Pumping Up Hope for a Gamma Ray Laser

Scientists generally agree that a laser that emitted gamma rays would have tremendous power. One of the scientists involved in efforts to make one, Carl B. Collins of the University of Texas at Dallas, estimates that such a laser might yield as much as 10^{21} watts. This surpasses the total power production of the United States (10^{12} watts) and is a respectable 0.03 percent of the total energy output of the sun. Thus it would enter a totally new energy scale for power sources made by humans — in Collins's words, "a cosmic scale." He told the Second International Laser Science Conference, which met in Seattle last week, that new approaches show a good prospect of overcoming the difficulties that frustrated previous attempts to develop this laser.

Collins counts 50 scientists in Europe and North America working full-time toward a gamma ray laser. With such power as a motivation, it is not surprising that gamma ray lasers have been a recurrent but frustrating and controversial dream. The difficulties come from the physics of atomic nuclei, which are the sources of gamma rays — the "hardest" (of shortest wavelength) and greatest-energy-per-quantum form of electromagnetic radiation. Collins's power estimate is for a wavelength of 1 angstrom — one hundred-millionth of a centimeter. By comparison, visible light ranges from about 3,000 to 9,000 angstroms; infrared, where the first lasers were made, starts around 10,000.

Lasing comes from a "population inversion" in the nuclei of the lasing material. A large number of nuclei must be raised to a particular high-energy level where few or none of them normally would be found, and then induced to drop from that energy level to a lower one, radiating in unison. To achieve the population inversion, scientists must "pump" the material with energy from an outside source in such a way that it will invest the energy, or part of it, in the level from which the lasing transition takes place. This level must last long enough without emitting spontaneously to permit the pumping to be accomplished; then the stimulated emission of a laser can be triggered.

Pumping has been one of the rocks on which previous efforts foundered. The first pumping schemes proposed would have put a great deal of energy into the lasing material very quickly — in microseconds or even picoseconds — in the hope of getting some into short-lived lasing states. This threatened to melt the material. A suggested alternative was to use an energy state that lasts a long time, perhaps 270 years, so that energy could be built up slowly, and then trigger the stimulated emission. But in the long time period, there are effects that degrade the sharpness of the wavelength, one of the qualities necessary for a good laser.

"This straightforward, brute-force pumping won't work," Collins concludes. What will work, he says, is a double process in which energy is first stored in a long-lived "isomeric" state — a state that naturally lasts about a year before it radiates. In this way energy can be introduced slowly to avoid overheating. Then another injection of energy pumps the nucleus to a nearby state that lasts only a second, and from this state the actual lasing occurs. This "upconversion" process is done with X-rays.

Once the nucleus is pumped, will it emit gamma rays? To counter the enthusiasm of the gamma ray workers, the organizers of the meeting invited Harry J. Lipkin of Argonne (Ill.) National Laboratory and the Weizmann Institute of Science in Rehovot, Israel, as devil's advocates for nuclear physics. He reminded the group that the nucleus would most likely get rid of its energy by a process that emits an electron rather than a gamma ray. The laser people responded that they intend to embed the lasing nuclei in a crystal; then a property of the crystal known as Borrmann effect would alter the energy balance so as to make gamma ray emission more likely. Lipkin is not sure the Borrmann effect exists.

Undeterred by Lipkin's skepticism, the laser workers are now looking for suitable nuclear species. There are 1,886 nuclei, counting all the isotopes of all the elements. Present knowledge indicates that 29 of them are "first-class candidates," Collins says. His group has developed a tabletop device that hits a sample with pulses of X-rays from all sides. This is intended as a prototype of an experiment that will look at the X-ray fluorescence of these nuclei to see which is the best candidate for a gamma ray laser.

— D. E. Thomsen

Heavy drinking increases stroke risk

A growing body of epidemiologic evidence is linking heavy alcohol use to strokes. The relationship, say scientists involved in the research, is underappreciated because of the relatively few studies on the matter and because those studies do not prove that alcohol itself is causing the strokes.

Nevertheless, studies of stroke patients in Finland as well as stroke incidence in Honolulu and Framingham, Mass., have shown that men who drink are at a higher risk of stroke. The latest addition to the body of evidence is a British study, reported in the Oct. 23 NEW ENGLAND JOURNAL OF MEDICINE, which found a heavy-drinking/stroke association among hospitalized men.

In the study, 230 stroke patients at Dudley Road Hospital in Birmingham, England, were asked about their drinking habits, as were age-, sex- and race-matched patients hospitalized with problems not related to stroke or alcohol use. The researchers found that drinking more than 300 grams of alcohol weekly — about 30 drinks — put men at four times the risk of suffering a stroke as nondrinkers. On the other hand, men who drank lightly — about one to nine drinks a week — were at half the risk of nondrinkers.

The researchers calculated these risks after statistically adjusting for two stroke risk factors, hypertension and cigarette smoking. Because only 87 of the stroke patients were women, no conclusive projections for women could be made.

The British study illustrates some of the limitations of retrospective analysis: It relied on the patients' ability to report previous behavior and used other hospitalized patients, who are not necessarily representative of the general population, as a control group.

Even so, the researchers concluded that heavy alcohol intake "is an important and underrecognized independent risk factor for stroke in men." Philip B. Gorelick of Michael Reese Hospital in Chicago, who is preparing the results of his own study for publication, says the connection suggests preventive measures. "Heavy drinking is a reversible risk factor," he says. The current study fits in with the body of evidence, he adds. "I think it's a stepping stone."

Discovering a mechanism by which alcohol causes stroke would firm up the relationship. Strokes result from a disturbance in blood flow to the brain, because a blood vessel has been blocked or has ruptured. Alcohol could induce stroke, the British researchers suggest, by altering the clotting components of blood or by altering blood flow.

Louis R. Caplan, a stroke specialist at Tufts University in Boston, says alcohol theoretically could induce some types of strokes and protect against others. "What needs to be done next," he says, "is to look at alcohol with respect to subdivisions of stroke." *— J. Silberner*