Physics Tip Sheet #40 - March 1, 2004

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Highlights of this tip sheet include the physics of file swapping; frictionless, nanoscale motion; a look at what makes some networks particularly resilient; precise manipulations of millions of atoms; and further research on sonolunminescent fusion.

1) Gnutella Gnetworks: the Physics of File Sharing
Nima Sarshar and Vwani Roychowdhury
Physical Review E, February 2004

File sharing networks, such as Gnutella, link together the computers of song and file swappers in much the same way that sites are linked on the Worldwide Web. But unlike the Web, which consists of sites that exist for long periods, Gnutella users may connect to the network for only hours or minutes at a time before logging off. Researchers studying file sharing networks are now developing models to help them understand the structure of Gnutella and other peer-to-peer systems. The efforts should lead to schemes that will optimize the organization and sharing of information among dynamic groups of file swappers.

2) Sliding Without Friction
A. Socoliuc et al.
Physical Review Letters (to appear)

Researchers have observed nearly frictionless sliding of two solids in contact for the first time, showing how friction can be controlled at the nanometer scale. The team dragged a silicon nanotip over a crystal surface in a high vacuum. As they reduced the load on the tip, they saw a transition from stick-slip behavior to continuous sliding. The work may help scientists achieve a deeper understanding of the fundamental mechanisms of friction, and could be important in a variety of nanoengineering applications.

3) Resilient network architecture
A. Valente, A. Sarkar, and H. Stone
Physical Review Letters (to appear)

Networks such as the Internet, the electrical power grid, and even terrorist networks, need to be resilient to both random accidental failures and targeted attacks. In this study, the authors show that the optimal configuration is one in which all nodes have one of at most three distinct connectivities, where the connectivity of a node is defined as the number of links emanating from it.

4) Precisely Manipulating Millions of Atoms
C.-S. Jiang et al.
Physical Review Letters (to appear)

In recent years, researchers have learned how to build nanoscale structures by moving atoms and molecules one at a time with the probe tips of scanning tunneling microscopes (STMs). It's a powerful assembly method, but even minuscule structures may consist of thousands to millions of atoms, which can lead to prohibitively lengthy assembly times. A group of researchers has now developed an STM technique that allows them to control millions of atoms at a time with nanoscale precision. The group found that delivering an electrical trigger pulse to the top of a nanoscopic mesa of lead atoms can cause the self assembly of additional layers of atoms on top of the mesa. Although the layers consist of thousands to millions of atoms, the layers can be added in precise, one-atom thicknesses. The method may soon help scientists build nanoscale devices much more rapidly than is possible with existing nanoassembly techniques.

5) More Bubble Fusion Research
R. P. Taleyarkhan et al.
Physical Review E (to appear)

Possible signs of nuclear fusion in tiny, imploding bubbles caused a flurry of controversy two years ago. The work relied on sonoluminescence in an attempt to fuse together deuterium atoms. Sonoluminescence is light emitted by bubbles floating inside a fluid that are forced to expand and contract with sound waves. The team that published the work in the journal Science in 2002 has conducted further research, and their results are scheduled to appear in this month's issue of the Physical Review E.

Journal articles are available to journalists on request.

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