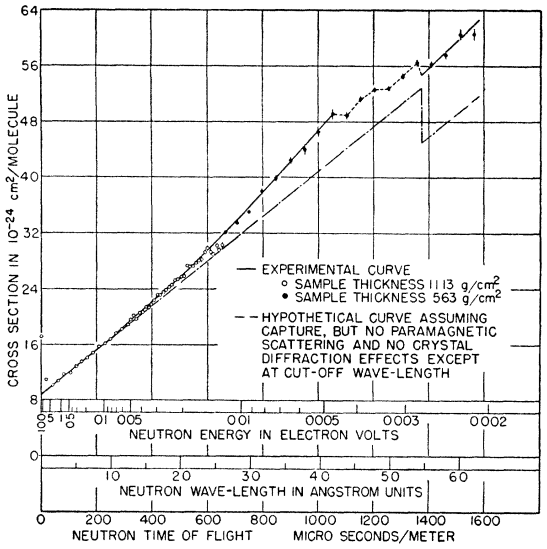

FIG. 2. The observed slow neutron total cross section of manganous fluoride compared with a hypothetical curve which neglects paramagnetic scattering.

$\Delta = 827$ for MnS which Van Vleck used as an example in his calculations), F for MnF_2 may not be too badly represented by the curve in Fig. 1.

The Columbia neutron velocity spectrometer[8] was used to obtain the transmission data shown in Fig. 2. For $\lambda > 3$A Be and BeO filters were used to eliminate perturbing effects caused by faster neutrons. Since paramagnetic scattering is incoherent with respect to nuclear scattering, we may separate the two types of scattering in regions where there are no interfering crystal diffraction effects. To aid in such a separation, the hypothetical curve shown in Fig. 2 was constructed by extending to 5.46A the experimental curve between 0 and 1.0A. The equation

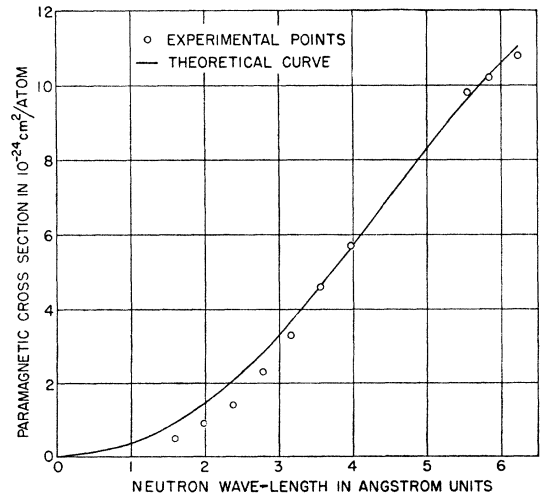

FIG. 3. Experimental values of the paramagnetic scattering cross section of Mn^{++} in manganous fluoride compared with a theoretical curve calculated on the basis of elastic scattering.

of the line so obtained is given by $\sigma = (8.7 + 2.31E^{-\frac{1}{2}})$, which agrees well in slope and intercept with reported data[8,9] for Mn and F. For simplicity, we assume that there is no loss of coherent scattering in the hypothetical curve up to 5.46A, the cut-off wave-length for Bragg reflections for MnF_2.[10] Beyond the cut-off the equation of the curve is given by $\sigma = (1.0 + 2.31E^{-\frac{1}{2}})$; the assumed residual incoherent scattering cross section of 1.0 barn appears to be a justifiable approximation on the basis of other studies carried out here. The difference between the experimental and hypothetical curve (Fig. 2) in the regions 0 to 4.2A and 5.5 to 6.2A was taken as the paramagnetic cross section. No analysis was made in the intermediate region, where the experimental curve indicates marked crystal diffraction effects. Figure 3 shows the values of σ_{pm} obtained in this way, as well as a theoretical curve calculated from Eq. (1) using values of F taken from Fig. 1 with r_0 set equal to 0.82A so as to give the best fit. The dependence of σ_{pm} on λ is seen to have the predicted form.

A similar investigation of the paramagnetic scattering of MnO, MnS, $MnBr_2$, MnI_2, and $MnSO_4$ is now under way. It is hoped that the variation of σ_{pm} with λ observed for this series of compounds of different magnetic dilution will shed some light on the nature of exchange coupling forces between ions in paramagnetic solids.

The authors wish to express their appreciation to Professor O. Halpern, who suggested this problem, for his valuable advice and criticism. They are also indebted to Professor F. Seitz for helpful discussions and to Professor J. R. Dunning for his interest and encouragement.

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The Theory of Statistical and Isotropic Turbulence

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January 24, 1949

IN two recent papers Heisenberg[1] has developed the theory of locally isotropic turbulence (in the sense of Kolmogoroff) by incorporating the idea that the energy dissipated by the eddies of the various sizes is constant along the hierarchy of eddies which is present in a turbulent fluid. Analyzing the velocity field in a Fourier series, Heisenberg obtains the expression

$$S_k = 2\left\{\mu + \kappa\rho\int_k^\infty dk''k''^{-3/2}\sqrt{F(k'')}\right\}\int_0^k dk'k'^2F(k'), \quad (1)$$

for the loss of energy of that part of the spectrum that is contained between the wave numbers $k=0$ and k. In (1), μ is the coefficient of viscosity, ρ is the density, κ a number of order unity (~ 0.8), and $\rho F(k)dk$ is the energy contained between the wave numbers k and $k+dk$.

