Experimental results on a granular gas driven by an air-generated stochastic force

Miguel Ángel López Castaño[1], Alvaro Rodríguez-Rivas[1], and Francisco Vega Reyes[1,2]
[1]Universidad de Extremadura, av. Elvas, 06071 Badajoz, Spain
[2]Instituto de Computación Científica Avanzada de Extremadura (ICCAEx), av. Investigación, 06006 Badajoz, Spain

There are many ways to fluidize a granular system, all of which involve injecting energy to it; this can be achieved by many different means, such as through a boundary or by mechanical agitation. But, a less studied method is by interaction of the particles with a gas flow intense enough to initiate movement.

This setup is much inspired on previous works by A. R. Abate, D. J. Durian *et al.* [1, 2, 3]. Contrary to previous works, in our setup there is no potential that causes the particles to recursively return to the system's central zone.

In this experimental work, we analyze the dynamics of a system of granular particles that are excited by means of a vertical air flow (see Fig. 1). The air current is produced by a fan, and carefully homogenized by means of an intermediate layer of polyurethane foam. Uniformity of the air flow is assured by hot-wire anemometer measurements.

More specifically, we investigate the statistical properties of the turbulent air forcing on the granular particles. Spheres are confined within a two-dimensional region so the average 2D occupied area fraction in the system not greater than $\phi \approx 0.01$. Therefore, the system can be regarded as an air-fluidized *granular gas*. The diameter of our particles (ping-pong balls) is $\sigma \approx 4$ cm.

The particles are moving on a metallic mesh and driven by a *uniform air flow* coming from below [1]. The air stream produces a turbulent wake near the ball's surface so that a stochastic force is generated. The intent of the experiment is to approach as much as possible this stochastic force to a white noise [4, 5].

The exact horizontal position and velocity of each particle are measured by a high speed digital camera (under our experimental conditions, the balls never lift up away from the grid). Our camera model is a Phantom VEO 410L, which is capable of recording 5200 fps at maximum resolution (1280×800 pixels).

Detection and tracking of the spheres is performed by a computer vision algorithm. OpenCV's implementation of the *Hough Transform* is applied to the image allowing us to detect borders and find the coordinates and radius of the balls. Thus, we are able to analyze the statistical and hydrodynamic properties of the system.

In a series of measurements, we analyze the experimental value of the coefficient of normal restitution. Additionally, we try to qualitatively deduce the roughness degree of our particles and compare this with previous results from kinetic theory for smooth hard particles [5].

This work is motivated by recent theoretical results that predict a peculiar behavior of the temperature time evolution in granular fluids under the action of a white noise thermostat [6]. By producing sudden changes in the fan's intensity we expect to produce temperature transients where memory effects may show up.

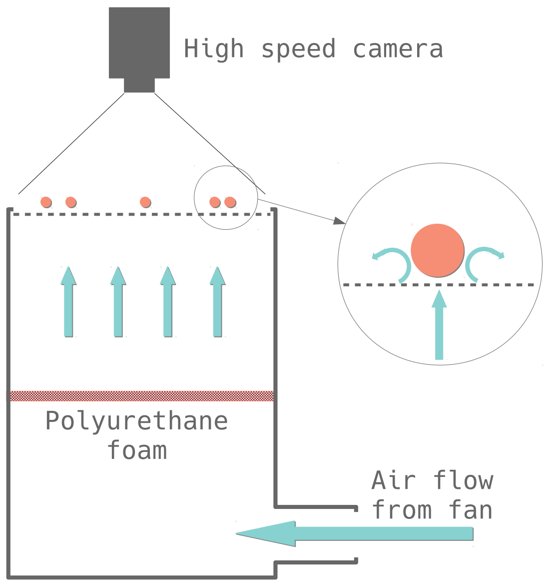

Fig. 1. Experimental setup sketch.

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