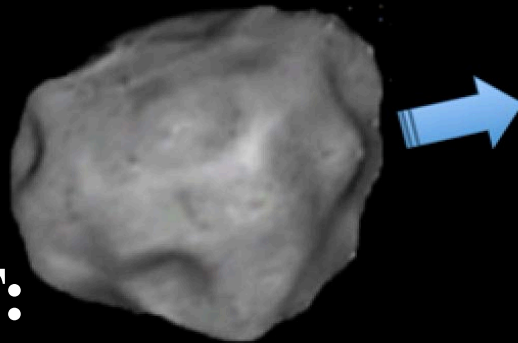
Red points are NASA's own data, omitted from NRC report.

Figure 1.9

REMOVED



# Asteroids in their native orbits: How abundant are they ?



## FACT:

A 10-meter sized object traverses  
cis-lunar space every week.

Oh, how  
embarrassing!

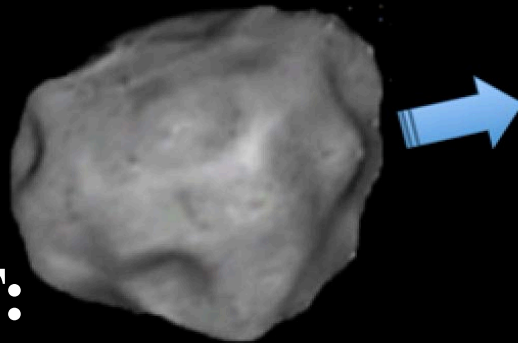


## The numbers:

A 10-meter object strikes the Earth at least  
once per fifty years. (NRC NEO Hazard report.)  
 $50 \text{ years} \times 12 \text{ months/year} = 600 \text{ months}.$

Cross-section of impact plane out to lunar distance  
is 3600 times the cross-section area of Earth.

$3600 \text{ cross section area} / 600 \text{ months} = 6 \text{ per month}$



## FACT:

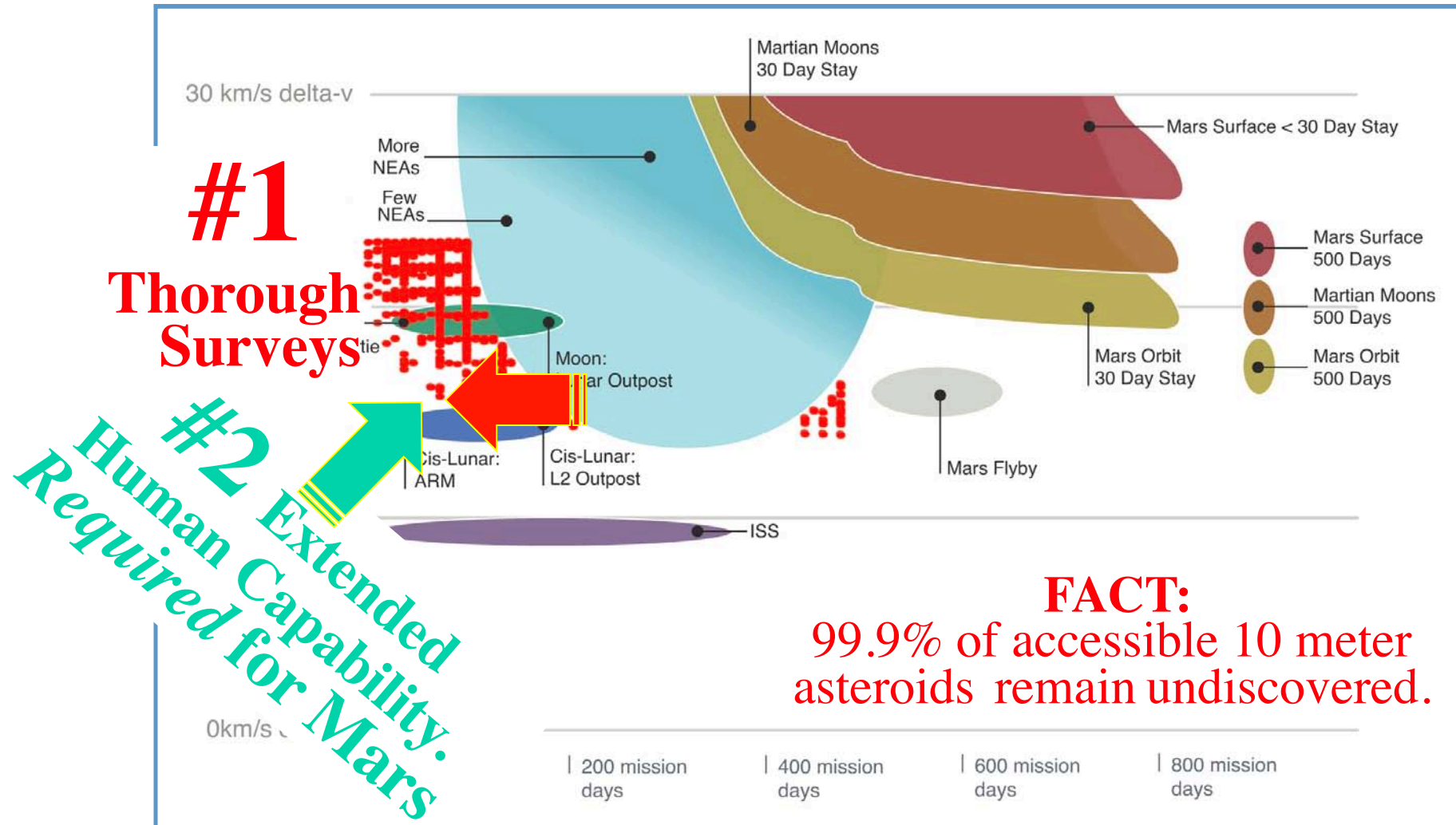
A 10-meter sized object traverses  
cis-lunar space every week.

