a result of this the growing of crystals in a hydrogen sulfide atmosphere was tried.[1]

The size of the largest crystals that were obtained by hydrogen sulfide method was approximately 2×2×10 mm. Since there are two forms of zinc sulfide crystals, i.e., alpha-form or wurtzite and the beta-form or sphalerite, the crystals were examined with polarized light and were found to be of the alpha-form.

The optical absorption of the zinc sulfide crystals was measured with a photospectrometer at room temperature to determine the absorption cut-off. The data obtained are shown in Fig. 1. The absorption cut-off for the crystals was found to be at 3350A and they are entirely opaque below this. This agrees with the value for powders obtained by Gislof.[2] The absorption decreases until in the red and infra-red region the crystals are completely transparent.

The purity of the crystals was determined by subjecting them to ultraviolet light. The crystals showed no sign of phosphorescence and only in rare cases did they fluoresce. The fluorescence in these few cases was the typical blue fluorescence supposedly due to an excess of zinc atoms predicted by theory. In general the zinc sulfide crystals grown in a hydrogen sulfide atmosphere exhibited neither phosphorescence nor fluorescence which indicates a high degree of purity.

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The Thermal Neutron Scattering by Ammonium Chloride

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May 18, 1950

NEUTRON scattering has proved to be a very powerful means of investigating crystalline states, especially those containing hydrogen atoms.[1] The following experiments[2] were performed during the last war, and as we have no facilities for continuing the experiment, it seems appropriate to report here briefly what we did. The transformation of NH_4Cl at −30.8°C has been interpreted as the mutation between the ordered and the disordered states in the orientation of the ammonium ions.[3,4] If this is the case it is to be expected that the diffractive scattering of thermal neutrons may not be the same for the two states. The transmission of thermal neutrons was measured as a function of the temperature of NH_4Cl ranging from about −70°C to room temperature. The experimental arrangement was much the same as that of Beyer and Whitaker,[5] the scatterer being put in a Dewar vessel. The scattering cross section showed a maximum (or minimum in transmission) at the transformation point. It had somewhat larger values at higher temperatures as compared with the values below −30°C as shown in Fig. 1. It is not an established matter, however, to interpret the above results as the mutation between the ordered and the disordered state of the NH_4 ions. The change in the secondary structure (the state of mosaic block or internal distortion) of the NH_4Cl crystal might cause the larger part, if not all, of the observed variation in the scattering, as we may naturally expect a lattice distortion of the crystal near the transformation temperature.[6,7] If this is the case, however, the scattering cross section must depend on the grain size of the powdered scatterer of NH_4Cl of the same temperature as in the case of a polycrystalline metal scatterer.[8,9] We measured the variation using scatterers of various grain size ranging from 2×10^{-4} to 4×10^{-1} cm, and found no change within the limits of error of ±2 percent. This result implies that, contrary to perfect crystals such as SiO_2, the crystal of NH_4Cl belongs to an imperfect type such as those of sulfur and lead[10,11] and cannot show any variation in scattering cross section by internal distortion. Further experiments are desired, however, for the final conclusion.

The author wishes to express his sincere thanks to Professor S. Nishikawa for his encouragement throughout this work. The author also wishes to express his gratitude to the Japanese Foundation for Cancer Research for the supply of radon.

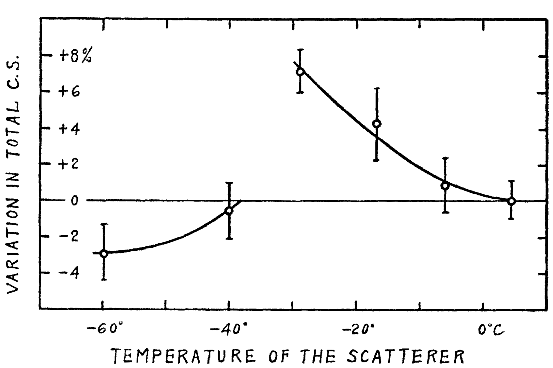

FIG. 1. Scattering cross section of thermal neutrons near the transformation point of ammonium chloride.

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The Shape of the Rossi Curve

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June 12, 1950

THE second maximum of the Rossi curve, first observed by Ackemann and Hummel,[1,2] was investigated in greater detail some time ago in our laboratory.[3,4] These experiments led to the conclusion that the second maximum indicates production of a special kind of shower differing from cascade showers in origin and properties: (1) most, if not all, of these showers contain two particles only, (2) the shower particles are probably mesons, (3) the angular spread is small (around 10°), (4) the showers are produced by the meson component of cosmic rays, (5) the cross section for production is approximately proportional to Z.

