MAP-fis Essay Proposal, 2013-2014

Supervisor

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Title

Origin and evolution of the natural satellites and their impact to planetary climates and habitability.

Area

Theoretical Astrophysics

Summary of Proposal

The origin of some natural satellites, including the Moon, is not fully understand. There exists several competing scenarios, in particular, giant impacts with proto-planets, or the capture of the satellites from an heliocentric orbit. The first scenario is more accepted nowadays, since the capture scenarios seem very difficult from a dynamical point of view. Although the origin from a giant impact has no dynamical obstacle, it has nevertheless some difficulties to explain some chemical composition observed on Solar System satellites. Whatever was the formation mechanism, all scenarios agree that the past orbits of the satellites were very close to the planet, and subsequently evolved into its present configuration by tidal dissipation. In addition, it is also known that the presence of the large satellites is essential to stabilize the obliquity of the planets, as it is the case the effect of the Moon on the Earth spin axis. Indeed, in its absence, the spin axis of the Earth would undergo large chaotic variations between 0 and 60 degrees, which completely destabilize the seasons and gives rise to dramatic changes in Earth's climate: in a few million years, it can oscillate between very temperate and a snowball. The aim of this Ph.D thesis is: 1) Understand if the capture scenario for satellites can be made more realistic. This study applies to the Moon, the martian satellites, Phobos and Deimos, and to the Neptune's moon Triton, which shows strong evidence of capture. 2) Study the consequences for the spin and climate of planets caused by the evolution of their satellite's orbits. 3) Generalize previous results to extra-solar planets, in particular to those that are transiting (and for which the observational detection of exomoons is possible), and for exoplanets in the habitable zones of their systems (in order to test their habitabilities)

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