



2007 Planetary Defense Conference

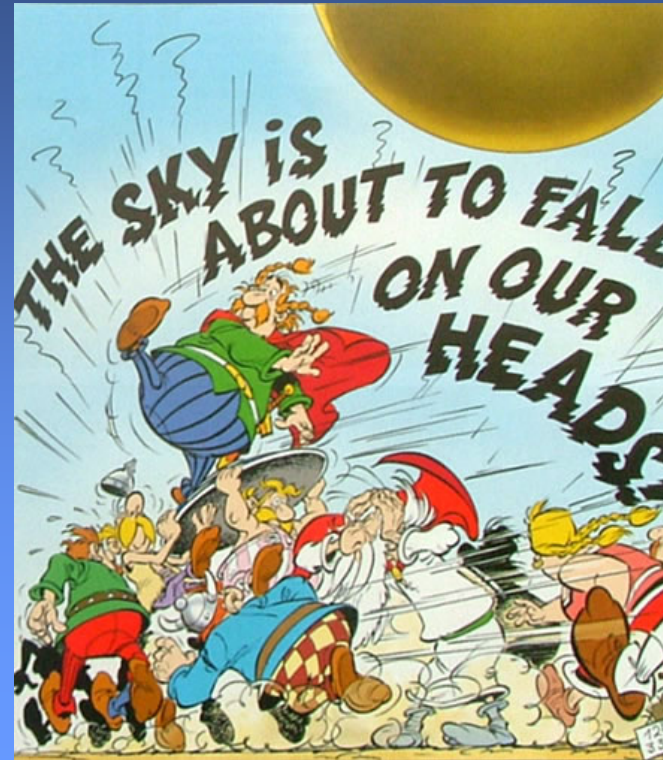
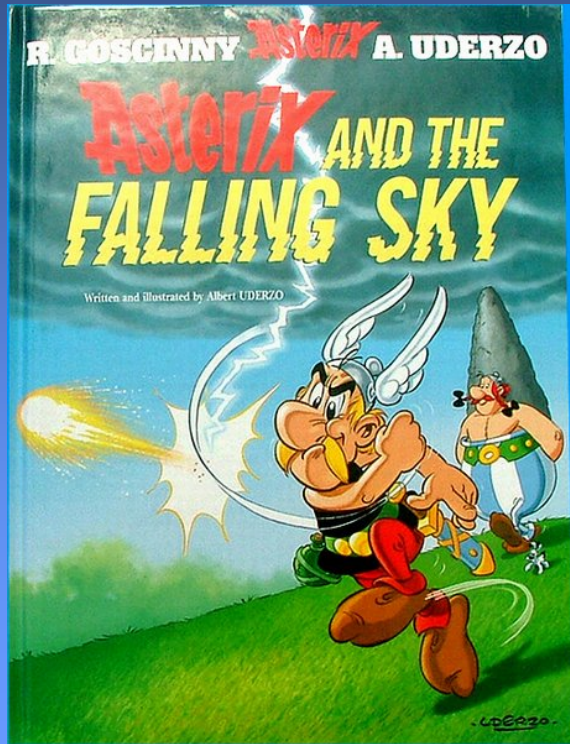
March 5-8, 2007, The Cloyd Heck Marvin Center
George Washington University, Washington, D.C.

PLANETARY DEFENSE AS A RATIONALE FOR SPACE EXPLORATION & HUMAN SPACEFLIGHT

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Director of Strategic Studies

8 March 2007

An Old Gallic Concern!



The only thing feared by French Gallic ancestors was the sky falling on their heads, as the famous Asterix cartoon character reminds us!

