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Characterization of granular collapse onto hard substrates by acoustic emissions

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Brittle deformation in granular porous media can generate gravitational instabilities such as debris flows and rock avalanches. These phenomena constitute a major natural hazard for the population in mountainous, volcanic and coastal areas but their direct observation on the field is very dangerous. Recent studies showed that gravitational instabilities can be detected and characterized (volume, duration,...) thanks to the seismic signal they generate. In an avalanche, individual block bouncing and rolling on the ground are expected to generated signals of higher frequencies than the main flow spreading. The identification of the time/frequency signature of individual blocks in the recorded signal remains however difficult.

Laboratory experiments were conducted to investigate the acoustic signature of diverse simple sources corresponding to grains falling over thin plates of plexiglas and rock blocks. The elastic energy emitted by a single bouncing steel bead into the support was first quantitatively estimated and compared to the potential energy of fall and to the potential energy change during the shock. Next, we consider the collapse of granular columns made of steel spherical beads onto hard substrates. Initially, these columns were held by a magnetic field allowing to suppress suddenly the cohesion between the beads, and thus to minimize friction effects that would arise from side walls. We varied systematically the column volume, the column aspect ratio (height over length) and the grain size. This is shown to affect the signal envelope and frequency content. In the experiments, two types of acoustic sensors were used to record the signals in a wide frequency range: accelerometers (1 Hz to 56 kHz) and piezoelectric sensors (100 kHz to 1 MHz). The experiments were also monitored optically using fast cameras. We developed a technique to use quantitatively both types of sensors to evaluate the elastic energy emitted by the sources. Eventually, we looked at what types of features in the signal are affected by individual shocks or by the large scale geometry of the avalanche.