# Small Body Missions

Wonder, Threat & Lure of Rocks from Outer Space[1]

**Joan Pau Sánchez**

**#WONDER**: Asteroids and comets are said to be leftovers from Solar System and planetary formation. Each of these tiny worlds offers a unique flavour to the different stages of evolution of our Solar System; from nearly pristine material of the solar nebula to metallic cores of differentiated protoplanets. Exploring a large and heterogeneous sample of small bodies is thus key to the understanding of solar systems and planetary habitats

Most asteroids reside in particularly quiet neighbourhoods of the main asteroid belt, some enter regions that are strongly influenced by the gravities of Jupiter and Saturn. Consequently, their orbits change rapidly (i.e. in geological terms ~$10^6$ years), and end up crossing the orbital path of the Earth.

**#THREAT**: An even smaller fraction of these ends up crossing the orbital path of the Earth when the Earth is actually there. This is what occurred to the *Chelyabinsk meteor*, a 20-meter boulder that impacted the Earth in February 2013, and to the 10-km diameter asteroid that triggered the dinosaur extinction at the end of the Cretaceous period.

Fortunately, during the last two decades, ground-based telescopes have made sure that there is no *dinosaur-killer* asteroid heading our way. However, we also know now that an impact of 1 km diameter object occurs every 500,000 years and an airburst such as that of Chelyabinsk will occur every 50 years. Mitigating these impacts will thus mean modifying the heavenly motion of the threatening asteroid.

**#LURE**: Together with the recognition of the potential need to nudge away threatening asteroids, there is also the realization that asteroids may contain a plethora of extremely useful resources. However, in order to transport these materials back to Earth in a cost effective manner, the costs of space missions will have to decrease by several orders of magnitude. On the other hand, because of the exponential costs of pushing anything out of the Earth's gravity well, the utilization of asteroid material in space holds much more promise.

The seminar will cover mission analysis research by Dr Sanchez on the full range of mission scenarios described above.

**BIO:**

Dr Sanchez research interests are in astrodynamics, mission analysis, trajectory optimization and space systems. He has been particularly active in the research fields of small body missions and space macro engineering projects. He completed a PhD on asteroid deflection techniques in 2009 (University of Glasgow), followed by 4 years as a researcher at Strathclyde University investigating visionary space systems. He then led a Marie Curie project on asteroid retrieval missions at the Universitat Politècnica de Catalunya. He became lecturer in Space Engineering at Cranfield University in 2015, where among other projects he has led CASTAway trajectory design.

[1] Inspired in Martin Elvis' original title "Love, Fear and Greed: Why We Should Go to the Asteroids"