Exploration & Human Space Flight Rationales

- Possible classification:
 - ◆ Strategic/Political
 - ◆ Scientific
 - ◆ Economic
 - ◆ Humanistic/philosophical
- Planetary defense goals could be considered as parts of two classes of exploration and human space flight rationales: scientific & humanistic

Current Global Exploration Strategy Addressing Themes



Human Civilization



Global Partnerships



Scientific Knowledge



Economic Expansion

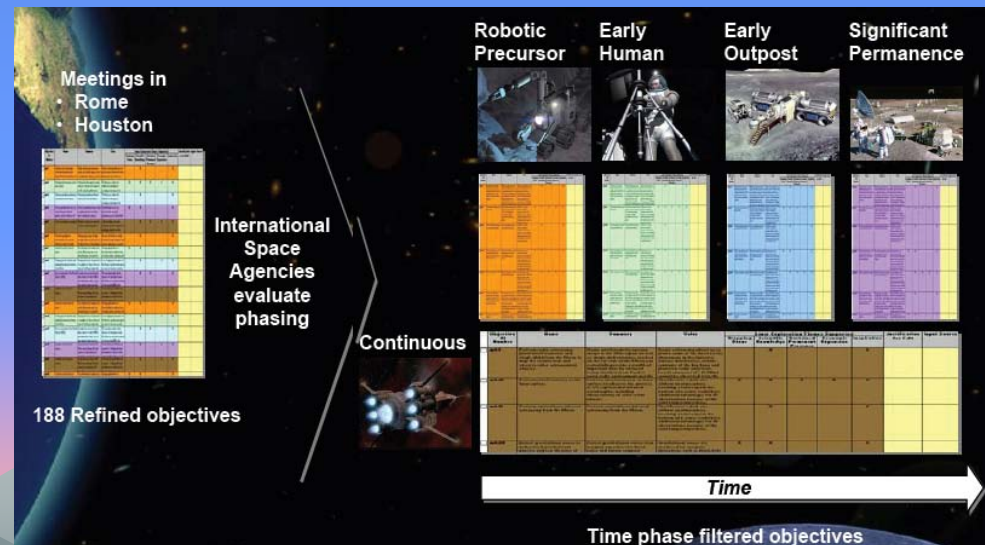
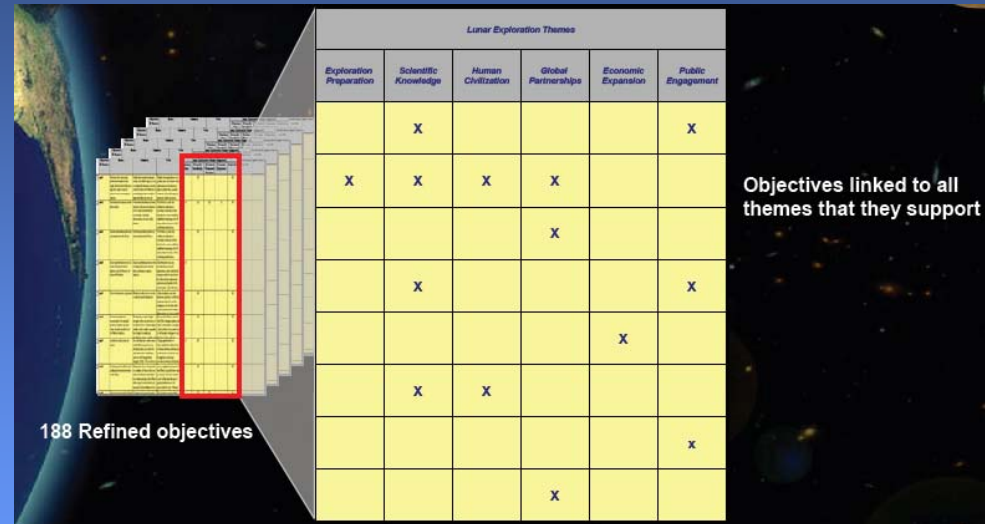
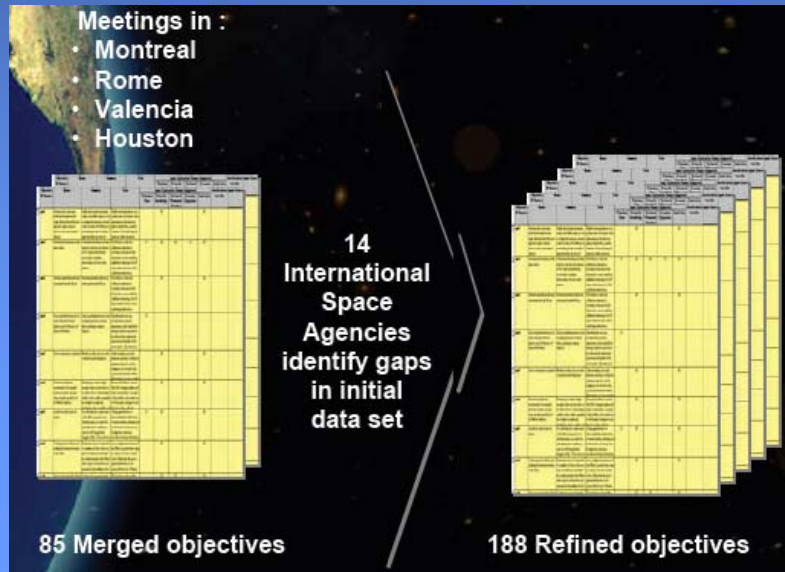


