Buckyball superconductors get warmer

As the recent sweltering weather broke records, those 60-carbon molecules called buckyballs set a different kind of temperature standard.

In late May, two research groups announced they had increased by 60 percent the working temperature of an organic superconductor by combining buckyballs – members of a new class of carbon molecules called fullerenes – with the metal rubidium. And this week, four teams shed light on how this fullerene, normally an insulator, can switch to a conductor. Now, the race is on to make buckyballs that superconduct at even higher temperatures.

Matthew J. Rosseinsky and his colleagues at AT&T Bell Laboratories in Murray Hill, N.J., made a thin film of buckyball-rubidium and found it conducted electricity with no resistance at 28 kelvins. This broke a record set at the same lab in April, when researchers made a buckyball-potassium superconductor that worked at 18 kelvins (SN: 4/20/91, p.244). While these materials do not work at as high a temperature as ceramic superconductors, they do function at temperatures much higher than expected, Rosseinsky's group reports in the May 27 PHYSICAL REVIEW LETTERS.

In the May 24 SCIENCE, Károly Holczer and co-workers at the University of California, Los Angeles, describe making fully superconducting samples of potassium-doped buckyballs and producing rubidium-based superconductors that work at 30 kelvins.

Superconductivity seems to arise in these materials because metal atoms so readily share an electron with a neighboring buckyball, two research groups propose in the June 7 SCIENCE. Gunther K. Wertheim's team at Bell Labs suggests that the electrons set up pathways across the thin film, which can then conduct electricity. Paul J. Benning and two colleagues at the University of Minnesota in Minneapolis, working with chemists at Rice University in Houston, draw a similar conclusion based on the energies of the electrons released when the researchers bombarded fullerene solids with light. When there are three metal atoms for each buckyball, this path contains just the right number of electrons for the material to become a superconductor, they report.

Other scientists have found that they can stuff in up to six potassium or cesium atoms per buckyball. X-ray crystallography indicates that the buckyballs shift slightly to accommodate these metals, reports a team headed by John E. Fischer at the University of Pennsylvania in Philadelphia. Normally, buckyballs arrange themselves as if they were corners on a cube, with another buckyball sitting in the center of each face of the cube. When metal is added, the buckyballs on the faces move over to let the new atoms occupy the central positions, the researchers report in the June 6 NATURE.

In the same issue, William A. Goddard III and two students from Caltech in Pasadena calculate the lowest-energy – and consequently, most stable – arrangement of buckyballs in a solid. Their conclusions about how these molecules stack fit with previous results.

Taken together, the recent studies indicate that adding relatively large metal atoms, such as cesium, should result in higher superconducting temperatures. So far, no one has reported getting the cesium-fullerene combination to work, although many are trying. – *E. Pennisi*

Smoking away vitamin C

Cigarette smoking seems to deplete vitamin C levels in the blood. Realizing this, the National Research Council in 1989 revised smokers' recommended daily allowance (RDA) for vitamin C, raising it from 60 milligrams – the RDA for the general population – to 100 mg. But a new study suggests the revised RDA for this vitamin still falls far short of providing smokers the same benefits that nonsmokers get from the general RDA.

As the body's premier scavenger of potentially damaging oxidants and highly reactive molecules called free radicals (SN: 8/26/89, p.133), vitamin C may assist in such important functions as protecting against carcinogens, boosting immunity and preventing heart-disease-fostering changes in fats.

Two years ago, a team led by Gordon Schectman at the Medical College of Wisconsin in Milwaukee published findings suggesting that more than one-quarter of U.S. smokers suffer marginal to severe vitamin C deficiencies. The same team has now studied data on 11,582 people who participated in the second National Health and Nutrition Examination Survey, comparing diets with blood levels of vitamin C. The new findings indicate smokers need more than 200 mg of vitamin C daily in order to lower their risk of deficiency (less than 23 micromoles of vitamin C per liter of blood serum) to the same level as that of nonsmokers consuming 60 mg.

The data show that about 57 percent of nonsmokers eat diets that fulfill their RDA from vitamin C. However, only 27 percent of smokers meet the revised, 100-mg RDA, and only 9 percent consume more than 200 mg per day, the researchers report in the June AMERICAN JOURNAL OF CLINICAL NUTRITION.

For smokers, they conclude, "vitamin supplementation may be necessary to reduce the prevalence of low serum concentrations of vitamin C to rates acceptable in nonsmokers." – *J. Raloff*

'Star Wars' generates sharper stellar images

They were conducting research on laser weapons, not trying to take the twinkle out of starlight. But the "Star Wars" studies that an Air Force laboratory and a university research team began a decade ago – and kept secret until last week – have yielded a laser system that corrects for the atmosphere's blurring of celestial objects. This technology promises to dramatically sharpen the images produced by some ground-based optical telescopes, potentially putting them on a par with costlier instruments that orbit above the interfering atmosphere.

Already tested on small telescopes, the laser system could revolutionize infrared and visible-light astronomy from Earth, its developers reported last week in Seattle at a meeting of the American Astronomical Society.

Ground-based astronomy is handicapped by distortions created when starlight travels through the atmosphere – a turbulent hodgepodge of hot and cold air masses that constantly alters its refractive index. The rapidly changing index deforms the wavefronts of incoming starlight so that the radiation appears to twinkle and come from a fuzzy blob instead of a celestial point.

Astronomers in Europe and Canada have made some headway in solving the problem with adaptive optics. This involves measuring the atmospheric distortion of light coming from a bright, easy-to-measure reference star near the celestial object of interest, then electrically deforming a flexible telescope mirror to optically compensate for the distortion. However, this technique has one key limitation: Most heavenly bodies don't reside near a bright reference star.

Physicists now report they have overcome this limitation by mimicking the effects of a reference star with a powerful laser. The researchers shoot an intense laser beam some 90 kilometers into the atmosphere and measure its resulting distortion as gas particles reflect the light back to Earth.

Although French scientists first publicly described such a theoretical laser-guide system in 1985, Robert C. Fugate says he and his colleagues had secretly conducted the first assays of atmospheric distortions in 1983. Fugate, of the Kirtland Air Force Base in Albuquerque, N.M., reports performing these and later imaging experiments with a 1.5-meter telescope at Kirtland.

Charles A. Primmerman and his group at the Massachusetts Institute of Technol-