Rotating Matter: The Bearing State

Hans Herrmann (PMMH, ESPCI Paris and UFC, Fortaleza, Brazil)

A packing of spheres is called bi-chromatic if every loop formed by contacts is even. Such packings can act as bearings by having all spheres rolling on each other without any slip. In three dimensions, many different of these sliding-free configurations, called bearing states, are possible. If all loops have length four the system exhibits four continuous degrees of freedom and a systematic way of constructing such bearing states can be devised [1]. By considering spheres of different size, packings with bearing states can even be made space-filling. The construction and mechanical properties of such space-filling bearings will be discussed. Space-filling bearing states can be viewed as a realization of solid turbulence exhibiting Kolmogorov scaling and anomalous heat conduction. In three dimensions a continuum of such configurations can be obtained as cuts through four-dimensional space-filling bearing states. Bearings states can be perceived as physical realizations of networks of oscillators with asymmetrically weighted couplings. These networks can exhibit optimal synchronization properties through tuning of the local interaction strength as a function of node degree or the inertia of their constituting rotor disks through a power-law mass-radius relation. As a consequence, one finds that space filling bearings synchronize fastest, when they are hollow. The synchronization of rotations occurs in avalanches following a broad size distribution [2].

References:

[1] D.V. Stäger, N.A.M. Araújo, H.J. Herrmann, Phys. Rev. Lett. 116, 254301 (2016)

[2] N.A.M. Araújo, H. Seybold, R.M. Baram, H.J. Herrmann, J.S. Andrade Jr., Phys. Rev. Lett. 110, 064106 (2013)