

Separation of isotopes in the gas phase is possible by the method of "evaporative centrifuging" used by Beams and Skarstrom⁶ and by Humphreys.⁴ The Lindemann-Aston separation factor is proportional to $\exp [1/T]$. I have therefore attempted to obtain a relatively large separation of the chlorine isotopes by using hydrogen chloride just above its melting point in a Beams centrifuge. The rotor was cooled to -98°C and the vapor from the liquid HCl was pumped through the hollow spindle which formed the axle. (See reference 6 for details.) Although no analysis by the mass spectrograph of the fractions was made, the operation of the centrifuge at low temperature was demonstrated. The theoretical isotopic separation coefficient which is 1.11 at room temperature, becomes 1.25 just above the solidification temperature of hydrogen chloride if the rotor velocity is 5×10^4 cm/sec. at the boundary of the liquid-gas phase. This velocity is the highest practical in "evaporative centrifuging" with hollow rotors.

The substitution of hydrogen chloride for carbon tetrachloride results in a decrease in molecular mass and a three-hundred-fold increase in ratio of gas pressure at the rotor center to that at the gas-liquid boundary. Under these conditions the time for equilibrium across a radial sector of the rotor is reduced and an increased rate of removal seems practical. If then the centrifuge is employed to separate isotopes, it would appear advantageous to use the hydrogen halides near their melting points to effect a partial separation of large amounts of chlorine and bromine isotopes.

Research Laboratory,
General Electric Company,
Schenectady, New York,
February 7, 1940.

H. C. POLLOCK

- ¹ J. Joly and J. H. J. Poole, *Phil. Mag.* **39**, 372 (1920).
² R. S. Mulliken, *J. Am. Chem. Soc.* **44**, 1033 (1922); **44**, 1729 (1922).
³ J. H. J. Poole, *Phil. Mag.* **41**, 818 (1921).
⁴ R. F. Humphreys, *Phys. Rev.* **56**, 684 (1939).
⁵ M. J. Polissar, *J. Chem. Phys.* **6**, 833 (1938).
⁶ J. W. Beams and C. Skarstrom, *Phys. Rev.* **56**, 266 (1939).

Observations on the Dark Current of a Willemite Crystal

Some time ago the photoconductivity of a single crystal of willemite was investigated at low temperatures.¹ Several times during this study it was noticed that the dark current showed a sudden large increase at about -60°C while the crystal was warming up with the field on, and then fell to its very low initial value. Subsequent studies on this crystal showed that this effect is obtained when the crystal is illuminated with ultraviolet light at low temperatures with field on (in our case 2000 volts/cm) and then allowed to warm up in the dark. However, if the crystal is depolarized and then warmed up in the dark with the field on, the effect observed was only about 1/100 of that obtained when the crystal was initially illuminated as described above. This small effect is probably due to the fact that the crystal was not completely depolarized. Since the rate of warming up could not be controlled conveniently with the present arrangement for cooling the crystal, no quantitative measurements were made concerning the dependence of dark current on temperature, time, and exposure to ultraviolet light. This phenomenon was observed for both λ 2537Å and λ 3125Å. It would doubtless

occur for the whole range of wave-lengths for which the crystal exhibits photoconductivity. Similar results were found when electrical contact was made with either gold (sputtered) or Aquadag electrodes.

We feel that this dark current effect is probably connected with the emission of trapped light reported by Johnson.² Further experiments are indicated, such as simultaneous observations of dark current and fluorescence.

We hope to publish a more detailed account of experiments on photoconductivity and absorption of crystalline willemite in the near future.

Palmer Physical Laboratory,
Princeton, New Jersey,

R. C. HERMAN

Randal Morgan Laboratory of Physics,
University of Pennsylvania,
Philadelphia, Pennsylvania,
April 29, 1940.

R. HOFSTADTER

- ¹ R. Hofstadter and R. C. Herman, *Phys. Rev.* **56**, 212 (1939).
² R. P. Johnson, *J. Opt. Soc. Am.* **29**, 387 (1939).

Resonance Scattering of Neutrons in Helium

Experiments of Staub and Stephens¹ on the scattering of neutrons in helium have shown that resonance occurs for neutrons of about one Mev, arising from the existence of a virtual P level of He⁵.² This resonance raises the ratio of the forward scattering cross sections of helium and hydrogen from 1.4 to 2.5 Mev to about 9 at 1 Mev. We have investigated the resonance scattering more closely by using a continuous neutron spectrum. This was produced by allowing the monochromatic neutrons of a dd generator to strike a paraffin howitzer of suitable shape, where, by elastic collision the neutrons lost part of their original energy. The howitzer was shaped so as to give a continuous neutron distribution which was almost uniform from 0.6 to 2.0 Mev. This distribution was determined by the scattering of the neutrons in a cloud chamber filled with methane. The shape of the resonance curve over this region has been measured in 0.1-Mev intervals by using the same cloud chamber technique as described by Staub and Stephens. From our results we conclude that the level of He⁵ has a width at half-maximum of 0.4 Mev. The shape of the resonance peak of the scattering cross-section curve indicates a doublet structure of the two levels $J = \frac{3}{2}$ and $J = \frac{1}{2}$ with a splitting of 0.24 ± 0.1 Mev. Since the more intense peak occurs at the lower energy and corresponds to $J = \frac{3}{2}$ the doublet is inverted. The $\frac{3}{2}$ level is unstable against decay into a neutron and an α -particle by 0.76 Mev and the $\frac{1}{2}$ level by 1.0 Mev. The shape and the absolute values of the resonance scattering cross-section curve are within the experimental error in agreement with the predictions of the dispersion theory derived for this particular case by Bloch.³ The previous experimental data of Staub and Stephens fit into the present curve within the statistical error. A full account of the experiments will be published shortly.

Stanford University,
Stanford University, California,
April 21, 1940.

H. STAUB
H. TATEL

- ¹ H. Staub and W. E. Stephens, *Phys. Rev.* **55**, 131 (1939).
² J. H. Williams, W. G. Shepherd and R. O. Haxby, *Phys. Rev.* **52**, 390 (1937).
³ F. Bloch, to be published soon.