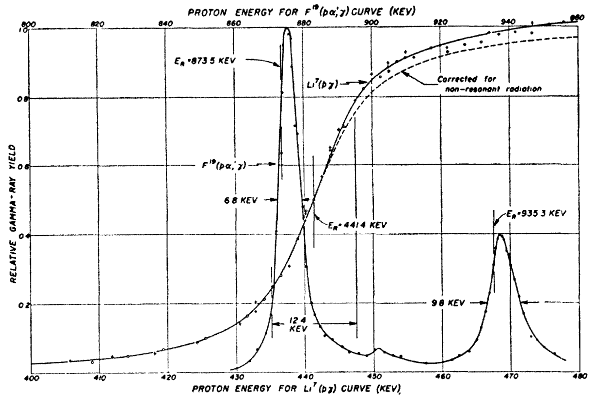

FIG. 1. Excitation curves for the reactions $F^{19}(p\alpha',\gamma)$ and $Li^7(p\gamma)$. In the fluorine reaction a target of 4.2 kev equivalent thickness for protons was used while in the lithium reaction a thick target was used.

value of 477.4±1.0 kev. From measurements on the energy of the protons inelastically scattered by Li^7 to be discussed in more detail in a forthcoming publication we find a value of 479.0±1.0 kev.[13] We have also measured the yield of the radiation following the inelastic scattering. The excitation curve from this reaction has been corrected for penetration factors for the incident and scattered protons and indicates a broad level in Be^8 at 1030±5 kev, superimposed on a continuous non-resonant background. The number of inelastically scattered protons has been measured at 1240 kev and the cross sections per 4π-steradians are 6.5×10^{-26} cm² at 81.1° and 3.6×10^{-26} cm² at 137.8°. The gamma-ray measurements which average over all angles give 5.7×10^{-26} cm² at this energy.

This work was assisted by the joint program of the ONR and the AEC.

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Thermal Conductivity of Glasses at Low Temperatures

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It was first shown by Debye[1] that for solid non-metals the heat conductivity, K, can be expressed in terms of a mean free path of the heat waves, Λ, by the equation $K=\text{const.}\times c_v q\Lambda$, where c_v is the heat capacity per unit volume and q is the average velocity of the waves. By applying this equation to the results of previous experiments on glasses, using the value of $\frac{1}{4}$ for the constant, the values of Λ in the neighborhood of room temperature were found to be of the order of the interatomic distances. Since q varies little with temperature, the thermal conductivity should vary as the specific heat. The few previous experiments in the hydrogen and helium regions,[2] however, had shown that at lower temperatures the heat conductivity did not fall as rapidly as the specific heat. From this it was deduced that the mean free path of the heat waves increased as the wave-length of the dominant waves became larger than the interatomic distance.

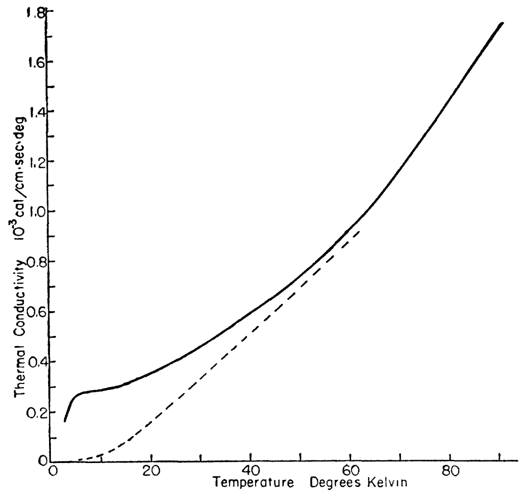

FIG. 1. Thermal conductivity of quartz glass as a function of absolute temperature. Dotted curve shows the specific heat in arbitrary units.

