PHYSICS

Shock Wave Created

High velocity shock waves, produced in nature by solar flares, have been duplicated for the first time in the laboratory, thus confirming a theory on the origin of magnetic storms.

SCIENTISTS have duplicated for the first time space shock waves that move at more than a million miles an hour from the sun to earth.

The laboratory-produced waves confirm a theory advanced six years ago by Prof. Thomas Gold, then chief assistant to the Astronomer Royal in Great Britain, and now at Harvard University.

Creation of the high-velocity waves was achieved at the Avco-Everett Research Laboratory, Everett, Mass., under the guidance of Dr. Arthur Kantrowitz, the Laboratory's director.

Shock tubes like that in which the waves were produced are being considered as a potential thrust device for space vehicles. The Avco shock tube produces such high temperatures with such a relatively small expenditure of power that it may be used in nuclear fusion research, the attempt to harness peacefully the power of the hydrogen bomb.

Prof. Gold told SCIENCE SERVICE that in nature the shock waves are produced by solar flares. During flares great "blobs" of ionized gas are ejected from the sun. They sometimes race toward the earth at up to two million miles an hour, preceded by a thin sharp wave front.

A front and the gas blob behind it compress the earth's magnetic field, and the gas feeds the Van Allen radiation belts. The ionized gas particles are captured in the belts, temporarily producing a tremendous increase in radiation. Such an increase, about 20-fold, was first detected by the Pioneer IV lunar probe a few days after a series of flares appeared on the sun.

The intense radiation in the Van Allen belts is believed a possible hazard to future space travelers. Now it is known that astronauts will have to dodge the highly charged gas balls thrown out from time to time by the sun.

Research leading to the achievement of the laboratory shock wave began in 1953 when Dr. Kantrowitz delivered a lecture in Cambridge, England, on the "dynamics of cosmical gas clouds." At the conclusion, Prof. Gold suggested that the existence of a shock wave would explain a long-puzzling phenomenon: the sudden commencement of magnetic storms simultaneously all over the earth. (Such storms disrupt radio communications.)

However, shock waves as then known involved collisions between molecules, and there were not enough molecules between the sun and the earth to transmit them. That is, a shock wave could only be propagated in a thick atmosphere in which molecules of gas bounced one against the next like billiard balls in a row.

This suggested a new shock propagating mechanism, perhaps involving magnetic fields, which allowed the formation of a previously unknown kind of shock wave in the extremely rarefied gases of interplanetary space. Using the analogous billiard balls again, if they were hundreds of feet apart it would be impossible to produce the same shock effect obtained when they are lined up one against the next. But, if they were surrounded by powerful magnetic fields, one ball could push another without ever touching it.

Somewhat later, Dr. Richard Patrick of the Avco-Everett Laboratory developed the electric shock tube that first demonstrated this new kind of space shock wave. Dr. Patrick told SCIENCE SERVICE the tube works in this way:

A rarefied mass of hydrogen gas at room temperature is contained in the 30-inch-long tube. The gas is tightly confined by a magnetic field on all sides but one. A four-billion-watt electrical impulse lasting two-millionths of a second is discharged into the tube. The gas temperature is suddenly raised to one-and-a-half million degrees and the hydrogeen is completely ionized (meaning the hydrogen atoms are stripped of their electrons). In this split second, the hydrogen ions are shoved a million miles an hour and a sharply defined shock wave front is produced by collisions of the ions' magnetic fields.

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ELECTRIC SHOCK TUBE—Drs. Arthur Kantrowitz and Richard Patrick of the Avco-Everett Research Laboratory and Prof. Thomas Gold of Harvard University (left to right) are shown with the electric shock tube in which interplanetary shock waves have been reproduced and speeds exceeding 1,000,000 miles per hour obtained.

CYTOLOGY

Cell's RNA Comes From Its Nucleus

THE CELL'S nucleus is pretty poor so far as its ribonucleic acid content goes.

However, studies of a mold indicate that all the cell's ribonucleic acid, or RNA, is formed in the nucleus and then migrates into the cell protoplasm later, Dr. M. Zalokar of Yale University's department of microbiology reports.

The mold was fed hydrogen-3 labelled uridine, an important constituent of RNA, and then centrifuged. When the hyphae then took their own pictures through the technique of autoradiographs, it was possible to trace the amount of RNA in various cell parts.

Most of the cellular RNA is in the microsomes, the so-called protein factories of the cell. Some is in the mitachondria, while none is detectable in remaining cytoplasm, fat, glycogen or cell vacuoles. The mitachondria contain enzymes used in the cell's oxidation of food.

"These findings suggest that ribonucleic acid is a direct product of gene action," Dr. Zalokar says. "Ribonucleic acid is formed in nuclei, the seat of chromosomes and genes; it migrates into the cytoplasm; and it is required for the synthesis of proteins."

Further details of the research with the mold *Neurospora crassa* appear in *Nature* (May 9).

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