Physicists determine density limit for randomly packed spherical materials

June 2 2008

The problem of how many identical-sized spheres can be randomly packed into a container has challenged mathematicians for centuries. A team of physicists at The City College of New York (CCNY) has come up with a solution that could have implications for everything from processing granular materials to shipping fruit.

Writing in the May 29 edition of *Nature,* they demonstrate that random packing of hard, i.e. non-crushable, spheres in three dimensions cannot exceed a density limit of 63.4 percent of the volume. This upper limit is a consequence of a completely "jammed" state that occurs when the materials are at their lowest energy levels, i.e. as close to inert as possible.

"Theoretically, the jammed state would be achieved by lowering the temperature of the spheres to approach absolute zero, since this would cause them to contract," explained Dr. Hernán Makse, CCNY Associate Professor of Physics and principal investigator. "In real life, however, it is attained by shaking the materials."

The findings have potential applications for the manufacture of pharmaceuticals and cosmetics, where powders have to be mixed to a homogenous consistency, he said. Currently, manufacturers must rely on empirical data, i.e. trial and error, to establish their formulas. Professor Makse said his goal is to develop a theory of powders that could enable manufacturers to more efficiently develop new products.

Source: City College of New York