Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

**Packing of hard spheres in cylinders and applications** ADIL MUGHAL, Institut fuer Theoretische Physik (LS Klaus Mecke) Friedrich-Alexander Universitaet Erlangen-Nuernberg Staudtraße 7, D-91058 Erlangen, Germany, DENIS WEAIRE, STEFAN HUTZLER, Foams and Complex Systems, School of Physics, Trinity College Dublin, Dublin 2, Ireland, HO KEI CHAN, School of Chemistry, University of Nottingham, Nottingham NG7 2RD, United Kingdom — We study the optimal packing of hard spheres in an infinitely long cylinder. Our simulations have yielded dozens of periodic, mechanically stable, structures as the ratio of the cylinder (D) to sphere (d) diameter is varied. Up to D/d=2.715 the densest structures are composed entirely of spheres which are in contact with the cylinder. The density reaches a maximum at discrete values of D/d when a maximum number of contacts are established. These maximal contact packings are of the classic "phyllotactic" type, familiar in biology. However, between these points we observe another type of packing, termed line-slip. An analytic understanding of these rigid structures follows by recourse to a yet simpler problem: the packing of disks on a cylinder. We show that maximal contact packings correspond to the perfect wrapping of a honeycomb arrangement of disks around a cylindrical tube. While line-slip packings are inhomogeneous deformations of the honeycomb lattice modified to wrap around the cylinder. Beyond D/d=2.715 the structures are more complex, since they incorporate internal spheres. We review some relevant experiments with hard spheres, small bubbles and discuss similar structures found in nature. We discuss the chirality of these packings and potential applications in photonics.

Adil Mughal
Institut fuer Theoretische Physik (LS Klaus Mecke)
Friedrich-Alexander Universitaet Erlangen-Nuernberg Staudtraße 7,
D-91058 Erlangen, Germany

Date submitted: 12 Nov 2013 Electronic form version 1.4