Exploration Preparation



Public Engagement

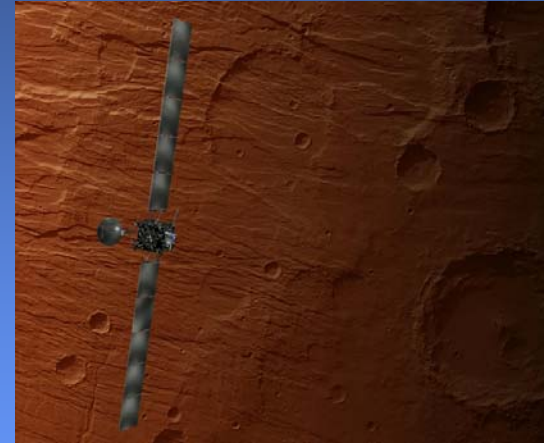
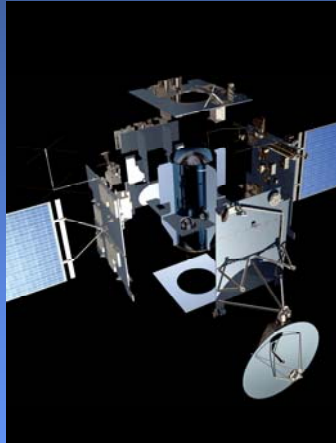
Themes To Objectives: On-Going Process