**GAME  
OVER**

Heaven forbid . . . an astronaut dies  
pulling a rock out of the baggie.

Who is going to defend why that sample  
*required* the risk of human life?

# Two Steps To a *Sustainable* Path



# Converging To a *Sustainable Path*

## *Survey First!*

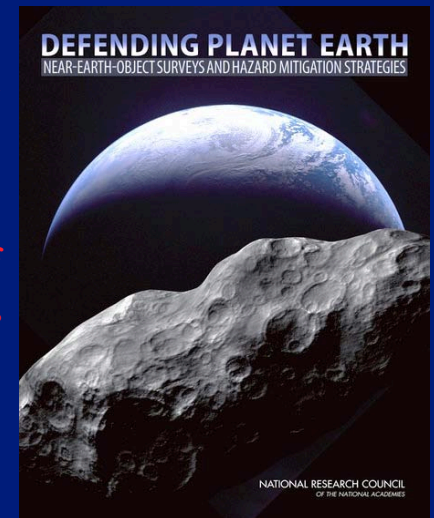
- Provides abundant targets in their native orbits.
- Also addresses the hazard survey imperative.

**Extend  
Human  
Capability**  
(patience, please)

**“True” Path  
To Mars**

(Competitively selected.  
Equivalent to Discovery  
or New Frontiers.)

Bring forth survey as  
direct outcome of  
**Grand Challenge.**



PUBLIC LAW 109-155—DEC. 30, 2005

Subtitle C—George E. Brown, Jr. Near-Earth Object Survey

SEC. 321. GEORGE E. BROWN, JR. NEAR-EARTH OBJECT SURVEY.

*A future path for asteroids as  
“stepping stones”  
becomes inherently sustainable.*



# Summary:



**Just say no:**  
*“One-and-done” stunt  
will irreparably damage  
small body exploration.*

- Like it or not, ARM is a small bodies mission.
- Ultimate ARM decision is above SBAG pay grade.
- SBAG can (must\*) give its candid assessment. (H.R. 4412)



\* “neutrality is complicity”

Extend  
Human  
Capability

(patience, please)



*Survey First!*

Keep saying  
**“YES”**

- Advocating for survey is in SBAG purview.
- Abundant native targets obviates *retrieval* architecture.
- Invest in *SURVEY*, not in retrieval architecture.
- Advocating for a sustainable path in small body exploration is in SBAG purview.
- Advocating for compelling, prioritized science is SBAG’s responsibility\*.

# Sustainability for humans at asteroids:

Requires a slower path  
driven by “Survey First.”



