ment of physics, a department of earth and planetary sciences or a department of oceanography. If such flexibility of program is not present in any one department of a university the student is now considering, the student should investigate the feasibility of an interdepartmental graduate program. Indeed, some universities have adopted interinstitutional programs to accommodate the recognized needs of their graduate oceanography students.

If a potential graduate student has a clear perception of what aspect of physical oceanography he wishes to pursue, say, the theoretical study of the generation of waves, then the above suggestions may well not be applicable.

Going beyond the scope of the questionnaire, we would suggest that a student interested in a career in oceanographic research would benefit from developing a dissertation topic related to the oceans, regardless of the formal title of the department in which he is a graduate student.

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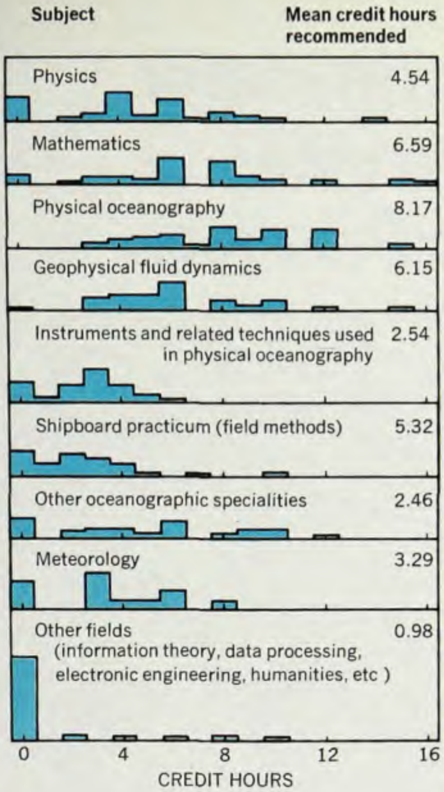

More laser fusion

The new report in the August issue (page 17) on the AEC laser-fusion program omitted mentioning the AEC's funded fusion program at Sandia Laboratories, Albuquerque, New Mexico. Following the organization of their laser program in the mid-1960's, Sandia was the first US laboratory to have a functional, high-energy, picosecond, Nd^{3+} glass laser (see June 1969, page 60). In 1969 Sandia reported the first confirmation of Russian experiments on neutron production by picosecond laser irradiation of LiD.

Subsequently, many laser plasma experiments have been performed at Sandia on a variety of LiD and $(CD_2)_n$ targets, including slabs and thin films, aimed at clarifying the physics of laser energy absorption and its transport into the target. In the course of this research, target-laser feedback was established as a major problem in laser fusion experiments. Means to circumvent it have been developed and laser-plasma experiments utilizing over 50 joules per pulse have been conducted with both picosecond and nanosecond pulses. The Sandia program is now moving rapidly toward a four-beam (Nd^{3+} glass rod) irradiation capability for spherical implosion experiments.

A principle goal of the Sandia research is the development of intense radiation sources utilizing hot, dense plasmas. The Sandia laser-fusion program has grown steadily to the present annual levels of about $3 million and a staff of 50 people.

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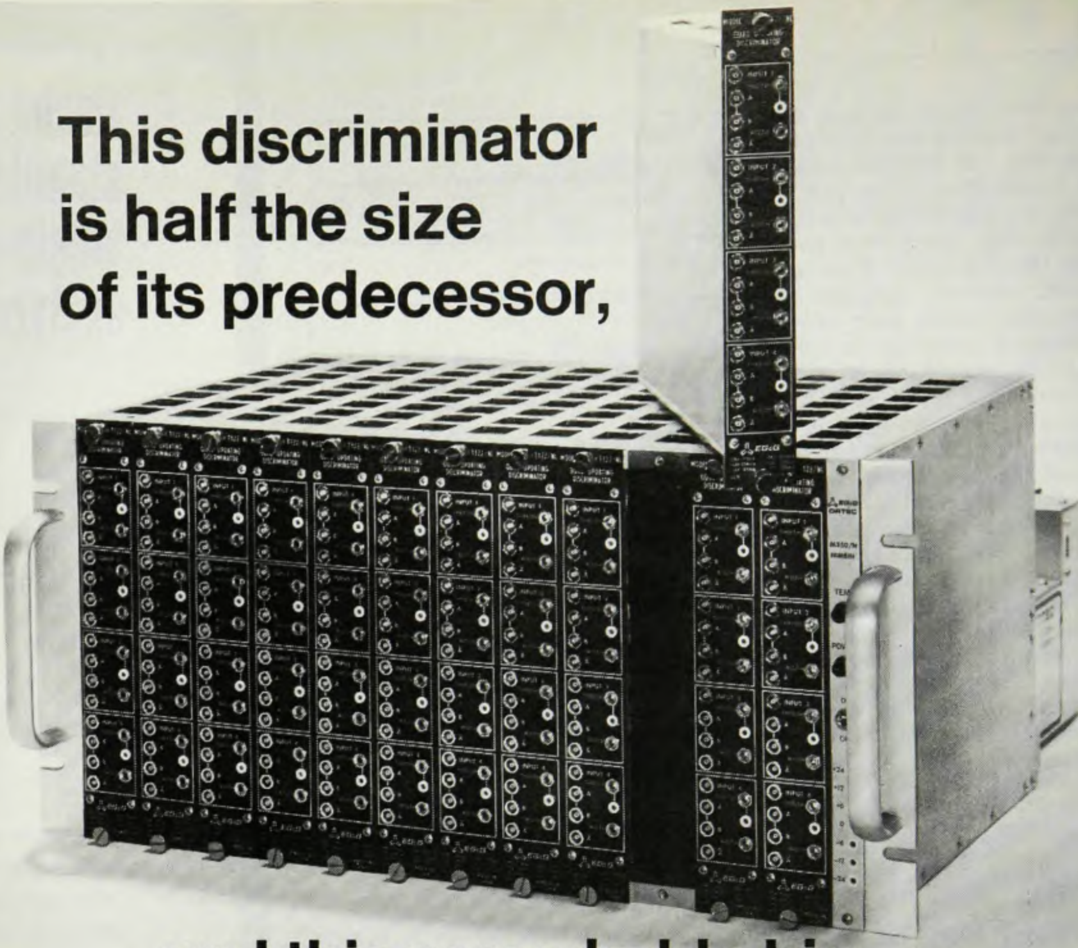
A charged Sun?

