Table I gives details of the angular measurements,[5] the last column showing the statistical chance for the particular star, calculated using the average distribution curve for all the stars (shown in Fig. 1). If one excludes the last event, which may include forward cone particles, the mean calculated chance from 20 stars with pairs approximates 4×10^{-2}. Assuming these to be representative of all 77 stars, we would, therefore, expect about three chance pairs, whereas 25 pairs were observed. The number of individual cases with two or more pairs is somewhat greater than we would have expected from the total number of pairs, and more data are desirable.

If one assumes the effect to be real, it seems unlikely that it could be explained solely on the basis of secondary collision processes because of the small angles between pairs. It is possible that some are electron pairs from the suggested alternative neutral pion decay, $\pi^0\rightarrow$electron pair$+h\nu$. Dalitz[6] estimates $\sim$1 in 80 for this mode of decay compared with the usual decay into two photons. If 70 percent of the shower particles are pions and there are an approximately equal number of neutral, negative, and positive pions, there will be $\sim$260 neutral pions for the 77 stars and thus about three electron pairs directly from neutral pion decay. Whether such electron pairs do occur in stars is not known at present.[7]

Another possibility is the decay of short-lived neutral mesons of mass $\sim550m_e$.[4] Our results are insufficient to confirm this, and in any case the selection of pairs with small angles means that the Q value obtained, assuming such a decay, would be small and insensitive to the energy of the pions unless this were very unevenly balanced. If the pairs originated in this way, the number of such neutral mesons would be about 10 percent of the number of neutral pions. Wentzel[8] has also discussed a mu-pair theory (e.g., neutral pion may be a bound state of negative and positive muons), but there is no evidence in stars for appreciable numbers of muons, which might then be expected.

Further work is obviously necessary to confirm these results.

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The Structure of Ammonium Chloride by Neutron Diffraction

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RECENTLY we published neutron diffraction patterns of ND_4Cl at -180°C and room temperature.[1] Subsequent measurements here and at Oak Ridge[2] have failed to confirm our values for the structure factors of the (111) and (210) lines at room temperature. Our deduction that the room temperature phase is ordered depended largely on the strength of the (111) line. The new measurements give much weaker intensity. Consequently, our conclusions concerning the room temperature phase can no longer be sustained. Levy and Peterson[2] have deduced a disordered structure from their results.

The intensity of the (111) line at room temperature was the major error in our measurements. This line was small compared to the background, and it was not well resolved from the strong (111) line because of the aluminum windows of the cassette. The error in the (111) line of ND_4Cl probably arose through a false enhancement owing to the subtraction of a background curve in which the neighboring (111) and (200) aluminum lines were too large. Preferred orientation in the aluminum may have contributed to the effect.

TABLE I. Structure factors of ND_4Cl at 23°C (units of 10^{-12} cm).

hkl	(100)	(110)	(111)	(200)	(210)	(211)
F	1.35	(2.47)	0.35	0.98	0.37	1.34

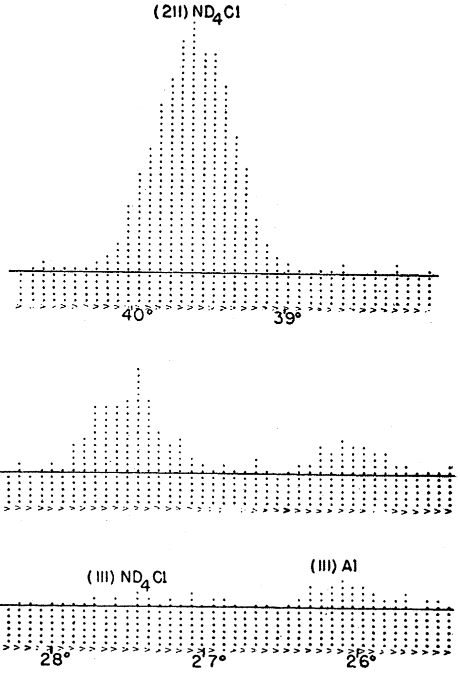

FIG. 1. Records of neutron scattering by ND_4Cl. Each dot represents 20 neutron counts. Each vertical column is recorded at a fixed angle for a predetermined number of neutrons incident on the specimen. The bottom record is the neighborhood of the (111) line at room temperature. Just above it is the same region at -170°C shifted slightly in angle to align the (111) peaks of aluminum. At the top is shown the (211) peak at -170°C. The incoherent background is shown by the horizontal lines.

Since the publication of the earlier results, the instrument has been greatly improved both as to resolution and methods of recording. In a new series of measurements by one of us, the (111) lines of aluminum and ND_4Cl were completely resolved. Only 0.004 inch of aluminum was in the beam, as compared to 0.010 inch previously. Samples of the records are shown in Fig. 1, where it is clear that the change in the (111) line between low and room temperatures is much larger than was found originally.

The structure factors obtained in the new measurements, normalized to 2.47×10^{-12} cm for the (110) line, are given in Table I.

We thank Dr. Levy and Dr. Peterson for bringing the discrepancy in the measurements to our attention.

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Soft Radiations from Am^{241}

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THE gamma- and x-radiation produced in the decay of the α-particle emitter Am^{241} have been examined over the energy range 5–120 kev by the proportional counter technique, using counters filled with argon, krypton, and xenon, respectively.

