Diario 2022

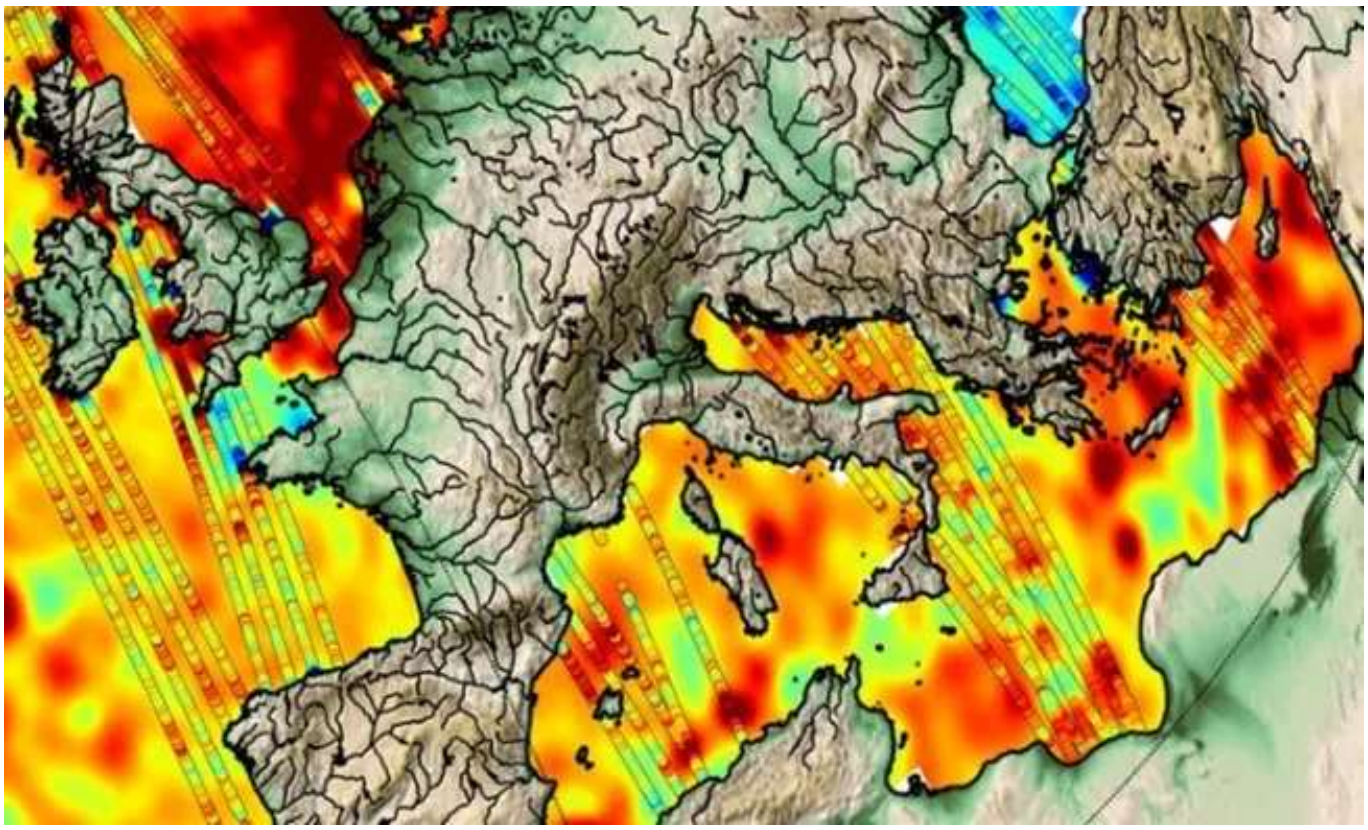
Milanese Universities and Mystery. Unknown Unknowns… In Space

October 5 2022

As part of the in-depth study of the themes of *Unknown Unknowns. An Introduction to Mysteries*, 23rd Triennale Milano International Exhibition, since June 2021 we have involved researchers, PhD students and undergraduates from universities in Milan and the network of foreign communities in a series of meetings and seminars organized and coordinated by Pupak Tahereh Bashirrad, architect and PhD.