Synergies Between Exploration Objectives & Planetary Defense Goals

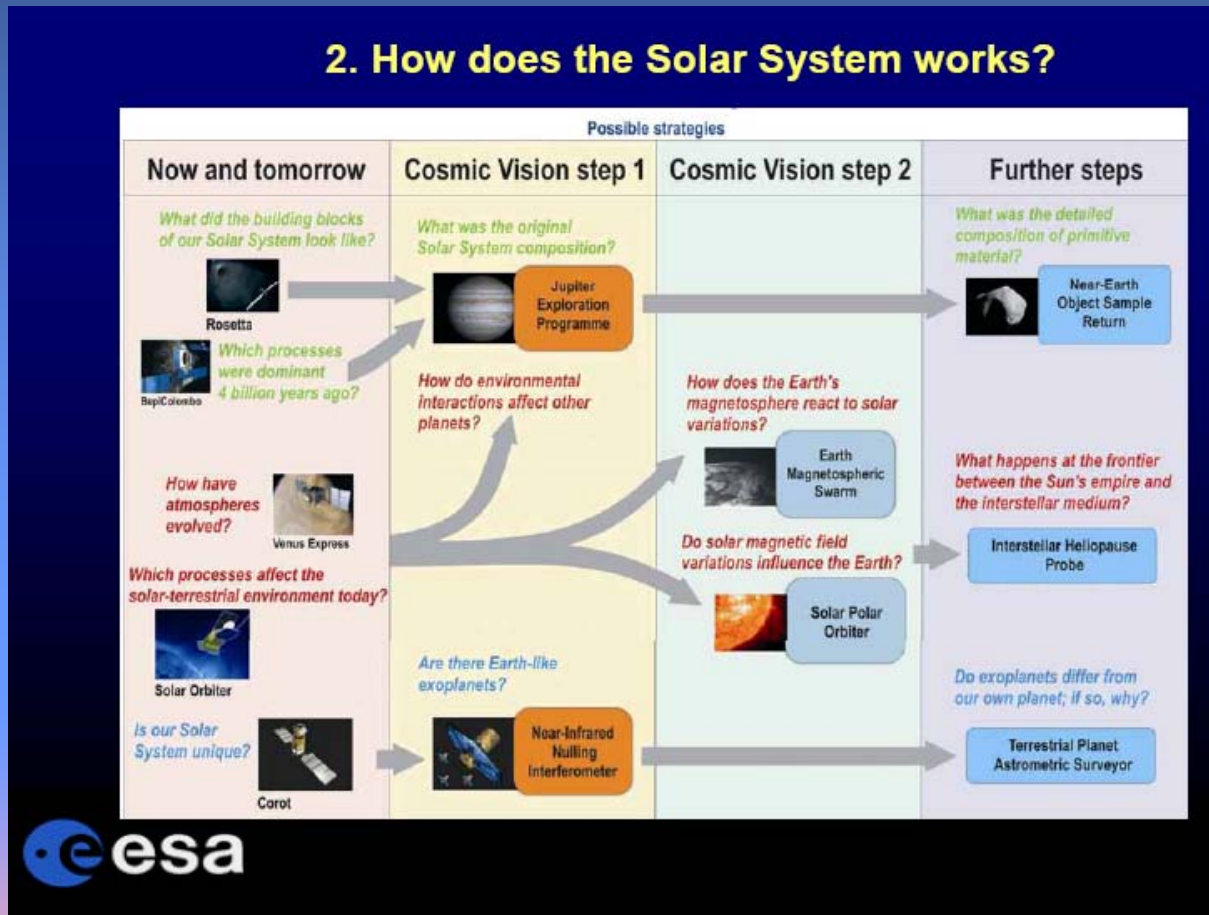
- Strong synergies exist between exploration objectives and planetary defense issues and activities
 - ◆ Asteroids are high on the list of scientific priorities for robotic exploration of the solar system
 - ◆ Exploration and planetary defense spacecraft share a common base of technologies and systems
 - ◆ Asteroid resources may prove to be in the long-term one of the principal economic enabler and rationale for human expansion in the Solar System

