Eröffnungsvortrag

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Rotating Matter: The Bearing State

Granular materials are characterized by an additional degree of freedom, rotations, which become particularly relevant for spherical particles. They allow for soft modes under shear which do find realizations for instance in tectonic faults. A packing of spheres is called bi-chromatic if every loop formed by contacts is even. In three dimensions, bi-chromatic bearings have many different sliding-free configurations, so called bearing states. 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. Their 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 . Under this condition, the average participation per disk is maximized and the energy dissipation rate is homogeneously distributed among elementary rotors. The synchronization of rotations occurs in avalanches following a broad size distribution [2].