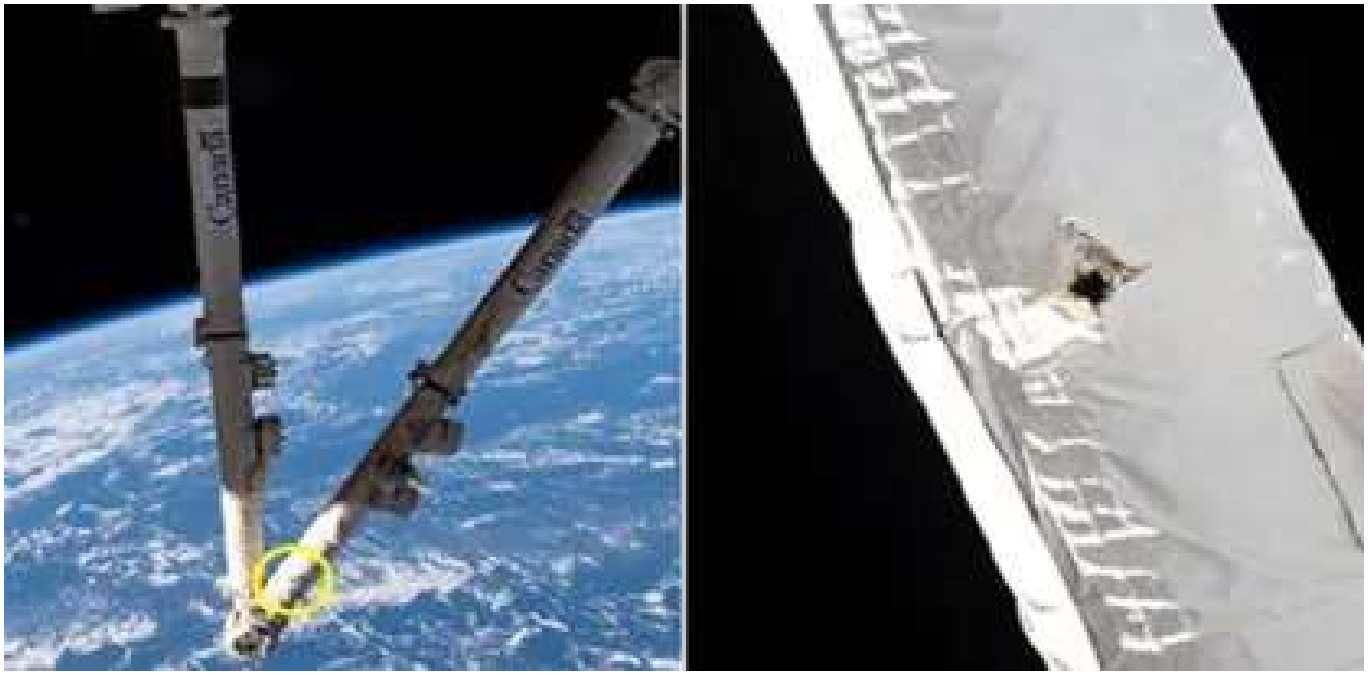
Mankind has always been driven to exploration, as testified by an ancient poem like the *Odyssey*. This is linked to another fundamental human feature, what drives us to raise our eyes and look for the reason of our existence in the stars, as described in Giacomo Leopardi's poem *Night Song of a Wandering Shepherd in Asia.* In October 1957, with Sputnik 1, humankind started populating this boundless unknown, managing, in few years, to set foot on the Moon, making Jules Verne's novel *De la Terre à la Lune* a reality.

Over the years, mankind has been able to populate this unknown universe with known objects, such as spacecrafts, which nowadays provide a multitude of essential services to modern society. Satellite constellations are now fundamental to telecommunication (phones and internet) and to climate change monitoring procedures, by measuring polar ice caps variations, oceans temperatures, sea levels and deforestation. Furthermore, they are also essential for numerous navigation and positioning services, supporting air and sea routes and facilitating people and goods to circulate freely. It is estimated that nowadays more than 9800 tons of spacecrafts are orbiting the Earth.



