physical sciences

PLASMAS

Tokamak problems: heat loss . . .

One of the most promising recent developments in the effort to achieve controlled thermonuclear fusion is the device called Tokamak which was developed in the U.S.S.R. The original Tokamak did so well at confining a plasma of ions and electrons that great enthusiasm was aroused for building more tokamaks.

Continuing study shows that tokamaks have their difficulties as well as their successes. One of these, an anomalously high rate of heat loss, is reported by Dr. Lev A. Artsimovich of the Institute of Atomic Energy in Moscow in the Jan. 20 JETP LETTERS.

A tokamak plasma, Dr. Artsimovich says, tends to lose heat at a rate more than 10 times that estimated from the so-called neoclassical theory of plasmas. The heat loss is not connected with diffusion, the escape of plasma particles from the confining magnetic field, he says, because the heat loss happens much faster than diffusion. Nor is the heat carried away by electromagnetic radiation, neutral particles escaping from the plasma or the plasma ions.

It is an unusual thermal conductivity of the plasma electrons that causes the fast heat flow, Dr. Artsimovich concludes, and he derives a formula whereby the heat conductivity can be calculated from the frequency of collisions between electrons and ions and the average radius of the electron's orbits in the magnetic field.

PLASMAS

. . . and pressure limits

The tokamak experiments that have generated all the enthusiasm were performed with plasmas of very low pressure, Drs. A. A. Galeev and R. Z. Sagdeev of the Siberian Division of the Nuclear Physics Institute of the Academy of Sciences of the U.S.S.R. remind their colleagues in the Feb. 5 JETP LETTERS.

For economic controlled fusion, however, dense, high-pressure plasmas will have to be used. Drs. Galeev and Sagdeev therefore set out to determine the limits of plasma pressure possible in a tokamak configuration. Previous efforts in this line they say, were done according to the theory of magnetohydrodynamics (mhd), the behavior of electrically conducting fluids in a magnetic field. But at high temperatures, those of interest in planning for fusion, mhd theory no longer describes the plasma behavior, they say.

Drs. Galeev and Sagdeev calculate a formula for the limiting value of the pressure taking into account non-mhd considerations. They find the limit depends directly on the density of the plasma and its ion and electron temperatures and inversely on the square of the toroidal magnetic field. In two hypothetical examples that they calculate, the pressure limit comes out lower than in the mhd model.

ASTROPHYSICS

A variably magnetic white dwarf

Last year Dr. James C. Kemp of the University of Oregon developed a method of determining the magnetic fields of white dwarf stars by observing circular polarization of their light (SN: 10/3/70, p. 290). The method enables astronomers to find magnetic white dwarfs that do not have prominent lines in their spectra. The older method looks for splitting of spectral lines in the magnetic field, the Zeeman effect.

Several magnetic white dwarfs have been discovered by Dr. Kemp's method. One of these, catalogued as G195—19, has a polarization that varies periodically, Drs. J. R. P. Angel of Columbia University and J. D. Landstreet of the University of Western Ontario report in the May 1 ASTROPHYSICAL JOURNAL LETTERS.

The circular polarization of the light from this star varies with a period of 1.34 days. In the wavelength band between 3,800 and 5,400 angstroms the mean polarization is minus 0.224 percent, and the size of the variation is 0.250 percent. The most obvious interpretation of the observation, according to Drs. Angel and Landstreet, is that they are viewing a rotating white dwarf whose magnetic field is not symmetrical about the axis of rotation.

X-RAY ASTRONOMY

Possible line emission

Astronomers studying the emissions of celestial bodies in different ranges of the electromagnetic spectrum are always happy when they discover spectral lines, wavelengths brighter than the background spectrum. Spectral lines are valuable reference points for calculating the speeds of objects and the strength of their magnetic fields. The lines are usually produced by specific physical processes, and thus give clues to the presence of particular atoms or molecules, their temperatures, motions and other characteristics.

X-ray astronomers have discovered a diffuse cosmic background of X-rays, which, like white light, contains a wide range of wavelengths. In the May 15 ASTROPHYSICAL JOURNAL LETTERS Drs. Seth Shulman, Gilbert Fritz, John F. Meekins, T. A. Chubb and Herbert Friedman of the Naval Research Laboratory and Richard C. Henry of NRL and the Johns Hopkins University report a possible bright line superimposed on the continuous spectrum.

The radiation that seems to be a line appears at an energy slightly greater than six kilo-electron-volts (about two angstroms wavelength). The observers suggest that it may be generated when an iron nucleus in the cosmic rays captures two electrons.

RADIO ASTRONOMY

Southern sky survey

The southern sky is less well known to astronomers than the northern sky because there are fewer observers and observing stations. A prime way of making the sky familiar is locating and cataloguing various kinds of sources. For radio sources in the southern sky, the Parkes Catalogue of Radio Sources, made at the Parkes Observatory in Australia, is the usual reference.

A project to supplement the Parkes Catalogue by locating sources not listed in it has been started by the South African observatory at Hartebeesthoek. The first section, covering 30 percent, of the southern sky is expected to be complete this year.