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# GRANULAR PLASTICITY AND OTHER EMERGING PROPERTIES OF PARTICULATE MATERIALS

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## ABSTRACT

Particulate materials form a class of complex materials in the sense that some of their macroscopic properties are strongly influenced by self-organization processes. In the change of scale, microscale fluctuations are smoothed but, in the meantime, new properties emerge that are not present at the particle level. In particular, irreversibility and incrementally non-linear responses at the continuum level originates from both particle interaction physics and microstructural rearrangements.

Particle scale simulations and imaging offers the possibility to discover emerging properties without postulating them. With the progress made in computation power and imaging techniques, richer and richer descriptions of the particle scale physics become accessible. This comes with a cost, as one of the biggest challenges now is to process and compress this large amount data to extract the micro-macro relationships and propose constitutive models with frugal approaches.

Micromechanics, complex system analysis, data driven approaches and physics-based machine learning offer promising pathways to process the huge amount of data coming from particle scale simulations (such as discrete element or molecular dynamics simulations) and imaging (such as X-ray and neutron tomography or scanning electron microscopy).

This session builds on the legacy of the six editions of the Granular Plasticity sessions (Barcelona 2015 and 2019, Hannover 2017, Hamburg 2021, Milano 2023, Barcelona 2025) deeply rooted in the understanding of the physics of particulate materials. In this session, we propose to explore how particle-based methods and particle scale imaging can be analysed to better understand and extract the physics of particulate materials responsible for their complex collective behaviour (e.g. what is the size of the underlying latent space of state variables?). A special (but not limited) focus will be dedicated to the origin of granular plasticity in the sense of irreversible strain in granular materials with various microscale physics (e.g. capillary effects, bonding/debonding chemical reactions or water freezing/melting processes) and geometries (e.g. varying grain shapes and sizes, fine grain erosion or infiltration). Analytical, numerical and experimental works are welcome. Cross-disciplinary approaches introducing new concepts or new tools will be appreciated.