European Rosetta Comet-Chaser On Its Way To 67P/Churyumov-Gerasimenko

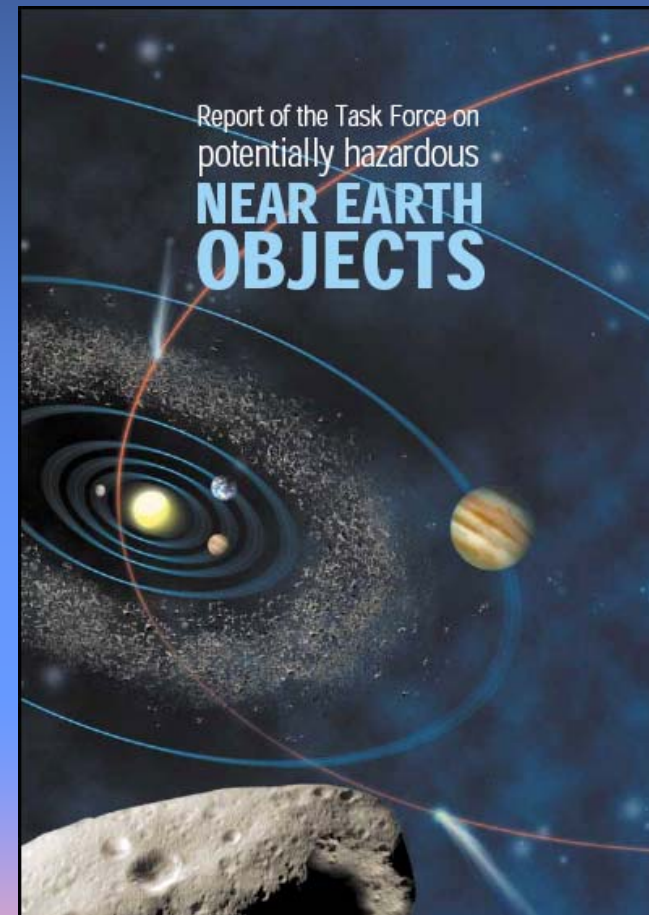
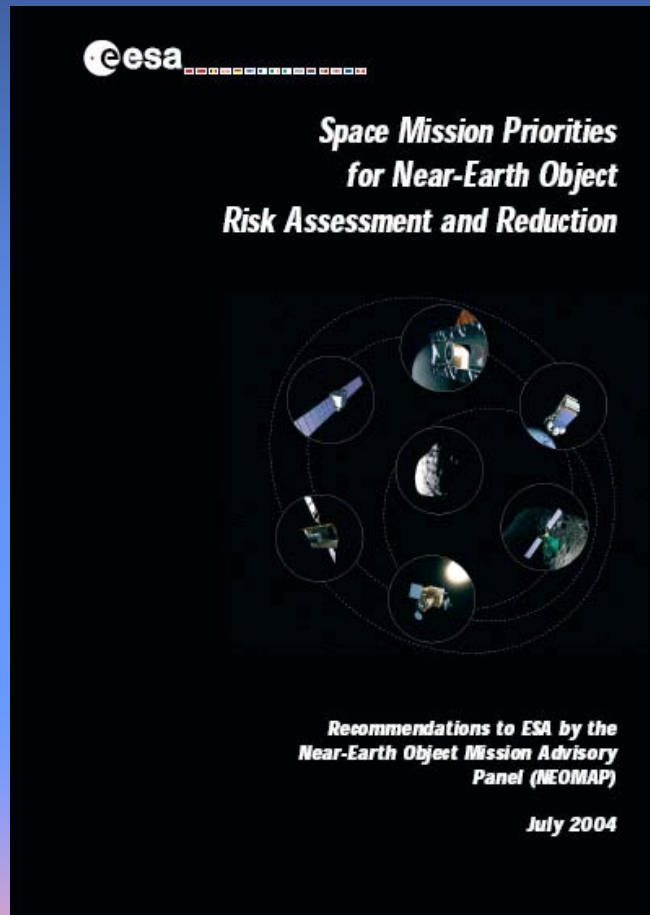


Asteroids As A Long-Term Priority in “Cosmic Vision” 2015-2025 ESA Roadmap

2. How does the Solar System works?



European Planetary Defense Reports...



... Are Taken Into Account In ESA NEO Mission Preparation

NEO Mission Preparation at ESA

■ Motivation

- Low impact probability but extremely severe effects
 - Very limited **practical** knowledge of the NEO threat and the best **technology approach** to tackle it
 - Council of Europe
UN COPUOS OECD
UK government task force
-
- ESA to take action and identify the potential role of space missions



ESA's Don Quijote mission



September 2006



Ian Carnelli – ESA-ESTEC

ESA Don Quijote Asteroid Mission Concept

- The Don Quijote mission would be a two-spacecraft mission with:
 - ♦ The Sancho spacecraft in orbit around the asteroid (typically 500 m in diameter)
 - ♦ The Hidalgo spacecraft launched later to impact the asteroid at a speed of about 10 km/s



Don Quijote In The Conclusions of ESA NEOMAP Panel

- Don Quijote has the potential to teach us a great deal, not only about the internal structure of a NEO, but also about how to mechanically interact with it.
- Don Quijote is [...] the only mission that could provide a vital missing link in the chain from threat identification to threat mitigation.
- Of all six missions reviewed, the Panel recommends that ESA gives highest priority to the Don Quijote concept as the basis for its participation in NEO impact-risk assessment and reduction."

