A new type of convection is proven in granular gases

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In physics, thermal convection of a fluid is exhibited by the appearance of geometric structures through which the fluid moves, forming closed circuits. This phenomenon is of vital importance for many industrial applications in which a fluid is present. Bénard convection is one of the most-studied problems in fluid dynamics. Now, a team of scientists from the University of Extremadura and the Sapienza University of Rome has found a new type of convection that appears in a granular fluid and had hitherto not been detected in traditional fluids (liquids, gases, etc.). The experimental development and results have been published in *Physical Review Letters*.

Granular media are formed by macroscopic solid particles measuring more than 1 micrometre (μm) in size which, due to agitation or injection of energy, interact and collide with one another, behaving like a gas or a fluid. In this specific medium, the researchers have determined the conditions that systematically produce thermal convection in a granular gas via gravity and fluidized by a vibrating base. The resulting convection is different from traditional convection in fluids, as it is produced by inert walls. The properties are different, too, as only two convection cells are formed (one per inert wall) which, in the experiment designed by the authors, are found on the lateral walls of the system. Because of this, these scientists have named it "lateral-wall thermal convection."

"Up to now, no similar experiment had found the key, or the reason behind this convection. We realised that the small spheres in the experiment box cooled upon colliding inelastically against the lateral wall. It is precisely this difference in temperature between the hot zone and the two colder walls, along with the action of gravity, that is responsible for this new type of granular convection," explains Francisco Vega Reyes, a theoretical physicist at the University of Extremadura and member of the Advanced Scientific Computation Institute. This occurs regardless of the temperature, although the more the lateral wall absorbs the heat, the more intense the convection will be.

"This is a convection caused by perpendicular gradients," says Vega. Two gradients, in parallel and vertical—gravity and the heat source at the base—and a horizontal gradient, comprised by the difference in energy derived from the inelastic collisions against the lateral wall.

These granular dynamics offer numerous applications in the aerospace industry, such as for increasing the effectiveness of the movement of robots in weak gravitational fields and in those in which the fluidization properties of the sandy medium in which they move are taken into account. Moreover, "if we control the convection conditions, we can improve the mixing and stirring process in the case of granular material components like pharmaceutical compounds," adds Vega.

The researchers are currently working on theoretical models for reproducing this type of convection in liquids, as from a technical point of view, this phenomenon could have an application in fluid mechanics.

More information: Giorgio Pontuale et al, Thermal Convection in Granular Gases with Dissipative Lateral Walls, *Physical Review Letters* (2016). DOI: 10.1103/PhysRevLett.117.098006

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