Earth Sciences

Pekeris wins earth sciences prize

The $25,000 Vetlesen Prize, which has been referred to as the Nobel Prize of the earth sciences, has been awarded to Chaim Leib Pekeris of the Weizmann Institute of Science in Rehovot, Israel, "as an outstanding pioneer in the application of advanced methods of applied mathematics to the solution of a wide range of fundamental geological and geophysical problems."

Established in 1960 at Columbia University by the G. Unger Vetlesen Foundation, the substantial prize is significant because of the lack of Nobel Prizes in the field. In past years it has been awarded to such geophysical luminaries as S. Keith Runcorn, Edward C. Bullard, Harold Jeffereys and Maurice Ewing.

Pekeris's contributions to the earth sciences have been concerned with such areas as convection within the earth, propagation of sound in layered media and certain properties of the helium atom. He is particularly noted for his calculations of the frequencies at which the earth vibrates when jarred by earthquakes, as well as of the frequencies of the global ocean tides.

Of plates and poles: Who goes there?

Most, if not all, of the apparent "wandering" of earth's magnetic pole in the last 55 million years is due to the movement of the plates that make up the planet's crust, rather than to true changes in the pole's position relative to the mass of the earth, according to calculations by Donna M. Jurdy and Rob Van der Voo of the University of Michigan in Ann Arbor.

The researchers developed a mathematical method of describing a pattern of movements, or displacements, on a sphere in terms of two separate components: one due to a rigid rotation and the other, which the authors ascribe to continental drift, made up of random motions. In applying their calculations, Jurdy and Van der Voo first reconstructed the estimated positions of the crustal plates and plate boundaries as they would have been in the early Tertiary period of about 55 million years ago, and assumed magnetic pole positions based on data from early Tertiary rocks.

The result, they report in the July 10 Journal of Geophysical Research, is that only two degrees of polar movement in the intervening years can be credited to the random component representing true polar wandering. Since the uncertainty in the estimated position of the early Tertiary pole was twice that amount, the authors conclude that most or all of the observed polar shifting may in fact be due only to movement of the crustal plates.

Ordeal by lava

An experimental heat-transfer system now under construction at Sandia Laboratories in Albuquerque is to be immersed in a crucible of molten lava to see if it can survive the corrosion well enough to be used in extracting energy from molten rock beneath the earth.

Molten rock, at a temperature of some 2,200 degrees F., offers sufficient concentration of energy that Sandia researchers feel it may be promising, even though the heat exchangers might have to be emplaced as far as 20 miles down under the continents or three miles beneath the ocean floor. The *extractable* energy in a cubic mile of magma, says Glen Brandvold, leader of the project team, "should be adequate to run several 1,000-megawatt power plants for 100 years."

Physical Sciences

Harmonic light waves for fusion

It seems that the optimum light waves for use in laser-induced thermonuclear fusion will be of fairly high frequency. Some Americans in the field speak of blue-green light. Soviet opinion, according to V. D. Volosov, V. N. Krylov, V. A. Serebryakov and D .V. Sokolov of the S. I. Vavilov Optics Institute, tends to the ultraviolet.

There lies a problem. Most powerful laser sources are in the infrared. One solution to the problem seems to lie in certain crystals that have the property of producing harmonics of light waves. That is, if a wave of a certain frequency is sent into the crystal, the crystal will convert some of its energy to waves whose frequencies are integral multiples of the original. In theory this is all very fine, but in practice problems involving the length of the converting crystal and the relationship between the group velocities of the fundamental and harmonic waves have limited efficiencies of conversion to about 50 percent.

But Volosov, Krylov, Serebryakov and Sokolov calculate that if the laser pulse exceeds several dozen trillionths of a second (a range that appears good for fusion purposes, by the way), the limiting factors are removed.

In JETP LETTERS (Vol. 19, No. 1) they report an experiment they did with 200-picosecond pulses (200 trillionths of a second). They claim 80 percent efficiency in generating the second harmonic (twice the fundamental frequency) and 30 percent in generating the fourth.

When fusion targets reflect the light

One of the important questions in laser-fusion studies is how much of the incident laser light is reflected by the target. The balance between reflection and absorption is a crucial factor in the delivery of energy to the target. Also if the reflected light gets back into the laser system, it can cause damage there.

Studies using targets of deuterated ice show high reflection coefficients that have a tendency to rise as the incident light intensity goes up, a very bad combination for fusion, which requires high intensities. Materials that have a high heat of sublimation (the amount of heat required to turn solid into gas) show more promise, however.

In JETP LETTERS (Vol. 19, No. 2), V. D. Dyatlov, R. N. Medvedev, V. N. Sizov and A. D. Starikov of the D. V. Efrimov Institute of Electrophysical Apparatus report an experiment with such a material, lithium deuteride, which has a heat of sublimation of 54 kilocalories per mole. They tested it with light from a high power neodymium-glass laser with a wavelength of 1.06 microns.

The intensity of the light incident on the target varied from 10^{12} to 10^{15} watts per square centimeter. The light reflected back into the aperture of the laser system, and the light scattered at an angle of 135 degrees were measured. The result gives the reflected light as a percentage of the light absorbed by the target. It ranges from about 0.8 percent at the low end of the intensity range to about 0.2 percent at the high end.

The experimenters attribute the decline of reflectivity with increase in intensity to the high heat of sublimation. This means that the first part of the pulse evaporates less material than with easily evaporated substances. This creates a cloud of lower optical density around the target, and the low-density cloud passes more light from the main pulse. A similar effect could be achieved for easily evaporated substances by increasing the contrast in the devices that irradiate them, the group suggests.