nance ($\Gamma=0.115$ ev).[9] A sheet of cadmium 0.056 cm thick, whose surface made an angle of 24° with the beam, scattered neutrons into a boron-lined counter. The counter subtended about 15 percent of the $4\pi$ solid angle. Scattered neutrons making angles between 35° and 160° with the forward direction could be detected. The geometry was calibrated using an iron scatterer for which $\sigma_{\text{scat}}{}^{10}=10.3\times10^{-24}$ cm$^2$.

Counting rates were very low. Despite bulky shielding of the counter and scatterer the scattering was small compared to the fast neutron background in the pile room. It seems probably that a complete scattering resonance could not be measured in a reasonable time without extensive redesign of the shields and counters.

A total of 5372 counts from the cadmium and 5040 background counts were recorded during equal counting times. Corrections were made for the scattering of higher energy neutrons in the beam, for air scattering, and for absorption of scattered neutrons by the scatterer itself. The scattering chamber was lined with cadmium to eliminate double scattering from the beam to the chamber walls and into the counter. The cross section was found to be $40\pm15\times10^{-24}$ cm$^2$ referring to the normal isotopic mixture. Approximately half the indicated error is the probable error from the counting statistics. The other half represents an uncertainty in the corrections. Only the correction for absorption by the scatterer was large. It was not calculated more accurately because of the large and somewhat poorly defined solid angle subtended by the counter.

Recent work[9] has shown that the cadmium total resonance is accurately fitted by a one-level Breit-Wigner formula with $E_R=0.176$ ev and $\sigma_T=7200\times10^{-24}$ cm$^2$. $\text{Cd}^{113}$ (abundance 12.3 percent, spin $\frac{1}{2}$) is known[11] to be the active isotope. If the spin of the compound nucleus is known, these data permit a calculation of the resonance-scattering cross section. Conversely, if the scattering cross section is measured, the spin may be determined.

The following equation,[12] valid when the scattering is small compared to the absorption, relates the quantities in question.

$$\sigma_S=\frac{\sigma_T{}^2}{f_A}\frac{E_R}{1.3\times10^{-18}\left(1\pm\dfrac{1}{2i+1}\right)}.$$

$\sigma_T$ is the maximum total cross section at a resonance, and $\sigma_S$ the maximum elastic scattering cross section at the same resonance. Both cross sections are measured in cm$^2$ and refer to the normal isotopic mixture. $E_R$ is the energy of the resonance in electron volts, $f_A$ is the fractional abundance of the active isotope, and $i$ is its spin. The plus or minus sign in the denominator is to be used accordingly as $J$, the spin of the compound nucleus, is $i$ plus or minus one-half. One calculates from this equation $\sigma_S=114\times10^{-24}$ cm$^2$ if $J=0$, and $\sigma_S=38\times10^{-24}$ cm$^2$ if $J=1$. To each of these must be added a potential scattering cross section[9] of $5.3\times10^{-24}$ cm$^2$.

The comparison of the measured and calculated cross sections is not seriously complicated by crystal effects. Because of the spin and low isotopic concentration of $\text{Cd}^{113}$, more than 90 percent of the predicted Breit-Wigner resonance scattering will be isotropic. The potential scattering depends on the properties of all the isotopes, and a larger fraction might be expected in the Bragg reflected component. These considerations introduce smaller uncertainties than arise from the measurement of the cross section. They do not affect the conclusion that the scattering is in satisfactory agreement with the assignment $J=1$ to the compound nucleus and in definite disagreement with $J=0$.

I wish to thank Mr. W. Sturm and Mr. G. Arnold for their assistance with the spectrometer and Mr. R. Sternheimer for several helpful discussions on coherence and incoherence in neutron scattering. The following formula, relating the isotropic part of the resonance-scattering cross section to that calculated from the Breit-Wigner relations, is from an unpublished investigation of Mr. Sternheimer's.

$$\sigma_{\text{isotropic}}=\left[1-\frac{2J+1}{2(2i+1)}f_A\right]\sigma_S.$$

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* On leave from the University of Wisconsin.

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## Rotors Driven by Light Pressure*

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In a series of experiments[1] on the production of very intense centrifugal fields it was found that the frictional drag on a magnetically suspended spinning spherical rotor could be accounted for almost entirely by gaseous friction even when the pressure surrounding the rotor was as low as $10^{-6}$ mm Hg. For example, when a magnetically supported 1.59-mm rotor spinning at about 100,000 r.p.s., in air at a pressure of $2\times10^{-6}$ mm Hg, was allowed to "coast" (without the driving torque applied) it required about an hour for it to lose 0.1 percent of its rotational speed. The existence of this exceedingly low frictional torque suggested that it might be possible to drive magnetically suspended rotors in a good vacuum by light pressure directed tangentially on the periphery of the rotor. It is well known that the pressure of sunlight is roughly $4.5\times10^{-5}$ dyne per cm$^2$ at the surface of the earth. Consequently, if a few cm$^2$ of sunlight directed tangentially on the periphery of, say, a 1.59-mm spherical rotor could be completely absorbed, it should be possible to drive the rotor to its explosion speed if the air pressure surrounding the rotor is less than $5\times 10^{-7}$ mm of Hg.

In order to determine whether or not rotor acceleration could be obtained by light pressure, light from a 100-watt concentrated arc-type lamp was focused by a large short focus lens and auxiliary mirror on the periphery of a magnetically suspended 1.59-mm rotor surrounded by air at a pressure of about $10^{-6}$ mm Hg. One-half of the spherical rotor was blackened and the other half left polished so that the speed of the rotor could be measured. The light was directed tangentially on the periphery of the rotor near the two ends of a diameter in such a manner as to exert a couple. If the rotor was spinning a few revolutions per sec., it was observed to accelerate when the light was applied. Experiments also were carried out with small cylindrical rotors both with and without small Duraluminum vanes, and acceleration, although sometimes small, was observable. Also the rotors could be started from rest or could be decelerated and their direction of rotation reversed. In order to start the rotors from rest by this method, it was found desirable to use "soft" iron rotors so that the magnetic axis of the material could be made to align itself automatically with the mechanical axis of rotation. However, the soft iron is not necessary when the rotor is once spinning.

It is believed that the acceleration of the rotors definitely was due to light or radiation pressure since, in the case of the symmetrical rotors, the radiometer effect should be practically eliminated. Also, at the pressures of $10^{-6}$ mm Hg used in these experiments Tear[2] found that the radiometer effect was very small. The fact that the radiometer effect should be either practically eliminated or reduced to a small value for a symmetrical spinning rotor suggests that it might be possible to obtain a precise measure of the pressure of light as well as of the angular momentum of light by this method. It is planned to investigate these possibilities further.

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