physical sciences

SOLID STATE

Superconducting hydrides

Some solid-state scientists hope to find substances that will be superconducting—capable of passing electric currents without resistance—at high temperatures. All known superconductors have transition temperatures above which they become ordinary conductors or nonconductors. So far the highest known transition temperatures are only about 20 degrees above absolute zero.

Theoretical speculation suggests that metallic hydrogen ought to be a high-temperature superconductor (SN: 6/27, p. 623). If this is so, then compounds of hydrogen and other metals in which the hydrogen concentration is high should also be candidates for high-temperature superconductivity. But studies of hydrides of niobium, vanadium, zirconium, titanium, lanthanum and the dihydride of thorium (ThH_2) have found no superconductivity.

There is, however, another hydride of thorium, which Drs. C. B. Satterthwaite and I. L. Toepke of the University of Illinois call the higher hydride (Th_4H_{15}). This, they report in the Sept. 14 PHYSICAL REVIEW LETTERS, is superconducting, but only at low temperatures, below 8.35 degrees K.

STELLAR ASTRONOMY

New class of infrared object

During observation at the University of Minnesota of the star AC Herculis, Drs. R. D. Gehrz and D. W. Strecker noticed that the star was particularly bright at the infrared wavelength 11.4 microns. This led Dr. Gehrz and Dr. N. J. Woolf to survey five stars of the class RV Tauri, to which AC Herculis belongs.

They found that some RV Tauri stars emit infrared over a broad band between 5 and 13 microns with a peak near 8.4. In the September ASTROPHYSICAL JOURNAL LETTERS they suggest that this radiation is produced as matter ejected from the star by shock waves condenses to form a solid circumstellar shell with a radius 25 times that of the star.

NUCLEAR PHYSICS

Possible violation of charge symmetry

The strong nuclear force, which binds nuclei together, is distinguished from the electromagnetic force, which holds atoms together, by three main characteristics. The strong force is stronger than the electromagnetic, has a much shorter range, and acts on the particles susceptible to it without being influenced by electric charge.

Evidence that casts doubt on the last characteristic, called charge symmetry, which is a basic ingredient of theories of nuclear structure, is reported in the Oct. 5 PHYSICAL REVIEW LETTERS by Drs. B. L. Berman, S. C. Fultz and M. A. Kelly of the Lawrence Radiation Laboratory in Livermore, Calif.

The evidence comes from an experiment in which helium nuclei were bombarded with photons. Such bombardment produces either free protons or free neutrons. If the strong nuclear force takes no notice of electric charge, the probability of producing neutrons should be equal to the probability of producing protons.

The Livermore experiment measured the probability of producing neutrons and found it considerably less than the probability of producing protons.

Drs. Berman, Fultz and Kelly suggest that the discrepancy is due either to a complicated and unexpected mixing together of isospin states (isospin is a number, with no simple physical meaning, that represents mathematically the difference between neutrons and protons) or to a component of the strong nuclear force whose action does depend on electric charge.

COSMOLOGY

Triangulating the universe

Modern cosmological theory predicts that the space of the universe is curved. In principle, the amounts and directions of curvature can be determined from the velocities and distances of the most distant objects known. The velocities and distances are determined from the brightness of the objects and their red shifts.

The method works in practice, says Dr. Steven Weinberg of the Massachusetts Institute of Technology, only if the matter in the universe is not under pressure and Einstein's theory of gravity is valid.

Since either of these assumptions may not be true, Dr. Weinberg suggests, in the September ASTROPHYSICAL JOURNAL LETTERS, that an independent determination of distances of galaxies and quasars by the method used on certain stars—triangulation or parallax—may help.

In the stellar case the star is observed from opposite ends of the earth's orbit. If it is near enough, there will be a change in its apparent position, and this change, the angle of parallax, can be used to draw a triangle that determines the star's distance. The more distant the star, the narrower the angle, so the method is limited to fairly close stars.

But if radio observations are used, the technique of very-long-baseline interferometry can measure extremely narrow angles. Dr Weinberg suggests using an artificial solar satellite and a radio telescope on earth as an interferometer to try to measure the parallax of quasars.

PLANETARY ASTRONOMY

Cubic crystals in the Mars atmosphere

Observers at the Lowell Observatory in Flagstaff, Ariz., and at the Central Observatory of the Ukrainian Academy of Sciences in Kiev have noticed an enhancement in the brightness of the planet Mars at times when the sun, earth and Mars were all in line.

In the September-October issue of SOVIET ASTRONOMY—AJ, Dr. V. D. Davydov of the Institute for Space Research of the Academy of Sciences of the U.S.S.R. suggests that the enhanced brightness may be due to corner reflectors in the atmosphere of Mars. Transparent cubic crystals would form corner reflectors, and Dr. Davydov suggests those on Mars are water ice.

By a series of internal reflections, corner reflectors act like a plane mirror on which light is shone perpendicularly: They reflect the light strongly back toward its source. Thus, says Dr. Davydov, Mars always reflects sunlight more strongly toward the sun than in other directions, and when the earth comes between Mars and the sun, the earth sees the enhancement.

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