physical sciences

SOLID STATE

One crystal stores 1,000 holograms

A crystal of lithium niobiate no larger than a sugar cube can be used to store up to 1,000 holograms, reports a group of scientists from Bell Telephone Laboratories.

Unlike photographic film, which records images by a permanent change in its light transition properties, lithium niobiate records them by a temporary change. The images can be erased by heating the crystal to 170 degrees C.

A sufficiently intense beam of light shining on the crystal frees enough electrons to set up an electric field within the crystal. This field alters the refractive index, the ratio of the speed of light in the crystal to the speed of light in vacuum.

The change in refractive index is proportional to the intensity of the light, and thus the intensity variations that make a hologram pattern can be recorded over the crystal. The effect is directional; only a light beam striking the crystal at the same angle as the reference beam that made a hologram will read out that particular hologram.

Rotating the crystal a fraction of a degree allows a second hologram to be recorded, and so on around.

The work is reported by Drs. J. T. LaMacchia, F. S. Chen and D. B. Fraser.

HYDRODYNAMICS

Spectra of water waves around islands

The study of surface waves on water near shores is beset by mathematical difficulties, and very few results are available on motions near resonance, which usually have a three-dimensional character.

Drs. Mei-Chang Shen and R. E. Meyer of the department of mathematics at the University of Wisconsin and Dr. Joseph B. Keller of New York University's Courant Institute of Mathematical Sciences have explored approximate methods of analyzing the three-dimensional case.

They report in the November PHYSICS OF FLUIDS that their small wavelength approximation is promising, although still mathematically tentative. If actual observations support the predictions made by their approximate mathematical models, the formulas they developed could have important applications in forecasting the height of tsunami, or tidal waves.

ATMOSPHERICS

The spectrum of lightning

The spectrum of the light emitted by a stepped leader lightning stroke has been analyzed by Dr. Richard E. Orville of Westinghouse Research Laboratories in Pittsburgh. He converted a high-speed camera into a slitless spectrograph to do the work.

A stepped leader is a lightning stroke that proceeds downward in a series of stepwise motions and serves as the forerunner of a heavy return stroke that comes up from the ground.

In the 5,600 to 6,600 angstrom region, Dr. Orville reports in the JOURNAL OF GEOPHYSICAL RESEARCH for Nov. 15, singly ionized nitrogen emissions at 5,680 and 5,942 angstroms and hydrogen alpha emissions at 6,563 were prominent. He calculates a temperature of 30,000 degrees K. for the leader step. The thickness of the emitting volume is about half a meter.

QUANTUM ELECTRODYNAMICS

Fundamental constants and Josephson junctions

A Josephson junction consists of two pieces of superconducting material that are joined so that there is some insulating material or a partial air gap between them. Subjecting such a junction to electromagnetic radiation will make it pass a direct current that goes up in abrupt steps as the voltage increases, rather than smoothly as would happen in an ordinary conductor.

The steps appear at voltages determined by the frequency of the radiation and a constant that equals twice the charge of an electron divided by Planck's constant.

This constant, called $2e/h$, is related to constants that appear in some of the basic formulas of the theory of electric interactions between atomic particles. Calculating with the previous best value of one of these led to a troublesome discrepancy with experimental observation of some behavior of atomic hydrogen.

To resolve this disagreement, Drs. W. H. Parker, B. N. Taylor and D. N. Langenberg sought to use Josephson junctions to determine an accurate value of $2e/h$. They got 483.5912 ± 0.0030 megahertz per microvolt, which is precise to six parts in a million, enough to settle the discrepancy.

But, says Dr. John Clarke of Lawrence Radiation Laboratory, one ought to make sure that $2e/h$ is really a constant of nature and does not depend on the characteristics of some superconducting material. He now reports, in PHYSICAL REVIEW LETTERS for Dec. 2, that the value of the constant is the same in lead, tin and indium to an accuracy of one part in 100 million.

METEOROLOGY

Radioactive tracer in rain studies

Meteorologists at the University of Michigan are using a radioactive tracer, indium 113, to measure motions in severe storm systems (SN: 11/9, p. 480).

Other aims of the new project, headed by Dr. A. Nelson Dingle, are to obtain an exact understanding of how rain droplets pick up airborne contaminants, from plant pollens to radioactive particles, and to develop a dependable method of verifying rainmaking attempts.

One estimate is that some 80 percent of atmospheric pollutants are cleansed by rain or snow. Thunderstorms quickly deposit large amounts of contaminants in small areas.

The tracer is dispensed from an aircraft into a convective storm. At the same time ground crews speed to where the rain is likely to fall and place portable rain samplers in predetermined patterns. The samples are later collected and analyzed by neutron activation analysis (SN: 11/30, p. 552).