Planetary Defense Issues & Science-Driven Exploration Scenarios

- ESA is in the process of developing exploration scenarios driven by scientific, economic and political drivers in the framework of its Aurora program
- One of the three science-driven scenario: “Life & Life Factories” gives a great role to asteroids and comets and refers explicitly to “hazard mitigation” (Source Pr. Zarnecki)

Life precursors - Asteroids

- We know some asteroids contain significant amounts of organic material such as amino acids and PAH.
- NEA sample return will provide us with pristine uncontaminated samples for detailed analysis in terrestrial laboratories
- A NEA SR mission will demonstrate many technologies required for MSR.
 - Precision navigation
 - Drilling
 - Sample collection
 - Sample containment
 - Earth return
 - Earth re-entry
 - Curation, sample distribution and analysis
- Further science aims would include investigation of Solar System formation and early history/chronology.



Further Asteroid Science

- In addition to their possible biological role, studies of asteroids can increase understanding of other significant issues
- Hazard mitigation
 - The effect of an asteroid impacting Earth could be severe
 - Strategies for deflecting an incoming asteroid depend significantly on its make up e.g. loosely bound agglomerate (rubble pile) or dense solid body.
- Resource exploitation
 - This has been a driver for exploration for thousands of years.
 - Iron, Nickel or rare Earth elements may be found and extracted from asteroids in the future – eg 3554 Amun (~2.5 km diameter) contains thirty times more metal the humans have ever mined on Earth.

«Manageable Asteroid Threats»

- This conference deals mainly with threats coming from asteroids that can be detected well in advance and would create major destructions and casualties, on a par with the largest natural catastrophes of terrestrial origin
- It is a call for action against a threat that can in principle be quantified and compared to other catastrophic risks using statistical tools

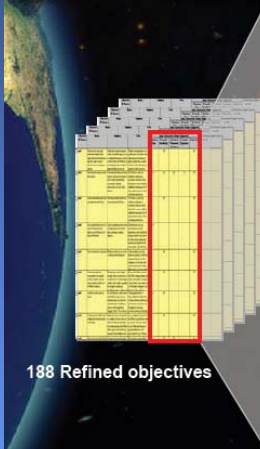
Uniqueness Of Large-scale Cosmic Threats

- All cosmic threats are not “manageable”. This is the case of the impact of larger objects like the ones involved in mass-extinctions
- They are the only threats able to wipe-out suddenly humankind as a civilization or even as a species
 - ◆ Usual answer: the risk is extremely small
 - ◆ Other answer: statistical assessment have no value for such rare events – they happen or not
- Should options be considered by humankind for such events?

Positive Context: Rising Long-term Concerns About Earth & Humankind Fate

- Current concerns about global climate change show a new worldwide interest in long-term issues of Earth and humankind fate and even survival
 - ◆ State of Earth and humankind in 2050 or 2100 are widely discussed
 - ◆ “Save the planet” is an extremely popular theme
- These concerns are extremely important and space systems can and will play a major role in understanding, managing and possibly mitigating them
- One can however consider that these issues do not threaten human civilization survival in the 21st century nor human species survival...which is the case of “killer asteroids”

“Human Civilization” Objective Example: Historic Preservation



188 Refined objectives

Lunar Exploration Themes					
Exploration Preparation	Scientific Knowledge	Human Civilization	Global Partnership	Economic Expansion	Public Engagement
	X				X
X	X	X	X		
			X		
	X				X
				X	
	X	X			
					X
			X		

Objectives linked to all themes that they support

Lunar Exploration Themes Human Civilization



Extend human presence to the moon to enable eventual settlement

Category	Name	Summary	Value
Historic Preservation	Preserve an archive of Earth's civilization to safeguard mankind's historical, cultural, and knowledge base against catastrophic loss.	Establish an agricultural cultivar bank, a data back-up site, and other archives of life on Earth.	In the event of a catastrophic planetary event on Earth, the remains of civilization could potentially reconstruct society as it was before the disaster.

A Precedent: The Royal Library of Alexandria Destruction

- Historic preservation objective focus on avoiding the fate of the Royal Library of Alexandria for our civilization...
- ... but you have to preserve much more: a human community to restart everything
- Could a space settlement be the answer?



