An Electric Bottle for Colloids: Densifying and Jamming Spheres and Ellipsoids

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We have performed experiments with hard spheres and ellipsoids ranging from ball bearings to Couscous and M&M's to colloidal particles aimed at understanding packing and how the packing effects the kinetics and thermodynamics of condensed phases. We have used different fields including gravity, and microgravity, and gradients in temperature, electric and light fields to control the density, position and motion of isotropic and anisotropic colloids among other effects creating an "electric bottle" - a region of constant high field where the force is zero but the density controllable and separately a "colloidal lighthouse". In the packing problem we have shown experimentally and with a new simulation algorithm that ellipsoids can randomly pack more densely than spheres; up to $\approx 0.68 - 0.71$ for spheroids with an aspect ratio close to that of M&M's Candies, and even approach ≈ 0.75 for general ellipsoids. We suggest that the higher density relates directly to the higher number of degrees of freedom per particle. We support this claim by measurements of the number of contacts per particle Z, obtaining Z ≈ 10 for our spheroids as compared to Z ≈ 6 for spheres. We have also found the ellipsoids can be packed in a crystalline array to a density, ≈ 0.7707 which exceeds the highest previous packing.