physical sciences

OPTICS

Parametric conversion of X-rays

Parametric conversion of light is a process whereby a substance with appropriate properties changes a beam of light of one frequency into two beams of different frequencies. The sum of the outgoing frequencies is equal to the frequency of the incoming beam. Parametric converters can be used for optical tuning, to change the frequency of laser light, for example.

Drs. Peter Eisenberger and S. L. McCall of Bell Telephone Laboratories in Murray Hill, N.J., report in the March 22 PHYSICAL REVIEW LETTERS that they have observed parametric conversion of X-rays. A beryllium crystal oriented in a certain way, they say, splits a beam of X-rays at 17 kilo-electron-volts energy (4.1×10^{12} megahertz) into two beams of 8.5 keV (2×10^{12} megahertz).

The parametric change, they say, is accomplished by the free electrons in the beryllium, which are set into vibration by the incoming X-rays in such a way that they emit the lower frequency ones.

SOLID STATE

Chemical bonds and superconductivity

Physicists searching for high-temperature superconductors would like to have a reliable guide to promising materials. Superconductivity, the ability to pass electric currents without resistance, exists in certain metals only at temperatures near absolute zero—so far no more than 21 degrees above absolute zero.

Every such metal has a transition temperature below which it is a superconductor, and various relationships between the transition temperature and other properties of metals have been suggested. Dr. Bernd T. Matthias of the University of California at San Diego has suggested a relationship between the melting point of a metal and its superconducting transition temperature.

This has found little favor with theorists, says Dr. J. C. Phillips of Bell Telephone Laboratories in Murray Hill, N.J., in the March 8 PHYSICAL REVIEW LETTERS, because the small energy associated with temperatures around 10 degrees K. ought not to represent a significant contribution to the structural energy that determines melting points, usually around 1,000 degrees K.

Instead Dr. Phillips suggests that the transition temperature is related to the length of the bond between atoms in intermetallic compounds. He presents evidence to show that compounds with anomalous bond lengths have high transition temperatures.

NUCLEAR PHYSICS

Catastrophically unstable nuclei

All known atomic nuclei above atomic number 92 are unstable and subject to spontaneous fission. So far elements up to 105 have been manufactured in laboratories, and the heavier they are the less stable they seem to be.

Relative stability for these nuclei seems to depend upon the number of neutrons they have; the more neutrons, the more likely is fission. But theory holds a hope of greater relative stability when the neutron number passes 156. (None above 157 is now known.)

To check this a group from the Lawrence Radiation Laboratory led by Dr. E. K. Hulet looked for fermium 258 (100 protons, 158 neutrons). They report in the March 1 PHYSICAL REVIEW LETTERS that they believe they have found it, and that it shows that nuclei with even numbers of neutrons and protons that have more than 156 neutrons will have a catastrophic tendency to fission. Therefore, they say, few nuclei heavier than element 105 are likely to be identified until the next proton or neutron shell is filled, possibly at 114 protons and 184 neutrons.

PARTICLES

Quarks fail to show again

It is now more than a year since Dr. Brian McCusker of the University of Sydney reported he had found tracks of quarks, the hypothetical subparticles out of which all the physical particles are supposed to be built, in his cloud chamber.

The latest attempt to check this experiment is reported in the March 8 PHYSICAL REVIEW LETTERS by Dr. W. E. Hazen of the University of Michigan. He says he has found no possible quark tracks in 3,200 cloud-chamber photographs.

No other reported attempt to find quarks, whether in cloud chambers or elsewhere has yielded evidence of their existence.

PLANETARY PHYSICS

Possibility of antimatter micrometeories

Ball lightning is a puzzling phenomenon associated with thunderstorms. Unlike stroke lightning it is a spherical or globular glow that moves through the air and can enter buildings or aircraft.

Two English scientists, Drs. D. E. T. F. Ashby of the Culham Laboratory and C. Whitehead of the Atomic Energy Research Establishment Harwell, suggest in the March 19 NATURE that ball lightning may be caused by the annihilation of minute particles of antimatter in the atmosphere.

According to this explanation specks of antimatter of a few microns radius would arrive in the upper atmosphere as micrometeorites. Since there appears to be a small repulsion between matter and antimatter, the antimatter specks would not be annihiliated by collisions with matter so long as they were going so slowly that the impact could not overcome the barrier.

Ionized specks of antimatter would be negatively charged. Thunderstorms bring negative charge down toward the earth. They would thus bring the antimatter down into the lower air and at the same time accelerate it enough for annihilation. The glow of ball lightning would be caused by ionization of the surrounding air by the energy released in the annihilation.

The annihilation would also generate gamma rays of 511 kilo-electron-volts energy. Drs. Ashby and Whitehead have observed a number of ball-lightning effects and have found unusual gamma radiation in four instances. One of these appears to correspond to annihilation radiation, but, they say, one instance does not prove the hypothesis.