physical sciences

PLANETARY ASTRONOMY

Liquid-center satellites

Several of the larger satellites of the outer planets may have icy crusts and liquid interiors. So suggests Dr. John S. Lewis of Massachusetts Institute of Technology in the June 11 SCIENCE.

He points out that infrared measurements of Jupiter's fourth satellite, Callisto, show a daytime surface temperature of 160 degrees K. This is only slightly below the lowest melting point of a mixture of water ice and solid ammonia (the two most prominent constituents), which is 173 degrees. The interior should be much hotter, he says, warmed by radioactive decay of potassium, uranium and thorium. Near the center of the satellite he postulates temperatures as high as 500 degrees.

Therefore he proposes that Callisto and similar satellites have a thin icy crust over a deep mantle of hydrated liquid ammonia and a dense core of hydrous silicates and iron oxides.

Satellites of this composition should be very susceptible to distortion by tidal forces, and he suggests that Saturn's rings may come from tidal disruption of liquid satellites.

SOLAR SYSTEM

Cometary halos

When they are near the sun, comets are surrounded by gaseous halos. In the case of comet 1969g the halo consisted of hydrogen and hydroxyl. The way in which the brightness of that comet depended on distance from the sun leads Dr. A. H. Delsemme of the University of Toledo in Ohio to suggest a three-step process in the formation and excitation of the halo. Writing in the June 11 SCIENCE, he proposes that first water snows are vaporized, then the sunlight dissociates the vapor into hydrogen and hydroxyl, and finally the hydrogen and hydroxyl are excited to fluorescence.

COSMOLOGY

Gravity waves and neutrinos

Ever since Dr. Joseph Weber of the University of Maryland reported that he was detecting bursts of gravitational waves that seem to come from the center of the galaxy, other observers have been looking for other forms of radiation associated with them. The reasoning is that if there is some process going on powerful enough to produce the gravitational radiation, it may also be sending out bursts of radio, X-rays, cosmic rays, neutrinos or what have you.

The latest in a series of more or less negative results concerns neutrinos of the sort associated with muons, and is reported in the June 7 PHYSICAL REVIEW LETTERS by Drs. Frederick Reines, W. R. Kropp, P. Landecker, W. G. Sandie, J. Lathrop and H. W. Sobel of the University of California at Irvine; M. F. Crouch of Case Western Reserve University in Cleveland; and D. Bourne, H. Coxell, D. Kramer and J. P. F. Sellschop of the University of the Witwatersrand in Johannesburg.

They used neutrino detection equipment set up in a South African gold mine and for 227 days looked for pulses of muon neutrinos arriving at the same time as Dr. Weber's gravity waves. Although Dr. Weber is recording one or two events a day, the best rate for muon-neutrino coincidences that Dr. Reines and associates can quote is two per year. But they say the statistics of the experiment are poor, and in the future they intend to increase the precision of their observations.

Similar attempts to find radio waves and the sort of neutrinos that associate with electrons in pulses coincident with gravity waves have not so far yielded any significantly positive observations.

PLASMAS

Curing drift instabilities

The attempts of plasma physicists to confine plasmas of ions and electrons in magnetic fields frequently overcome one difficulty only to meet another. For a long time diffusion, in which the plasma particles cut across the lines of the magnetic field and escape, was the most serious problem. In recent years experiments have shown how to make plasmas with substantially slower diffusion rates than before, and other forms of instability that fast diffusion had suppressed are becoming important.

One class of these are due to plasma drift. Plasma particles are supposed to move in uniform orbits in the magnetic field. But distortions in the field can cause an unbalanced motion in which they drift toward the weaker part of the magnetic field, and he plasma becomes unstable.

In the June 7 PHYSICAL REVIEW LETTERS Drs. M. W. Alcock and B. E. Keen report that applications of alternating auxiliary fields can stabilize some of the drift instabilities. Their experiments show that both alternating magnetic fields in the azimuthal direction—that is, with field lines curving around the axis of the cylinder in which the plasma is to be kept—and alternating electric fields parallel to the axis of the cylinder can have beneficial effects.

SOLID STATE

Infrared from ferroelectrics

A ferroelectric material is a substance that can have a spontaneous electrical polarization. This means that the electric fields of its atoms can line up together even in the absence of an external electric field.

In the presence of an external electric field, the spontaneous polarization may line up either in the same direction as the external field or opposite to it, Drs. Yu. I. Balkarei and E. V. Chenskii of the Institute of Radio Engineering and Electronics of the Academy of Sciences of the U.S.S.R. write in the March 5 JETP LETTERS. When the direction of polarization is parallel to the external field, the situation is stable, they say; the antiparallel case is metastable and can be changed to the stable one by a field of a particular strength called the coercive field.

As this happens, the two Soviet scientists theorize, a transient state should occur in which the material's polarization oscillates around the direction of the external field before it settles down. This oscillation should generate electromagnetic radiation, and Drs. Balkarei and Chenskii conclude that if uniform polarization reversal can be accomplished, such a sample can serve as a source of short powerful pulses in the far-infrared range at frequencies that vary according to the temperature.