Study on the effect of tribocharging on granular agglomeration and its relevance for planet formation

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Ph.D. or postdoc position (for more details, see https://goo.gl/1ZHru1)

QUIMAL Project: **E**xperimental **A**strophysical **R**esearch into **T**errestrial growt**H (EARTH)**

Despite the obvious evidence that terrestrial planets exist, there is no general agreement about the physical mechanisms that permit microscopic grains in protoplanetary disks (PPDs) to agglomerate into planet-sized objects. Starting with particles of ~1 μm, it is not until agglomerates reach over 1 km in size that gravity becomes strong enough to accrete new material. For objects below this size, many mechanisms contribute to agglomeration, but these compete with others that hinder it such as fragmentation during impact, erosion, and orbital decay due to gas-induced drag. These destructive processes lead to the so-called 'meter-sized barrier;' theoretically, we cannot account for how granular agglomerates in space become larger than this scale [1].

In the project, Experimental Astrophysical Research into Terrestrial growtH (EARTH), we will investigate the growth processes in PPDs from the point of view of granular physics. In particular we want to study the effect of tribocharging, *i.e.* the exchange of electrical charge between particles during collisions, which could offer a way to overcome the meter-sized barrier as it can dramatically increase growth rates [2]. Little work has been done to address this hypothesis, and our objective is to develop experiments that delineate how different particle and collisional properties, including tribocharging, lead to the sustained cluster growth beyond the meter-sized barrier.

In the first experiment, we will use a 3m free-fall apparatus to observe and characterize collisions between pairs of particles [3]. We will measure the electrical charges of grains in the zero-gravity, vacuum conditions of PPDs. In the second experiment, we will explore collisions between grains and clusters of grains using acoustic levitation [4,5]. This technique will give us unprecedented control over the conditions of the collisions and their subsequent outcomes (cohesion or fragmentation). In particular, we expect to be able to control the impact energy, size of the colliding clusters, constituent material(s), angular momentum, impact parameter, *etc*. Working with real and simulated meteoritic samples, we will probe, for the first time, the enhancement of clustering efficiency due to tribocharging. The results from these experiments will correspond to the most complete phase portrait to date of the sticking efficiency as a function of the aforementioned parameters. In parallel with our experimental efforts, we will collaborate with theoretical physicists and astronomers to develop numerical simulations that probe the implications of our findings for length and timescales relevant to planet formation in PPDs.

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