heimer patient. The noninvasive technique revealed a unique and "profound" decrease in blood flow to certain regions of the brain, a phenomenon previously observed using other techniques. Although the SPECT study also corroborates earlier descriptions of specific receptor site distribution based on other methods, the real significance of these findings, despite the very small sample size, may be the eventual introduction of an important diagnostic tool that may provide earlier diagnosis.

Neuronal biochemistry is also the scientific springboard for a search by scientists at Yale Medical School in New Haven, Conn., for drugs to ameliorate cognitive deficits like those associated with Alzheimer's disease, such as memory loss. Attempts to find a drug for age-related cognitive disorders have not produced sudden success stories (SN: 5/7/77, p. 292; 10/27/84, p. 263). Nonetheless, Amy F. T. Arnsten and Patricia S. Goldman-Rakic of Yale report in the Dec. 13 SCIENCE that a different approach may produce results — one that uses drugs affecting catecholamine transmission in the brain rather than the more commonly utilized acetylcholine transmission. Both neurotransmitter systems deteriorate in the aging brain.

Using five aged rhesus monkeys ranging from 17 to over 30 years of age, the 18-month study tested their performance in memory tests following injection of varying doses of various drugs that affect catecholamine transmission, alternated with doses of a saline placebo. The monkeys' performance with the placebo averaged 64 percent correct during the course of the study, with individuals showing a wide range of memory ability.

Specific doses of the drug clonidine, an antihypertensive agent, produced "near-perfect performance" in four of the five animals, with the oldest monkey showing the most marked improvement. Arnsten and Goldman-Rakic found higher doses of clonidine had a sedative effect on the animals, which apparently developed a tolerance to this side effect over a period of time. The researchers caution that clonidine's sedative effects may obscure its beneficial actions and should be considered if the drug is used in human clinical trials. *— D. D. Edwards*

Strategic defense of X-ray laser initiative

Nuclear explosions produce a lot of X-rays. That makes them a good place to start attempts to make X-ray lasers, and the Lawrence Livermore (Calif.) National Laboratory (LLNL) has done just that. "I can tell you that X-ray lasers exist. That is as far as I am allowed to go." Thus spake Edward Teller, associate director emeritus of LLNL, at last week's meeting of Lasers '85 in Las Vegas, Nev.

Teller's firm and categorical affirmative seemed to be at least partly a response to recent speculations in the press, which, he says, contain much that is untrue about Project Excalibur, as the effort is called. Some of these reports have suggested that the X-ray laser may not exist, or, if it exists, that it may not ever be good enough for its purpose, the Strategic Defense Initiative (SDI). They have also hinted that the resignation of Roy E. Woodruff, former associate director of defense systems at LLNL, was related to these difficulties. The laboratory officially denies any such suggestions.

To make a laser requires a "population inversion." Atoms emit radiation when they possess more energy than is required in their lowest possible energy state, their ground state. Each kind of atom can occupy a spectrum of energy states above the ground state. Usually when a large group of atoms shares a given amount of energy, statistically most of the energy should be shared by atoms in fairly low energy states, close to the ground state. Only a few atoms will be in high energy states. If, contrary to statistical expectations, a large number of atoms are brought to the same, high energy state, usually by some kind of resonant pumping, a population inversion exists. If these high-energy atoms can then be triggered to radiate in chorus, coherently, a laser exists.

The energy states that produce X-rays are those belonging to the innermost electrons of a heavy atom or to the nucleus itself. It may be that a nuclear explosion produces a fleeting population inversion in its own fuel, or it may be that X-rays from the explosion are used to pump up a population inversion in some other substance, which then does the lasing. The latter would be a very elegant application of a nuclear explosion. There has been mention of devices to focus X-rays. Such devices have been part of the triggering mechanisms of thermonuclear bombs as long as this variety of explosive has existed, and it could be that some derivative of them is used to focus X-rays on a lasing material.

All this is, of course, the rankest speculation, and Teller might say it was all wrong. But, as he himself points out, by keeping such things secret the government denies information only to its own citizens, not to potential enemies. Teller says he believes that the Soviet Union is ahead of the United States in research of the SDI sort, which includes this nuclear X-ray laser project. He calls for openness and sharing of information in matters of this kind. "We should be scientists and not alchemists. We should be for openness in the name of science, of the unity of the world, and in the name of the defense of the United States." But he refuses to try to change the rules by breaking them.

Another object that might go with an X-ray laser is a mirror for specular reflection of X-rays. A laser that is pumped and then emits is a one-pass device. As soon as they have one, experimenters try to put mirrors on the ends of it and reflect the radiation back and forth. In multiple passes radiation stimulates more of the same and so amplifies itself greatly. Most practical lasers have mirrors. The reason for not putting them on is that they are impossible or at least highly impractical.

Mirrors for X-rays in the wavelength range of those from nuclear explosions, roughly in the tens of angstroms, have been impossible up to now. Visible light, infrared and radio waves are easy to reflect. X-rays, because of their extremely short wavelengths and great penetrating power, are extremely difficult to reflect, particularly in the specular or near-perpendicular mode. Development of a substance that would reflect them specularly would be a technological achievement of very high magnitude and many possible uses.

However, for wavelengths in the few hundreds of angstroms, such specular reflectors do exist. Products of fairly recent technology, they are composed of thin layers of different substances that collaborate with one another in such a way as to reflect a good portion of the incident radiation. In this wavelength range two experiments demonstrated lasing a little over a year ago (SN: 11/3/84, p. 278). At Lasers '85 the leaders of both, Szymon Suckewer of the Princeton (N.J.) Plasma Physics Laboratory and Dennis L. Matthews of LLNL, detailed numerous extensions of their experiments, including use of such multilayered reflectors to make multiple-pass amplifiers.

Although SDI hangs in the background — and, in the case of the nuclear-explosion laser, drives the research — lasers of this wavelength range have many other potential applications. Matthews lists the study of biological cell structures, materials science, microelectronics, atomic physics and studies of laser physics itself. Holograms of small structures are among the methods of these studies, and Matthews expects soon to begin collaboration with AT&T Bell Laboratories to do some surface holography. A very short X-ray laser, if it is more than just a nuclear explosion, could have similar uses.

— D. E. Thomsen