the separation of the crystals was changed by many acoustic wave-lengths. In these attenuation measurements the direct signal from the transmitter was kept constant at a level above that of the highest output of the receiving crystal. Standing wave effects were not important in these measurements because the sound absorption was so high at the frequencies used.

The results of these measurements are summarized in Table I, which also shows some of the results obtained by earlier workers. Attenuation is ascribed entirely to absorption, largely on the grounds that the frequency-free attenuation coefficient (i.e., the attenuation coefficient divided by the square of the frequency) is very near the value of the frequency-free absorption coefficient given by the Stokes–Kirchoff formula, which is 5.1 for Hg. The data show no significant change in velocity or frequency-free absorption coefficient with frequency.

It is planned to extend this work to higher frequencies and to fluids other than Hg.

* Now at Engineering Research Associates, Inc., Washington, D. C.
[1] J. C. Hubbard and A. L. Loomis, Phil. Mag. 5, 1177 (1928).
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The Fission Cross Section of Np^{237}*

ERNEST D. KLEMA[1]
University of California, Los Alamos Scientific Laboratory, Santa Fe, New Mexico
May 28, 1947

THE fission cross section of Np^{237} has been measured for neutrons of energies from near thermal to 3 Mev by counting simultaneously the fissions from known foils of Np^{237} and U^{235}, placed back to back in a parallel-plate comparison chamber filled with pure argon.[2]

The source of monoenergetic neutrons in the energy range from near thermal to 1.67 Mev was the Wisconsin electrostatic generator, using the $Li^7(p, n)Be^7$ reaction with a Li target 60 kev thick. The 2.5-Mev and 3.0-Mev points were taken with the Illinois Cockcroft-Walton set, using the $D-D$ reaction with a thick heavy-ice target and an accelerating voltage of 200 kev.

The Np^{237} foil was prepared from material purified and analyzed by the Chicago Metallurgical Laboratory groups.

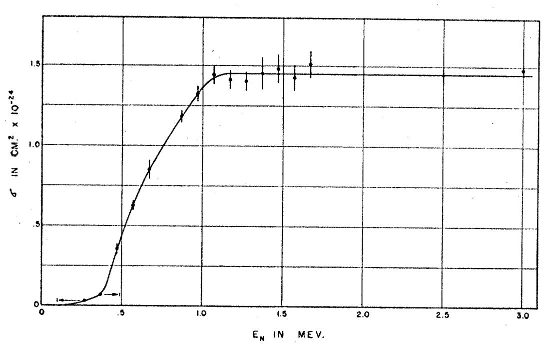

FIG. 1. The fission cross section of Np^{237} as a function of the incident neutron energy. The errors given are the statistical errors of counting. Because the errors of the two lowest energy points are so small, they have been drawn to the side and are the vertical lines at the heads of the horizontal arrows.

According to the analysis furnished us, the $1N$ sulfuric acid solution contained 100 micrograms of Np^{237} metal, about 0.05 microgram of Pu^{239} metal, and 50 micrograms of potassium as bisulfate. The solution was deposited in drops on a platinum foil by means of a micropipette and evaporated. Care was taken to transfer all the material in the solution to the foil, and the Np^{237} mass was taken as 100 micrograms.

Figure 1 gives the fission cross section of Np^{237} as a function of the incident neutron energy. For each point the statistical error of counting is given. For the points obtained with the electrostatic generator, the cross sections are given for the average neutron energy in each case. A correction was made for the Pu^{239} in the Np^{237} foil for the 270- and 370-kev points.

A point was taken with the electrostatic generator with a maximum primary neutron energy of 150 kev and a block of paraffin about $1\frac{7}{8}$ inch thick between the target and the comparison chamber. Using the ratio of cross sections of U^{235} and Pu^{239} at near thermal energy, and assuming the Np^{237} foil to contain 0.05 percent Pu^{239} by weight, the fissions from the Np^{237} foil obtained by this means can be more than accounted for by the fission of Pu^{239} in this foil. Thus no thermal fission was observed in Np^{237} within the accuracy of this experiment.

The cross sections given here for Np^{237} are based on the fission cross sections of U^{235}, U^{238}, and Pu^{239} as measured at Los Alamos.

* This paper is based on work performed under Contract No. W-7405-Eng-36 with the Manhattan Project at the Los Alamos Scientific Laboratory of the University of California.
[1] Now at the University of Illinois.
[2] Work on the relative cross section as a function of energy was carried out at Los Alamos by D. H. Frisch and K. Greisen prior to the measurements reported here.

Solar Magnetic Field and Diurnal Variation of Cosmic Radiation

H. ALFVÉN
Department of Electronics, The Royal Institute of Technology, Stockholm, Sweden
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THE effect of the solar magnetic field on the cosmic radiation, according to the Störmer theory, is that particles below a certain momentum $P_1=(a/r^2)(3-2\sqrt{2})$ (a = sun's moment, r = distance sun-earth) cannot reach the earth at all, whereas particles above a certain momentum $P_2=a/r^2$ can reach it from any direction. For momenta between P_1 and P_2 some orbits intersecting the earth's surface come from infinity, whereas others are periodic (or quasi-periodic) in the solar magnetic field. In the theory of the influence of the solar magnetic field on cosmic radiation proposed by Jánossy[1] and further developed by Vallarta,[2] Epstein,[3] and Rossi,[4] it is tacitly assumed that the asymptotic orbits possess full intensity whereas no particles move in periodic orbits.

