Physical Sciences

Dietrick E. Thomsen reports from New Orleans at the meeting of the Optical Society of America

Green light for laser fusion

"New green laser shines in Livermore," runs the title of a paper by Kenneth R. Manes and nine colleagues from the Lawrence Livermore National Laboratory in Livermore, Calif. The laser's name is Novette, and it represents a departure in lasers intended for controlled thermonuclear fusion.

The laser light must couple its energy to tiny fuel pellets and crush and heat them to ignite nuclear fusion. For some time now, studies have indicated that the most efficient frequencies of light for the purpose are in the green to ultraviolet range. The problem is that the giant lasers that fill large buildings and use large slabs of neodymium-doped glass as their lasing elements give red or infrared light. Novette is designed to see whether the beams from such a powerful laser could go through an optical element that doubles the light frequency without unacceptable power loss.

Novette generates 20-trillion-watt infrared pulses, which, after frequency doubling, become 6-trillion-watt green pulses. Initially, it has been shooting targets with pulses of 530-nanometer wavelength and 5,000-joules energy.

Smoking makes your blood glow

A group of researchers from Tohoku University in Sendai, Japan, reports it has succeeded in detecting the chemiluminescence of human blood for the first time on record. Chemiluminescence is extremely weak light generated by chemical processes. Blood chemiluminescence has to be measured by counting individual light quanta or photons.

The researchers found that a 2 milliliter sample of the blood of a healthy non-smoking person emits about 500 photons in 300 seconds. The same amount of blood from people with cancer, diabetes, or hyperlipidemia emits three or four times as much light. Blood of otherwise healthy smokers also yields three to four times the light that blood of non-smokers does. The researchers, Humio Inaba, Choichi Takyu, Binkoh Yoda, Katsuro Sato and Yoshio Goto, believe the chemiluminescence is related to the presence of chemically active oxygen in the blood.

Precise positronium spectroscopy

For centuries physicists have used the simplest possible systems to study the basic elegances of various dynamic interactions. The earth and the moon were the arena for the study of gravity. The hydrogen atom gave us basic quantum mechanics. Now the simplest of atoms, or quasi-atoms — positronium — is used to study electromagnetic behavior and more exotic dynamics on the subatomic level. Steven Chu, Allen P. Mills Jr. and John L. Hall of Bell Laboratories in Murray Hill, N.J., report that they have measured the frequency of light involved in a particular energy transition of positronium with ultra-fine accuracy.

Positronium is a bound system containing an electron and its anti-particle, a positron. The positronium is irradiated with laser light to induce the desired quantum energy transition. The frequency of the light that does it was measured as 616,803,585.9 megahertz. Theory predicted 616,803,598.9, only 13 mHz difference.

As Chu puts it, this is not just "Rococo physics," ultra-precision for precision's sake. The theoretical calculation is derived from basic principles of quantum electrodynamics, the theory of electricity and magnetism in subatomic physics. This accuracy makes the experiment a good probe of those principles. With somewhat more accuracy, the experiment could probe the basic dynamics of the weak interaction, another kind of force important in subatomic physics. Still more accuracy and it might lead to exotic domains of microscopic dynamics that were hitherto unnoticed because experiments were not precise enough to find them.

Nutrition

Steaking out cholesterol

A well-marbled steak — usually the tenderest and tastiest — contains no more cholesterol than less-marbled cuts, according to a study by meat scientist Ki Soon Rhee and colleagues at Texas A&M University in College Station. Measuring cholesterol in raw beef-loin steak, they found that only those samples judged "practically devoid" of marbling were statistically different from the rest. Seven other marbling classes—from "traces of marbling" to "moderately abundant" marbling — varied, per 100 grams of steak (measured on a wet-weight, or uncooked, basis), from 60.06 milligrams of cholesterol to 65.88 mg. Steaks practically devoid of marbling had an average 51.77 mg of cholesterol per 100 g.

Once the meat was cooked to an internal temperature of 60°C (medium rare) or to 75° (well done), even the statistical variation that had distinguished the "practically devoid" group disappeared. Although on a wet-weight basis, cooked steak had 22 to 40 percent more cholesterol than raw beef, the difference was "just due to moisture loss through cooking," Rhee pointed out.

Rhee's team also looked at cholesterol changes after cooking fattier, boneless-rib steak. Unlike the trimmed loin steak, this cut contains seam fat between muscles, and subcutaneous (outside) fat. Samples included a range of yield grades (the higher the yield grade, the more associated fat a sample contains).

Rhee said they found no statistically significant difference in cholesterol levels between grades, though "there was a numerical trend toward increasing cholesterol content as the yield grade (or fat) increased." Constituent analyses showed that compared on a 100 g (wet weight) basis, muscle — or meat — contained 62.4 mg of cholesterol, seam fat 108.2 mg and subcutaneous fat 114.2 mg. Once the meat was cooked, however, the ratios changed notably. Now measured on a 100 g dry-weight basis, muscle contained 206.9 mg cholesterol, seam fat had 140 mg and subcutaneous fat 135.8 mg. Moisture loss again explains the difference, as muscle begins (raw) as 69.6 percent water, seam fat as 22.5 percent water and subcutaneous fat as 15 percent water.

In the end, Rhee points out, "even after cooking, you still have more cholesterol in fat than muscle" because servings are calculated on a wet-weight basis. However, she adds, "fattier cuts of meat don't have as much cholesterol as people tend to think because they lose so much fat through cooking."

To those who fight colds with vitamin C

Persons consuming megadoses of vitamin C—usually to fight colds — may run a risk of developing secondary iron-deficiency anemia, especially if their diet is normally low in the trace element copper. So suggests research by Elizabeth Finley and Florian Cerklewski at Oregon State University in Corvallis.

In an experiment, 13 male volunteers aged 20 to 33 consumed 500 milligrams of vitamin C (ascorbic acid) along with each of their three major meals daily — an amount 25 times the recommended daily intake level. As the study progressed, each volunteer experienced a steady decline in blood-copper levels and a related decrease in ceruloplasmin-activity levels. Ceruloplasmin is a copper-containing protein that "is apparently necessary for our normal recycling of iron" to make new red-blood cells, Cerklewski explains. By the 10-week study's end, volunteers' ceruloplasmin activity had fallen an average 26 percent and blood copper had dropped roughly 10 percent — effects that reversed once the vitamin supplementation ceased.

This is consistent with "a tremendous amount of information on laboratory animals indicating that when an animal is subjected to extreme quantities of vitamin C, it can develop secondary iron-deficiency anemia — even though the iron content of the diet should be adequate" Cerklewski notes. It appears, he says, vitamin C blocks the effects of copper.