Under stationary conditions S_k is independent of k and this constancy of S_k determines the spectrum of turbulence, $F(k)$. Heisenberg discusses the condition

$$S_k = \text{constant}, \tag{2}$$

and derives the correct asymptotic behaviors of $F(k)$. However, it can be shown that the condition (2) leads to the following explicit solution for $F(k)$:

$$F(k) = F(k_0)\left(\frac{k_0}{k}\right)^{5/3} \frac{(1+C)^{4/3}}{[C+(k/k_0)^4]^{4/3}}, \tag{3}$$

where c is a constant given by

$$3/4c(1+c)^{\frac{1}{2}} = \mu/\kappa\rho[k_0/F(k_0)]^{-\frac{1}{2}}. \tag{4}$$

For large Reynolds numbers (to which, alone, this theory is applicable) c is a very large member. Accordingly, defining

$$k_s = k_0 c^{\frac{1}{4}}, \tag{5}$$

we can rewrite the solution (3), to a sufficient accuracy, in the form

$$F(k) = F(k_0)(k_0/k)^{5/3}[1+(k/k_s)^4]^{-4/3}. \tag{6}$$

This solution is to be contrasted with the expression

$$F(k) = F(k_0)(k_0/k)^{5/3}[1+(k/k_s)^{8/3}]^{-2},$$

suggested by Heisenberg as a suitable "interpolation" formula. The use of (6) modifies some of the numerical results of Heisenberg, but the physical picture is, of course, unaltered.

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Some Characteristics of Antimony (125)*

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THE radiations of the 2.7-year Sb^{125} have been investigated by Stanley and Glendenin[1] who report two beta-ray spectra having end points at 0.3 and 0.7 Mev, the intensity ratio being 65:35. Friedlander, Goldhaber, and Scharff-Goldhaber[2] have found a 60-day daughter activity, emitting conversion electrons and x-rays, which they have assigned to an isomer of the stable tellurium (125).

The activities discussed in this letter were obtained when metallic tin was irradiated by slow neutrons in the Oak Ridge pile. After aging for four months, the irradiated tin was dissolved in aqua regia and carrier antimony and tellurium in $3N$ HCl solution were added to the tin solution. Metallic tellurium was precipitated from a hot 10 percent HCl solution with SO_2 and removed by filtration. Metallic antimony was precipitated from the filtrate with iron powder after the excess SO_2 was removed. To insure high purity, both the tellurium and antimony precipitates were dissolved in aqua regia and reprecipitated with SO_2 and iron powder as before.

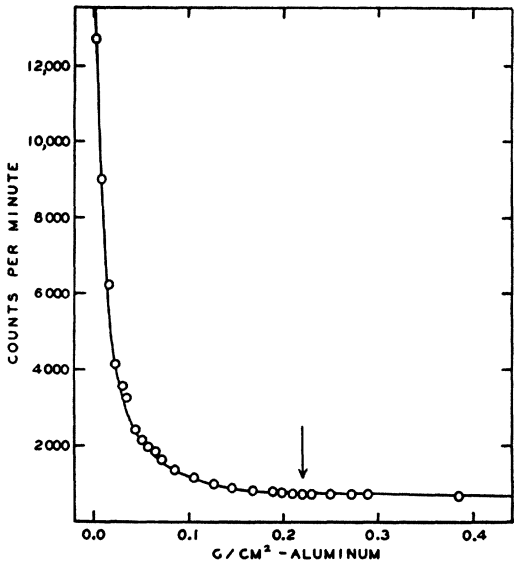

FIG. 1. Absorption in aluminum of the beta-rays of Sb^{125}.

The beta-rays of the 2.7-year antimony were absorbed in aluminum as shown in Fig. 1. The end point, 220 mg/cm², corresponds to a maximum energy of 0.704 Mev as calculated by Feather's equation. The beta-gamma-coincidence rate of Sb^{125} is plotted in Fig. 2 where it seems to be independent of the beta-ray energy. This would suggest a simple spectrum. However, there is evidence to the contrary.[3] Since the coincidence rate of Fig. 2 is constant out to the end point of the 0.704-Mev beta-ray group, it

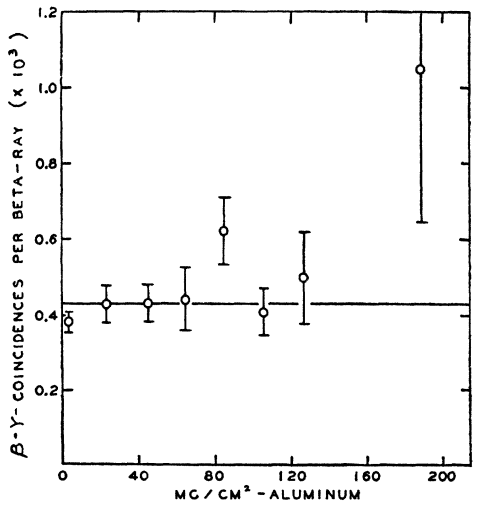

FIG. 2. Beta-gamma-coincidence rate of Sb^{125} as a function of the surface density of aluminum placed before the beta-ray counter.