This is not certain, however, because particles may be *scattered* from the asymptotic into the periodic orbits. Interplanetary dust, and also the electric fields associated with magnetic disturbances,[5] may produce scattering, but probably the most effective source is the magnetic field of the earth. In order to be scattered considerably a particle must approach the earth so closely that its radius of curvature, ρ, in the terrestrial magnetic field, H, is of the same order as the distance R to the earth's magnetic dipole (moment $=A$). If P is the momentum of the particle we have

$$R\approx\rho=P/H\approx PR^3/A,$$

or

$$R^2\approx A/P.$$

For $P=10^7$ gauss-cm (corresponding to $3\cdot10^9$ ev for electrons), and with $A=8\cdot10^{25}$ gauss-cm^3, we find for the scattering cross sections of the terrestrial magnetic field

$$S=\pi R^2=2.5\cdot10^{19}\text{ cm}^2.$$

If cosmic radiation is leaking with the velocity c through this "hole" in the screen of the solar magnetic field, the volume τ inside the "screen" will be filled after the time

$$T=\tau/Sc.$$

Putting $\tau\approx r^3$ (r = orbital radius of the earth) we find

$$T=0.5\cdot10^{10}\text{ sec.}$$

The number of particles in the periodic orbits is determined by the absorption in interplanetary matter during this time. If the density is ρ g/cm^3, the matter which the radiation passes in the time T is $D=cT\rho=1.5\cdot10^{20}\ \rho$ g/cm^2. According to Baumbach[6] the density in the outer corona is $\sim10^{-19}$ g/cm^3, and in interplanetary space the density must be much less. Consequently D is probably less than 1 g/cm^2, so that the absorption is small.

This seems to indicate that for momenta above P_1 cosmic rays reach the earth from all directions. Below P_1 all directions are forbidden unless scattering by the outer planets or other causes cause some of the weaker radiation to leak in.

Hence theoretically the solar magnetic field is not likely to produce a diurnal variation. Through a study of the trajectories, Malmfors[7] has shown that the observed solar time variations cannot be due to the solar magnetic field.

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The Magnetic Threshold Curves of Superconductors

JOHN G. DAUNT
Mendenhall Laboratory of Physics, Ohio State University, Columbus, Ohio

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IN a recent letter Stout[1] has ably summed up the evidence in favor of assuming that the magnetic threshold curves of superconductors are approximately parabolic functions of temperature, a suggestion that was put forward by Kok.[2] He has pointed out that a three-halves power function, as has been suggested recently by Sienko and Ogg,[3] cannot be supported by known magnetic or calorimetric data.

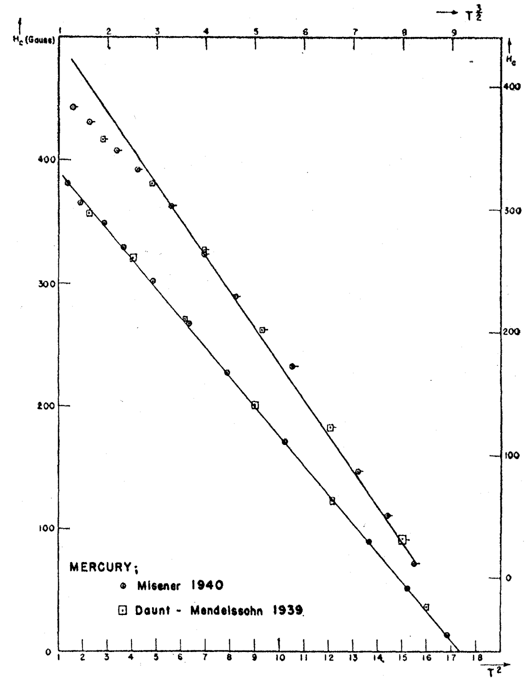

FIG. 1. The variation with temperature of the magnetic threshold of mercury.

As is well known, the magnetic transition of a superconductor is strongly dependent on small chemical or physical impurities. The significance of the latter effect has been emphasized recently by the experiments of Lasarew and Galkin[4] on tin specimens subjected to anisotropic stress. In view of these impurity effects, considerable care must be taken in assessing the magnetic measurements on various superconductors. Probably the material with the highest purity and smallest strain is mercury, as measured by Daunt and Mendelssohn[5] and by Misener,[6] the magnetic transition of which was found by these independent workers to agree within one percent. The temperature variation of the magnetic threshold field, H_c, in mercury, therefore, is given in Fig. 1. The lower curve plots H_c against T^2, which for a parabolic function should be a straight line. It will be seen that the measured points do not deviate from the straight line by more than ±4 gausses, a variation which, for the higher fields, is probably covered by the experimental error. The upper curve shows H_c plotted against $T^{3/2}$, which according to Sienko and Ogg[3] should be a straight line. It will readily be seen that the deviations of the measured points from a straight line are too systematic and too large to be covered by experimental error.

Similar curves have also been drawn up for other superconductors and all show that the $T^{3/2}$ function is the more unsatisfactory.

The immediate significance that can be attached to an exact formulation of the magnetic threshold curve is two-