Oceans monitoring by CryoSat satellite, © ESA/CNES/CLS

Nevertheless, as any device, even spacecrafts have a limited life-cycle. Unlike any other technical tool, which can be disposed and recycled, satellites remain in orbit indefinitely, with no possibility to be controlled. The known object then becomes unknown and dangerous, with the risk to collide with other operative satellites. The high impact velocities (up to 11 km/s) could generate partial damage, or even thousands of dangerous fragments. This could create a ripple effect, called Kessler syndrome, which could prevent future space exploration, as described in the film *Gravity* (Cuaron, 2013), where spacial debris endangers the crew of the International Space Station.



Damage to the Canadarm2 of the International Space Station, caused by a space debris, © NASA/Canadian Space Agency

Satellites (knowns) become debris (unknowns): actions for their identification are needed. This can be done by monitoring space from the Earth, with laser, radar, and optical sensors, or by recognition in orbit, which allow the identification of 22,300 debris. Once identified, remediation procedures are required to mitigate the possible danger. The most important actions are to prevent the collision with operative satellites and to monitor the re-entry towards the Earth, to avoid any impact with densely populated areas.

Due to technological limitations, not all objects can be observed from the Earth. Thus, it is necessary to introduce models to assess the number, size, and location of these unknown objects. They estimated the presence of at least 34000 objects that measure more than 10 cm, at least 900,000 between 1 cm and 10 cm, and at least 128 million between 1 mm and 10 cm.

Guidelines to try to contain the debris proliferation are currently available, such as the request to return non-operating satellites within a fixed time, or to confine them to “graveyard orbits”. Moreover, over the last few years, the possibility of removing debris actively (i.e., by capturing and dragging it back to Earth) is investigated. What awaits us in the future beyond space debris? The first step is to return where we have already been, to know again and better what has already been encountered in the past. Several research organisations are planning future missions to the Moon, no longer to conquer it but to be able to analyse, in a microgravity environment, experiments that are already being carried out on the International Space Station. Furthermore, several studies want to demonstrate the possibility of living and cultivating in a seemingly hostile and sterile environment such as lunar soil. An example of a future mission to the moon is the ALINA lander, studied by the Planetary Transportation Systems.

Landing module of the ALINA mission, © PTScientists

The following step is to get to know better the outer space to safeguard our home. Each year, in proximity of the Earth, tens of asteroids transit. They are large enough to destroy a city and, despite of the low impact probability, we must be prepared to face such possibility, more or less like in the movie Armageddon (M. Bay, 1988). To stop an asteroid, first of all we have to know it, by detecting it through optical means (similarly to what done with space debris), and then change its route. Asteroids deflection strategies are currently under study. A first strategy will be tested by the NASA mission DART: trying to deflect an asteroid through a satellite high-velocity impact. A key factor for the success of these missions is the knowledge of the asteroid physical characteristics; hence, keeping studying the asteroid structure and composition is of utmost importance. The mission Hayabusa 2 of the Japanese JAXA allowed to study and gather samples of the asteroid 16,273 Ryugu.

Impact instant of the Hayabusa 2 mission with Ryugu, with the asteroid samples collection, © ISAS/JAXA.

Nowadays, many research institutions worldwide carry on this type of studies, to discover the universe. The Aerospace Science and Technology department of Politecnico di Milano is known all around the world as an excellent institution in this field. In particular, the COMPASS group mainly deals with the Earth services study, solutions to mitigate space debris problems and future missions to asteroids. In a more operational field, the S4U group is specialized in the study of techniques and strategies for space surveillance, both for on-ground and on-space activities. COMPASS and S4U

cooperate with multiple national end European institutions, and with the main international space agencies.

We could not help but wonder what we could do once we collect every piece of information about this immense vastity. Indeed, as engineers, we know that "*The great aim of education is not knowledge, but action*" (H. Spencer). As mentioned above, some suggestions lead to imagine a stable colonization of the Moon, or asteroid mines, or even the transformation of Mars in a planet suitable for life (operation known as *Terraforming*), with forests, lakes and oceans.

These sketched of a possible future make the words from *Ossi di Seppia* (by Italian poet Eugenio Montale) resonating:
sotto l'azzurro fitto
del cielo qualche uccello di mare se ne va;
né sosta mai: perché tutte le immagini portano scritto:
" più in là "!
[under the dense blue / of the sky some sea birds leave; / and they do not stop: as all the images carry the inscription: / " further on "!]

Credits
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