The present experiments were made in order to obtain continuous curves, for each specimen, of the variation of heat conductivity with temperature in the region between 2° and 90°K, from which the variation of mean free path with temperature could be calculated. Since the interpretation of the thermal conductivity of glasses has recently been discussed by Kittel,[3] it seems worth while to give a preliminary report on the results obtained for glass in the present experiments. Two kinds of glass were measured—quartz glass and Phoenix glass (a Pyrex type glass). The values for the two glasses differed by only a few percent over the whole range, and since the specific heat of Phoenix glass has not yet been measured, only the results for quartz glass are shown in Fig. 1. The deviation from proportionality to the specific heat can be seen from the dotted curve, which shows the specific heat[4] plotted in arbitrary units.

The temperature variation of the mean free path is shown in Fig. 2. At the lowest temperature at which measurements were made, 2.5°K, the mean free path is about 6×10^{-5} cm and is roughly proportional to the inverse square of the absolute temperature. If this temperature dependence continued down to lower temperatures, the mean free path would only be comparable with the dimensions of the specimen at about 0.025°K.

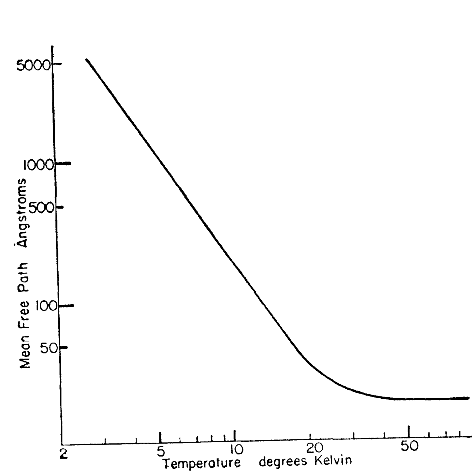

FIG. 2. Mean free path of heat waves in quartz glass as a function of absolute temperature.

In marked contrast to this is the conductivity of a rod of microcrystalline graphite which has also been measured. Over the whole temperature region below 90°K the mean free path is limited by the grain size, which is of the order of 100A. The specific heat is lower than that of quartz glass owing to the high Debye temperature. As a result of these two factors, the conductivity at 90°K is about 80 times greater, while at 1°K it would be about 50 times less than that of glass. This may be of practical interest for the temperature region obtained by magnetic cooling.

A fuller account of these experiments will be given elsewhere. Theoretical work on the conductivity of glasses at low temperatures is being carried out in this laboratory.

I wish to thank Professor F. E. Simon for his interest and advice.

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Energy Levels in N^{15} and N^{16}

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The experimentally determined mass values of N^{16} have shown large discrepancies. The latest values[1,2] as determined from the ground state Q-value of the $F^{19}(n,\alpha)N^{16}$ reaction and from the maximum β-decay energy of N^{16} still show differences of 0.7 mMU. An independent determination of this mass has been made from a study of the $N^{15}(d,p)N^{16}$ reaction. In connection with their photographic work on the scattering of 6.5-Mev deuterons by nitrogen, Guggenheimer, Heitler and Powell[3] found proton groups corresponding to new higher excitation levels in the N^{15} nucleus. A check of these excitation levels has been made using the counters described by Martin[4] for proton detection.

Ammonium nitrate containing 61.5 atom percent of N^{15} in the ammonium radical was obtained from the Eastman Kodak Company. The ammonia was released by reaction in an evacuated system with an aqueous solution of sodium hydroxide. The resulting ammonia gas so obtained was dried with potassium hydroxide to remove the water vapor. The first runs were taken at an observation angle of 90° using a target gas pressure of 20 cm of Hg. The results obtained for both a normal ammonia target and the enriched target at ranges beyond the alpha-particle groups arising from the associated $N^{14}(d,\alpha)C^{12}$ reaction are shown in Fig. 1. It is evident that no proton groups attributable to the $N^{15}(d,p)N^{16}$ reaction are present in this absorption interval. However, a proton group from this reaction has been found at shorter ranges as shown in Fig. 2. The proton group was deduced by normalizing the unenriched target data to the enriched target data and subtracting the former from the latter. The normalization factor was the ratio of the N^{14} present in the enriched target to that in the unenriched target; the numerical value was obtained from the relative heights of 7.2-Mev excitation proton groups and the long range alpha-particle groups. It will be noticed that there is good evidence that the group is double with the higher state at approximately 0.3-Mev excitation. Other data taken at 30° and 90° did not show the two groups as well resolved as shown in Fig. 2; however, all data did show evidence that the group is double. Using the longest range component an average ground state Q-value of 0.23±0.15 Mev is obtained for the $N^{15}(d,p)N^{16}$ reaction. If the mass values of Flugge and Mattauch[5] are used for proton, deuteron, and N^{15} a mass value of 16.01121±0.00023 MU is obtained for N^{16}.

