physical sciences

2.7-degree infrared background

For nearly a decade evidence has been building up indicating that the galaxy—and presumably the universe—is bathed in a background of electromagnetic radiation that has the spectrum of a blackbody at a temperature of 2.7 degrees K. Some theorists have taken this as evidence of a big-bang origin for the universe since a big bang would have produced such a background.

When observation was extended from the radio to the infrared range trouble arose for the blackbody idea. The first infrared measurements fell a good way above the 2.7-degree blackbody curve (SN: 11/30/68, p. 543). Now, from the Los Alamos Scientific Laboratory comes a report of infrared measurements that fall on the 2.7-degree blackbody curve.

The measurement was made by equipment flown on a rocket from the Kauai Test Range Facility in Hawaii and is reported in the Oct. 25 PHYSICAL REVIEW LETTERS by A. G. Blair, J. G. Beery, F. Edeskuty, R. D. Hiebert, J. P. Shipley and K. D. Williamson Jr.

A background spectrum at wavelengths between 0.8 and 6 millimeters was obtained and is consistent with the 2.7-degree blackbody, they say. They suggest that the earlier discrepant reading may arise from strong line emission at some wavelength between 0.8 and 1 millimeter from a source that has nothing to do with the blackbody.

Observing extrasolar planets

If any large optical telescopes are ever built in space—and there is much current talk of such things—planets belonging to other stars may be directly visible. The light from them will probably be too weak to do detailed studies of spectroscopic lines, Gregory Matloff of PHYSICS TODAY and Queens College writes in a forthcoming issue of ICARUS, but he suggests that the overall color of the images can tell something about them. Earthlike planets will appear bluer than their stars; those resembling Mars, Jupiter or Venus will be redder.

Electrical field limit and superheavy elements

In the original version of quantum electrodynamics, the theory of electromagnetic processes on the level of particle physics, the self-energy of the electron comes out infinite. (Since all parts of the electron are negatively charged, they are mutually repulsive; the self-energy or self-mass is generated by the electron holding itself together against this disruptive tendency.)

A number of attempts have been made to modify the theory so as to make the electron's self-energy finite. Several of these, especially one by Max Born and Leopold Infeld, require an upper limit to be placed on the strength that any electric field may have. The limit would run somewhere around one or two times 10^{18} volts per centimeter.

In the Oct. 4 PHYSICAL REVIEW LETTERS Johann Rafelski, Lewis P. Fulcher and Walter Greiner of the University of Frankfurt am Main suggest that if nuclei above atomic number 150 can be made, the energy levels and wave functions of electrons bound to them would be significantly different from the usual predictions if the field-limit theories are true. The same test could also be made in the collision of two heavy ions (say lead on lead) which would simulate superheavy molecules from the electron's point of view. The three physicists estimate that such an experiment could be feasible in one or two years.

Searching for transplutonian planets

Nine major planets are known to exist in the solar system. One of the continuing questions is whether there are any more. Since Pluto was discovered in 1930, none have shown up, but searches continue.

Theoretical astronomers attempt to predict locations of new planets by analyzing the motions of known planets to see if they show any effects that cannot be attributed to the influence of the sun or other known planets. Both Neptune and Pluto were predicted in this way. Anomalous motion of Mercury once led to suggestions of an intramercurial planet, but Einstein explained that discrepancy another way.

Several astronomers have suggested that there might be one or more transplutonian bodies since recent calculations have severely reduced Pluto's mass (SN: 8/28/71, p. 154). The position in which Pluto was found was predicted for a hypothetical planet with a mass 100 times Pluto's. The success seems to be coincidental and leads to suspicions that there may be more mass out there somewhere. P. K. Seidelmann of the U.S. Naval Observatory has made a theoretical search.

Seidelmann calculated orbits for the known outer planets including the influence of three different hypothetical transplutonians. The results, reported in the October ASTRONOMICAL JOURNAL, were so nearly identical to the observed orbits of the known planets that he concludes that if there are any transplutonian planets, their effects on the known planets are so small that their presence or absence cannot be detected by this type of calculation.

Liquid-crystal diffraction gratings

Liquid crystals are liquids in which the atoms are arranged in regular structures analogous to solid crystals even though the substance retains its liquid state.

Liquid crystals have a number of unusual optical characteristics. Certain liquid crystals of the nematic class (those with threadlike shapes) will form so-called domains of differing optical properties when they are placed in thin layers between electrically conducting glass plates and a particular threshold voltage is applied.

W. Greubel and U. Wolff of the Siemens AG in Munich have discovered that in certain of these substances the width of such domains is inversely proportional to the voltage applied over a range between the threshold and a high voltage at which the domains break up into turbulence. They report in the Oct. 1 APPLIED PHYSICS LETTERS that they used the substance called NLC N4 (a mixture of complex hydrocarbon compounds) at thicknesses of 3 to 10 microns between glass plates coated with transparent tin-oxide electrodes.

The domains of the nematic crystal form a diffraction grating whose spacing can be varied electrically and which can be made to have a very high diffractive efficiency, they say. They suggest that this property will find practical uses.