In a letter in the September 1971 issue (page 13), C. J. Ransom called for a careful examination of Velikovsky's work. One of the points mentioned concerns a net charge Q on the Sun, or in its atmosphere, arguments for and against which have been given.[1] It is worth remembering[2] that the validity of Maxwell's equations have not been established for distances greater than about 10^{10} cm.

Some information on $|Q|$ can be obtained from the perihelion motions of Mercury[3,4] and, more particularly, Icarus[5]: the force between Q and a dipole moment it induces results in a perihelion advance rate δ. The value 2.9×10^{28} esu for $|Q|$ would give, for Mercury, $\delta = 3.4$ seconds of arc per century, the same as the effect of the solar oblateness determined by R. H. Dicke and H. M. Goldenberg, but only if Mercury is regarded as a perfect conductor and screening is neglected. For Icarus, the observed[6] δ agrees with general relativity to within 20%. Hence[5] if general relativity is accepted, then, to



the extent that Icarus can be represented by a perfectly conducting sphere of density 3.5 gm/cm^3 (photometric observations have shown it to be nearly spherical), $f|Q|$ is less than 6×10^{27} esu, f being a screening factor. The corresponding limit obtained from Mercury is about 10^{28} esu.

These limits may be compared with values of $-Q$ of around 10^{27} to 10^{28} esu suggested by V. A. Bailey. These values correspond to an excess of one electron for each 10^{20} or 10^{21} nucleons. It is of interest to compare Bailey's charges with some geophysical quantities[7]: the mean charge in a lightning stroke is around 5×10^{10} esu and the Earth's negative surface charge is around 10^{15} esu.

Write Q as $\beta G^{1/2}M$ where G is the Newtonian gravitational constant and M is the mass of the charged body. The charge will modify the space–time metric; hence[4], with the Reissner–Nordström metric, the perihelion precession rate is multiplied by $(1 - \beta^2/6)$. In Bailey's work, $-\beta$ is around 10^{-3} to 10^{-2}, so the gravitational effects of Q are negligible. For a black hole, the maximum possible value of $|\beta|$ is one. For a proton β is approximately 10^{18}; for an electron β is approximately -10^{21}.

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Superconductors again

I would like to comment on the letter of W. A. Little (April, page 11), in which he has stated that "the absolute value of T_c is less important technologically than its value relative to what can be achieved economically." He has further suggested that "it would be far more worthwhile from the technological point of view to devote proportionally less effort to this dying approach of raising T_c and a much bigger effort to the goal of improving the efficiency of cryogenic refrigerators."

Absolute value of T_c is quite important if superconductivity is to be used as an inexpensive technique in big operations. Helium gas cannot be compared with hydrogen or neon in availability or cost of production; therefore high efficiency of a refrigeration system would not play a major role in cutting down the cost. Only liquid helium can be used for the superconductors having T_c below 20 K, but the discovery of the $Nb_3(Al\text{-}Ge)$ superconductor[1] (T_c = 21 K) has already brought T_c into the temperature range of liquid hydrogen (boiling point = 20.3 K). And G. W. Webb and his colleagues[2] have recently discovered a binary superconductor, Nb_3Ga, with a T_c of 20.3 K. An emphasis on efforts to raise T_c would give us a better superconductor in the temperature range of liquid hydrogen or even liquid neon (boiling point = 27.1 K). Of course there are problems in handling liquid hydrogen, but these can be solved. Therefore a 13% increase in T_c should not be considered a modest return in 17 years. At the same time it is not possible to develop technically better superconductors if the dying approach of raising T_c is not kept alive.

Apart from the technological question, this same effort has given us a lot of understanding about the basic mechanism of superconductivity. It is not possible to study the influence of various physical structural parameters over T_c without the synthesis of new superconducting materials. By no means is superconductivity a mature field and it is too early to give up all hope.

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THE AUTHOR COMMENTS: Khan is quite incorrect in stating that "only liquid helium can be used for the super-conductors having T_c below 20 K." This is an error which is often made and should be corrected. Closed-cycle refrigeration using helium *gas* are widely used to provide refrigeration in the 6–20-K region. Furthermore, hydrogen can and has been used as a cryogen down to about 14 K. It is not limited to 20 K as suggested by Khan. The 20-K figure, of course, is related to the normal boiling point of hydrogen at one atmosphere pressure. There is no pressing reason for a refrigerator system to be operated