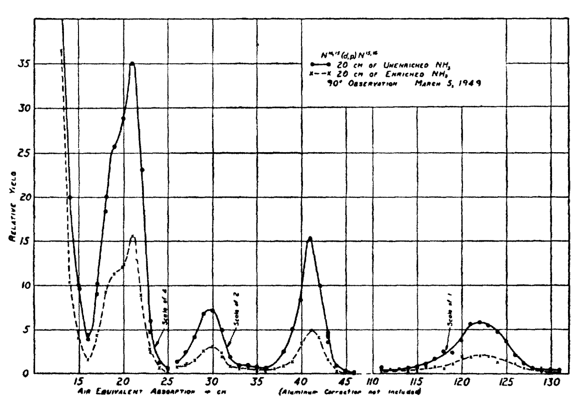

Fig. 1. The atom percent of N^{15} in the enriched target was 61.5 percent. Deuteron bombarding energy was 3.32 Mev.

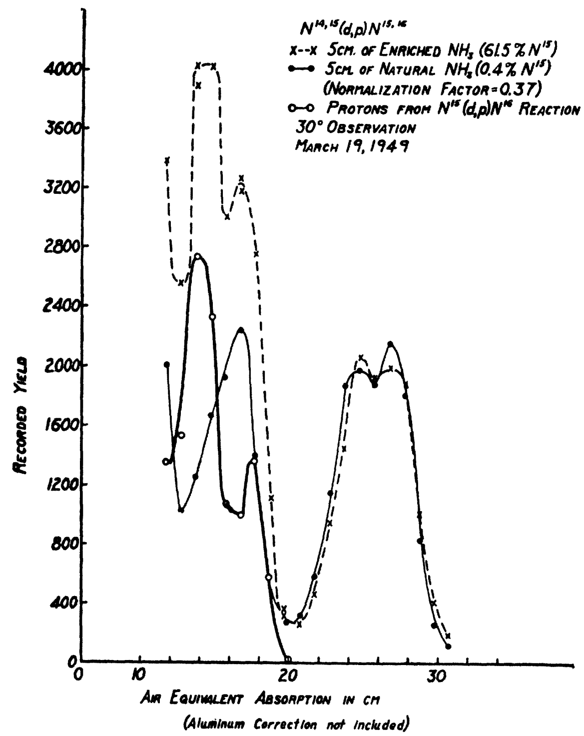

Fig. 2. Deuteron bombarding energy was 3.38 Mev.

The average Q-values for the $N^{14}(d,p)N^{15}$ reaction are given in Table I together with those reported by Guggenheimer, Heitler, and Powell. It is to be noted that the 6-Mev level is confirmed as well as the fact that the 7.2-Mev level is double (see Fig. 2).

Table I. Q-values for the $N^{14}(d,p)N^{15}$ reaction.

Present work	Guggenheimer, Heitler, and Powell
8.61±0.1 Mev	8.55 Mev
3.29±0.1 Mev	3.5 Mev
2.30±0.1 Mev	2.5 Mev?
1.40±0.1 Mev	1.3 Mev (double?)
	0.3 Mev (double?)