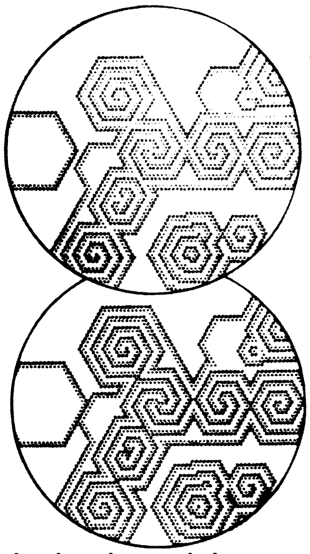
# Chemistry

## The world's full of swirls

Freedman/Science



The spiral is one of the more ubiquitous patterns in nature. From the ancient chambered nautilus to the great galaxy in Andromeda, the spiral provides a lasting record of growth or dispersion from a center. Scientists have long been concerned with modeling the dynamic processes that create spirals. Chemists have been especially fascinated by the rotating spirals produced by some oscillating chemical reactions (SN: 9/19/81, p. 188). However, this class of so-called autocatalytic reactions (self-feeding processes in which a catalyst that fuels a reaction is also produced by it) is very difficult to reproduce analytically. This is why a computer simulation developed recently by two astronomers at the University of Toronto should be a welcome tool to scientists in many fields.

Wendy L. Freedman and Barry F. Madore originally wrote the computer code to trace the evolution of a galaxy triggered by the formation of a star. By modifying the initial conditions and scale they found that the computer generated spiral patterns characteristic of oscillating chemical systems.

Since they published their findings in a recent SCIENCE (Vol. 222, No. 4624), Freedman says that chemists, biologists and mathematicians from all over the world have contacted them about everything from chemical reactions to growth patterns in slime molds and embryonic development. She notes that while Soviet scientists created simulations for similar processes twenty years ago, their work is not well known in many of the diverse fields now concerned with self-propagating phenomena.

Freedman and Madore are now working with a chemist to see if their computer model can predict the patterns obtained in the laboratory as the relative concentrations of the reagents and temperature are varied in a real chemical system.

## A new brand of hydrogen bonding

A new and unlikely kind of hydrogen bonding—the weak coupling between polar molecules that is responsible for many of the unique properties of liquids—has recently been found. The most familiar example of hydrogen bonding is water. Hydrogen links up with oxygen which, because of its high electronegativity, attracts the electrons shared in a covalent bond away from the hydrogen. This polarizes the water molecule, leaving each atom slightly charged. Hydrogen bonding then occurs when hydrogen attracts oxygen atoms in surrounding water molecules

Carbon is not normally thought to participate in this kind of bonding because it is not as potent an electron thief as atoms like oxygen and fluorine. However, researchers at the University of Anglia, England, have found evidence that carbon can indeed play a role in hydrogen bonding. Ferdos Al-Mashta and co-workers discovered the new bond while studying how anatase (titanium dioxide) catalyses the polymerization of ethylene ($C_2H_4$). Infrared spectroscopy of polyethylene revealed that as the chain grew a new peak at an unusual frequency appeared. The researchers reasoned that this peak is due to hydrogen bonding between the hydrogen atom in a carbon-hydrogen ethylene bond and a titanium atom at the surface of the anatase. This is, they reported last fall in the JOURNAL OF THE CHEMICAL SOCIETY, "the first record of such an interaction on an oxide surface of catalytic interest." Since then, they have used infrared spectroscopy to measure the angle of the new bonds.

# Environment

## Polluted plants aid pest growth

Annual surveys in England have shown that the abundance of black bean aphids *(Aphis fabae)* in areas downwind of London and in proximity to heavy industry were higher than expected based simply on the quantity and distribution of aphid eggs measured. Intrigued that pollution might play a role in enhancing the survivability of the aphids, biologists from Imperial College in London set up experiments to expose the insects to air pollutants—both directly and through food grown in the presence of industrial pollutants.

In the study, two-day-old aphids were fed field beans *(Vicia faba)* that first had been fumigated for a week with either $SO_2$ (sulfur dioxide) or $NO_2$ (nitrogen dioxide). After feasting three days, the aphid nymphs fed $SO_2$-polluted beans had a mean relative growth rate 6.5 percent higher than controls, and those fed $NO_2$-polluted beans were 8.4 percent bigger. When aphids eating a laboratory diet of "sachets" were exposed to the polluted air directly, no growth stimulation was seen.

Pollutant levels in the experiments were higher than those typical of Britain, so to check ambient effects the researchers placed pots of beans on an Imperial College rooftop in downtown London and let aphids munch away. For comparison, some aphid/bean communities had their air filtered through charcoal (removing at least 70 percent of the $SO_2$ and 50 percent of the $NO_2$). Again, aphids grew better—12 percent bigger—in the more polluted environment.

Reporting on their study in the Jan. 9 NATURE, G. P. Dohmen, S. McNeill and J. N. B. Bell note that these industrial pollutants seem to pose a double hazard to agriculture: Not only do the pollutants poison plants, but they also enhance the growth rate of pests feeding on the plants. To find out why aphids thrive so much better on polluted beans, the biologists are now characterizing changes in the amino-acid composition of the plants brought about by their exposure to $SO_2$ and $NO_2$.

## Formaldehyde-emitting products

Formaldehyde, a known animal carcinogen, is released by a number of common consumer products. This "offgassing" has been posed as one probable cause of asthmatic reactions and respiratory irritation in highly-sensitive individuals working in recently renovated or new buildings. It was to characterize the relative potential of products to emit the chemical that a Consumer Product Safety Commission (CPSC) study looked at pressed-wood products, new unwashed clothing, fiberglass insulation, paper products, fabric and carpeting.

John Pickrell and colleagues at the Lovelace Inhalation Toxicology Research Institute in Albuquerque, N.M., measured the formaldehyde released per square meter ($m^2$) of surface area for 46 products using what is known as the Japanese Industrial Standard desiccator test; it's a common procedure for assessing formaldehyde offgassing. Writing in the December EVIRONMENTAL SCIENCE AND TECHNOLOGY, they report, along with CPSC's Ambika Bathija, that the eight highest emitting products tested were all made from pressed wood: particle-board samples emitted from 13,000 to 28,000 micrograms ($\mu g$) per $m^2$ per day, plywood up to 15,000 $\mu g/m^2$, and wood paneling at up to 36,000 $\mu g/m^2$. Compared to these, none of the other products came close. At several hundred micrograms per square meter, the unwashed clothing had a formaldehyde-release rate comparable to many insulation products, to cotton-drapery fabrics and to some paper plates and cups. Carpeting and most upholstery fabrics—even those of cotton—had no detectable offgassing.

Pickrell notes that test emissions do not necessarily reflect levels that might be encountered in the home. Observed rates were for new products (levels decline over time) under 100 percent relative humidity — not a normal indoor condition. Also, rates varied up to 1,000-fold within some products.