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Highlights in this Issue:

- Self re-assembly in sea sponges
- A better immunization scheme
- PRL Milestones

A Day in the Life of a Sponge: Regrowing Lost Parts

J. M. Belmonte, G. L. Thomas, L. G. Brunnet, R. M. C. de Almeida, and H. Chat'e
Physical Review Letters (forthcoming)

Physicists in Brazil and France have developed a mathematical model explaining the physics behind self-reassembly in simple creatures like hydras, sea urchins, and sea sponges. Self-reassembly involves the startling reorganization of cells back to the organism's original size and shape, after being shredded apart so completely that individual cells become separated.

In order to investigate how cells manage to coherently rearrange themselves within a certain amount of time, the physicists created computer simulations of moving particles. Time is important during cell sorting. The process may end up incomplete if there are too many cells that don't make it to their correct spots before they die. If too few cells reassemble, the rebuilt creature will be too fragile to survive.

Their model is the first to account for the complex relationship between the number of cells involved, the amount of time taken, and the extent to which cells resume their original positions. They found that cells move faster if they have lots of neighboring cells to follow, like people in a busy crowd who simply follow the herd.

Aside from offering a deeper understanding into a fascinating natural phenomenon, the model has useful implications for the study of cell movement in other biological conditions, such as wound healing, tumor growth, and in the early stages of embryo development. - NR

A Better Shot at Immunization

Yiping Chen, Gerald Paul, Shlomo Havlin, Fredrik Liljeros, and H.Eugene Stanley
Physical Review A (forthcoming, a PRL Editors' Suggested paper)

A new immunization strategy could reduce the vaccine doses needed to protect a population from disease (and reduce the antivirus updates required to protect a network of computers) by as much as 50%.

The immunization scheme was developed by a collaboration of physicists from Boston University, Bar-Ilan University in Israel, and Stockholm University. It's similar to previous strategies that focus on immunizing the most highly connected people (or computers) first. The more connections you have to neighbors, coworkers, customers, and relations, the more vital it is to make sure you don't catch the disease and pass it on to your many contacts. Once the most highly connected people are protected, it's time to move to the next most highly connected people, and so on down the list. The benefit of the technique is that only a fraction of the population has to be vaccinated in order to quash an epidemic.

The innovation in the new immunization strategy focuses on using the connections among a network of people to assign them to a number of small, but equally sized groups. Then people in each group are immunized based on their connections within the group. The equipartioning is key - other immunization methods tend to be less efficient because they overemphasize immunizations of small clusters of individuals relative to larger clusters.

That can't happen if population is divided up so that all the clusters are the same size.

The physicists confirmed the effectiveness of their scheme by simulating infections on various populations, including an Internet-based computer network and a network of Swedish workers and their families compiled by the Swedish government. The need for immunization was reduced by 5% to 50% in each of the networks, significantly lowering the potential expense and time that it would take to protect populations and networks from contagious infections. - JR

50 Years of PRL

Martin Blume

Physical Review Letters turns 50 this year. Martin Blume is celebrating the green journal's birthday by summarizing the most intriguing papers to appear in PRL each year since 1958. To see past editions of visit Marty's Milestone PRL project.

This week, Marty is taking a look at milestone papers from 1977 on the discovery of conductive polymers and the discovery of the cosmic microwave background.

Electrical Conductivity in Doped Polyacetylene
C. K. Chiang, C. R. Fincher, Y. W. Park, A. J. Heeger, H. Shirakawa, E. J. Louis, S. C. Gau, and Alan G. MacDiarmid
Phys. Rev. Lett. **39**, 1098 (1977)

Polymers were generally considered to be insulating materials, but in an accidental discovery Shirakawa, in Japan, found that polyacetylene, when prepared with too much catalyst, was not the usual color of an insulating material, but had a silvery tint. Chemists Shirakawa and MacDiarmid met at a conference in Japan, where both presented aspects of their research. (MacDiarmid had been working with Heeger in the US on another polymer that had a metallic appearance.) When they encountered one another during a coffee break MacDiarmid invited Shirakawa to come to the University of Pennsylvania, where the three continued their research on doped polyacetylene. Measurements by physicist Heeger and his students showed that, depending on the mode of preparation of the polymers the electrical conductivity could be varied over eleven orders of magnitude! Theoretical explanations for this variation showed great complexity in the mechanisms for the conductivity. Possible practical applications also became apparent, and several have already been realized.

The 2000 Nobel Prize in Chemistry was awarded to Alan J. Heeger, Alan G. MacDiarmid, and Hideki Shirakawa ¿for the discovery and development of conductive polymers¿. Heeger stated in the concluding remarks of his Nobel Lecture [Rev. Mod. Phys. 73, 681 (2001)] that he had become an interdisciplinary scientist, between chemistry and physics. Both aspects were essential for this discovery. The opening of the Nobel Committee's "Information for the Public" describes the accidents that led to this collaboration.

Detection of Anisotropy in the Cosmic Blackbody Radiation
G. F. Smoot, M. V. Gorenstein, and R. A. Muller
Phys. Rev. Lett. **39**, 898 (1977)

This Letter reports the measurement, by apparatus carried on a NASA U-2 aircraft, of the dipole moment of the anisotropy of the cosmic microwave background (CMB) radiation. Similar results were obtained by D.T. Wilkinson and collaborators in balloon-borne experiments done before and after the U-2 experiments (published in astronomy journals). The dipole can arise from the Doppler shift due to the motion of the measuring instrument with respect to the rest frame of the CMB. The simplest interpretation was that the Milky Way was moving at around 600 km/s; at the time, such a motion was inconsistent with that inferred from measurements of the velocities of nearby galaxies. Today, this motion is understood to arise from the gravitational acceleration of the Milky Way due to the inhomogeneous distribution of galaxies. The U-2 experiment did not have sufficient sensitivity to measure the intrinsic anisotropy of the CMB, whose amplitude is now known to be almost two orders of magnitude smaller.

At the time of this experiment NASA had issued a call for proposals for satellite experiments. One of the resulting proposals, from authors George Smoot and Richard Muller, was for detailed measurements of the CMB, and made use of concepts similar to those used for the U-2 experiment. This proposal and two proposals from other groups led to the development of the Cosmic Background Explorer (COBE) satellite. COBE made the first detection of the intrinsic anisotropy of the CMB, providing an important confirmation for a key idea in big bang cosmology - namely that structure in the distribution of matter arises from the gravitational amplification of tiny primeval fluctuations.

George Smoot and John Mather shared the 2006 Nobel Prize in physics "for their discovery of the blackbody form and anisotropy of the cosmic microwave background radiation," as a result of the COBE work, which was published in astronomy journals. Smoot's Nobel lecture [Rev. Mod. Phys. 79, 1349 (2007)] discusses the U-2 experiment as well as the COBE results. Mather's Nobel lecture [Rev. Mod. Phys. 79, 1331 (2007)] provides more information about the history of the COBE satellite.

- Nadia Ramlagan and James Riordon contributed to this Tip Sheet.

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