Issues For A Real Space Biosphere-2

- Is a totally autonomous and survivable space settlement conceivable?
 - ♦ Size, population, resources
- What would be the best place:
 - ♦ Moon, Mars, asteroids or comets, O'Neill colonies...or an Earth location?
- What should be preserved in it?
 - ♦ The “Noah’s Ark” model?
- Could the long-term goal of establishing some kind of survivable Earth-2 be put forward as an humanistic rationale for space exploration?

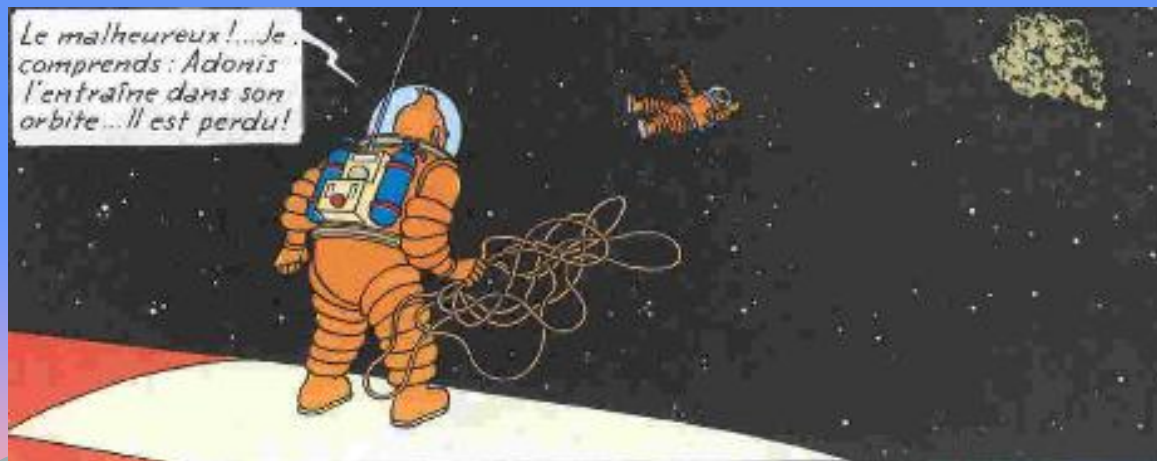
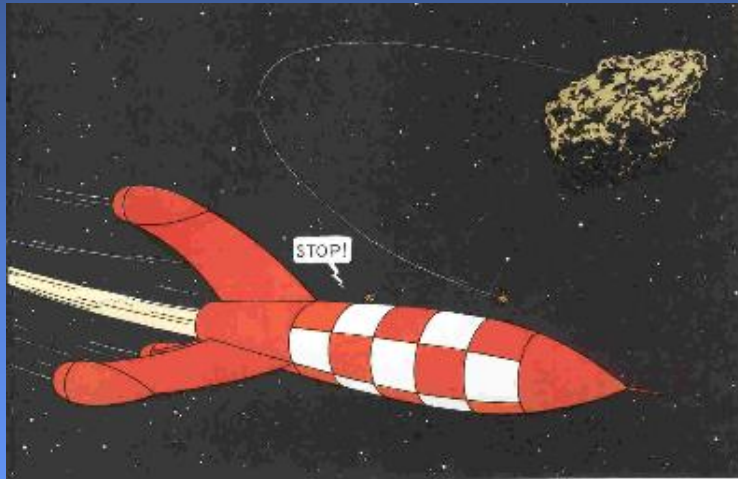
Final Remarks On Earth & Humankind Uniqueness

- Earth is the only known object in the Universe where cosmic evolution reached the stage of life emergence
 - ♦ We can observe and study billions of galaxies and stars but there is only one Earth
- Earth is the only place we know where life evolution lead to emergence of “intelligent” beings able to develop a societal culture including scientific awareness and technology
 - ♦ We know only one space-faring species: humankind
- Long-term preservation of human civilization is without doubt a goal to be seriously considered...but beware the “giggle effect”

Human Mission To NEAs? Tintin Was First!



And Captain Haddock Becomes Adonis Satellite...





Thanks for Attention.

Questions?