Credit: W. K. Hartmann

Extend  
Human  
Capability

(patience, please)



*Survey First!*

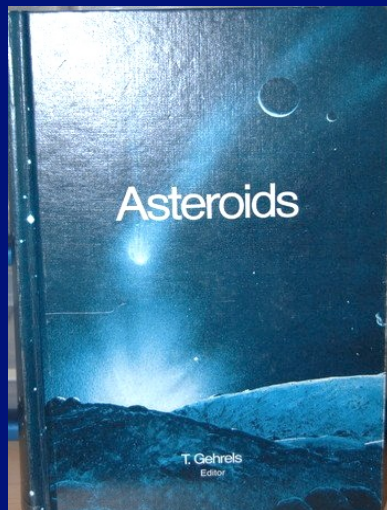
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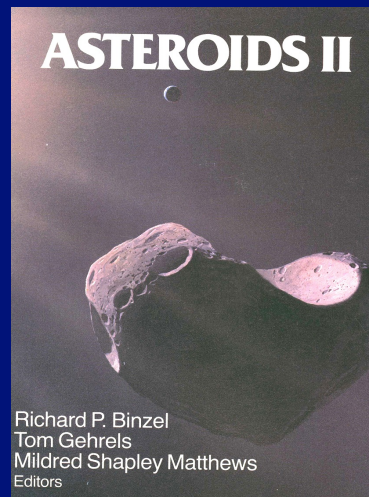
- SBAG finds for the ARM that neither the purported science benefits nor the claimed relevance to planetary defense meaningfully advance the strategic objectives and science priorities outlined in the most recent planetary decadal survey.
- The contended merits of ARM do not justify the investment or the substantial risks required to execute the mission.
- We also express deep reservations regarding the potential loss of prioritized small bodies science or broader planetary science opportunities given the zero-sum nature of the NASA budget.
- Dedicated surveys will reveal an abundant population of accessible asteroids in their native orbits, providing ample destinations for future exploration.
- Abundant targets in native orbits obviates need for retrieval. Invest in survey, not in retrieval.



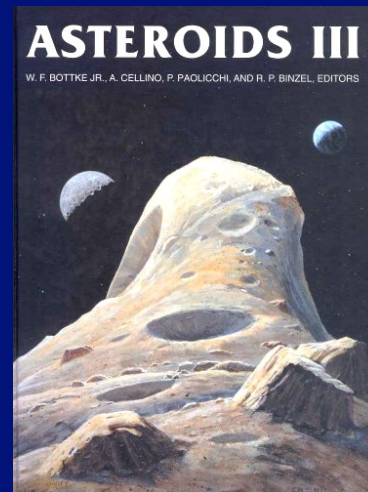
**Richard P. Binzel** is a world authority on asteroids and their exploration. He is a Professor of Planetary Science, for 25 years, at the Massachusetts Institute of Technology. He has a 40-year track record of publications on asteroids, publishing his first scientific paper on asteroids at age 15. He is an author and editor for the past and forthcoming principal textbooks on asteroids spanning three decades within the University of Arizona Press Space Science Series.



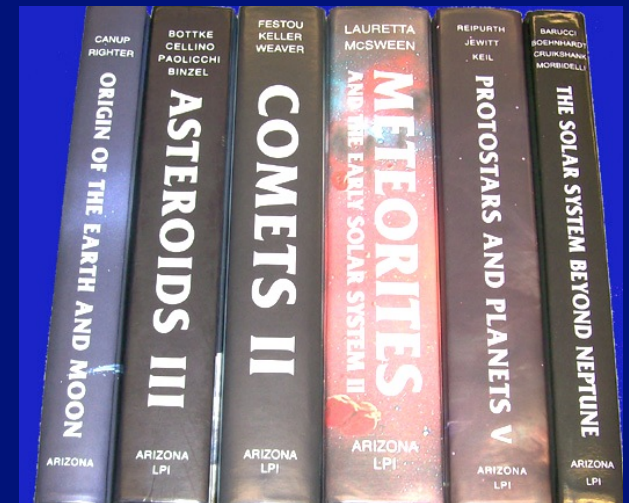
**Author  
1979**



**Lead Editor  
1989**



**Co-Editor  
2002**



***Asteroids IV* (2015)  
(General Editor)**