Cloud-chamber experiments,[5,6] as far as they go, have confirmed these results with regard to points (1) to (4), and to absolute rate of production. On the other hand, several investigators using counter arrangements obtained more or less divergent results.[7–9]

We have started fresh experiments with a counter arrangement much more effective than the original one (Fig. 1). Showers are recorded by the two crossed counter trays A, B. Fourfold coincidences between two counters each are recorded. The angular spread is determined by the diagonal distance between the intersecting squares of the four counters. A third counter tray, C, is arranged above the shower-producing lead layer. Connections between C and A, B can be made in different ways, so that the showers are recorded if produced either (a) by ionizing as well as non-ionizing rays or showers (tray C removed), or (b) by showers of at least three ionizing particles, or (c) by ionizing single particles, no second ionizing particle hitting tray C, or (d) by non-ionizing rays, no ionizing particle hitting tray C.

Experiments have so far been performed at an altitude of 100 meters under about 290 g/cm² of concrete ceiling. We believe that all possible sources of misinterpretation of the results, as an in-

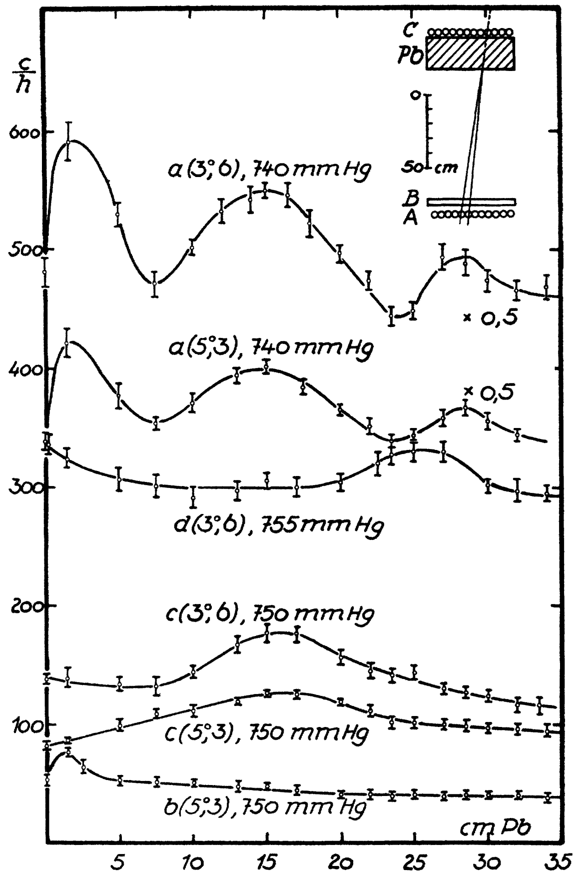

FIG. 1.

fluence of the supporting frame, shape of the lead screen, knock-on electrons from the counter walls, have been ruled out. Some of the Rossi curves obtained for cases (a) to (d) are presented in Fig. 1. Our earlier results concerning the second maximum could be reproduced with much greater accuracy, and some more remarkable facts are revealed. In curves *a* not only the first and second maxima are well pronounced, but in addition a third maximum appears at about 28 cm of lead. Clay,[10] too, has reported, besides the second maximum, a third maximum in about the same region. Curves *b*, *c*, *d* show that each of the three maxima can be completely isolated from the others by controlling conditions of shower production. In this way evidence on the origin of the maxima is obtained. Absolute intensities in the different curves cannot be compared. The initial drop in curves *c* (3°, 6) and *d* springs from imperfections in the apparatus.

The first maximum appears in curve *b* only, and therefore is evidently produced by cascade showers originating in the ceiling and enhanced by the lead.

The second maximum, as previously shown,[3] indicates production of hard narrow showers. Curve *c* is additional proof that the primaries are single ionizing particles.[4] For reasons of penetrating power and rate of shower production it seems almost certain that the primaries can only be μ-mesons. Assuming this, the shower-producing cross section of the lead atom can be estimated as a few percent of the geometric nuclear cross section. As to the nature of the shower particles there is little doubt that our former assumption of mesons is correct (compare the cloud-chamber photographs[5,6]). Experiments are in progress to discriminate between μ- and π-mesons.

It seems difficult at the moment to explain the showers or pairs responsible for the second maximum by one of the known interaction processes. Apparently there is little or no relation to the penetrating meson showers connected with star production.

The third maximum is not easily explained either. It indicates shower production by some non-ionizing radiation, as the comparison of curves *c* and *d* shows. Since high energy neutrons are rare at sea level it will possibly be necessary to assume a new long-lived neutral meson (neutretto). The position of the third maximum depends markedly on the barometric pressure. This explains the shift of the third maximum between curves *a* and *d*, and might also explain discrepancies on the third maximum found by other investigators.

The experiments are being continued.

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