The sources used were extracted from heavily irradiated plutonium, the parent isotope of Am^{241} being the β-emitter Pu^{241}.

The energy scale was established by observing the K radiation following K capture in the isotopes Os^{185}, Sn^{113}, and Zn^{65}, giving lines at 60.8 kev, at 27.3 and 24.1 kev, and at 8.05 kev, respectively. Lines attributable to Am^{241} were observed at 59.7 ± 0.3, 26.3 ± 0.2, 20.9 ± 0.2, 17.3 ± 0.2, and 13.5 ± 0.2 kev. There were indications of the presence of a line at 75 ± 2 kev of intensity roughly $\frac{1}{2}$ percent of that of the 60-kev line. The line at 26.3 kev has not previously been reported. A typical spectrum is shown in Fig. 1, as taken with a thirty-channel pulse analyzer.

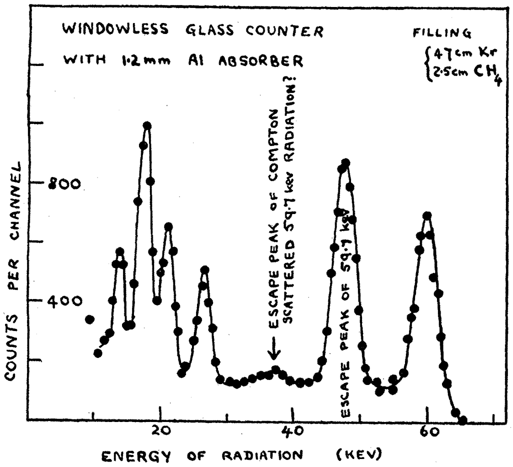

FIG. 1. γ- and L-ray spectrum of Am^{241} observed in a krypton-filled proportional counter.

The relative intensities of the various lines were obtained by collimating the radiation and admitting it to a krypton-filled counter through a thin mica window, the efficiency of the counter being calculated from known mass absorption coefficients. A correction of 14 percent was necessary for the 59.7-kev peak due to wall effect.[1] The intensity of the 13.5-kev peak required correction for two reasons. Firstly, the "escape" peak of the 26.3-kev radiation occurred at 13.6 kev (the difference being the energy of the K radiation of Kr). Secondly, as the 13.5-kev radiation lies below the K absorption edge of Kr and must therefore be detected by absorption in the outer electronic shells of the counter gas, it cannot have a K escape peak, and all absorbed quanta give rise to counts in the "normal" (13.5-kev) peak. The magnitude of these corrections was determined from the observation that the ratio of the counts in the escape peak to counts in the main peak for any energy of radiation was 1.00 ± 0.03. The relative intensities of the principal lines are shown in Table I. Upper limits to the relative intensities of lines in the energy ranges 4–10 kev, 29–40 kev, 40–48 kev, 48–56 kev, and 86–120 kev were 2.5 percent, 0.02 percent, 1 percent, 6 percent, and 0.5 percent, respectively, of the 59.7-kev line.

TABLE I. Relative intensities of γ- and L-rays resulting from the decay of Am^{241}.

Radiation energy (kev)	59.7	26.3	20.9	17.3	13.5
Relative intensity	1	0.075 ± 0.008	0.177 ± 0.018	0.66 ± 0.04	0.42 ± 0.04

The three lowest energy lines fit well with the energies 13.9, 17.3, and 20.9 kev to be expected for the L_α, L_β, and L_γ x-ray lines of Np^{237}, as determined by extrapolation from the published values for U, Pa, and Th.[2]

To demonstrate that the observed lines were not due to fission product contamination, the spectrum of γ-rays which were in coincidence with α-particles was observed. A coincidence resolving time of 2 μsec was found sufficient to avoid loss of true coincidences, and it was found that the lines appeared in the same relative intensity in the single and coincidence spectra.

The number of 59.7-kev quanta per α-particle was measured by the coincidence method, using a 2-mm thick sodium iodide crystal as the gamma-detector. The discriminator in the gamma-ray channel was set to reject all pulses below the peak due to the 59.7-kev radiation. The results required correction for the fraction of pulses lost into the "escape" peak, which is produced by the escape of iodine K radiation from the crystal. The magnitude of this correction was determined by measuring the relative areas of the main and escape peaks when the source was covered with sufficient platinum to absorb the L rays and the 26.3-kev line. Apart from this correction the net efficiency of the γ-counter was assumed to be equal to the solid angle which it subtended at the source. The absolute intensity of the 59.7 kev γ-ray was found to be 0.40 ± 0.015 per α-particle. This is to be compared with other work,[3] where a value of 0.32 was obtained.

The authors are grateful to Dr. J. Milsted for preparing the sources used and to Mr. D. West for much guidance. One of us (J.K.B.) wishes to express his gratitude to the Director, A.E.R.E., Harwell and to the Officer-in-Charge, ONR Branch Office, London, for permission to work at Harwell and for leave of absence from ONR, London.

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The Microwave Spectrum and Molecular Constants of Hydrogen Cyanide*

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THE microwave spectra of the $J=0\rightarrow1$ transition of three isotopic species of HCN have been re-examined using a harmonic generator driven by a 2K33 klystron with a fundamental wavelength of about 1.3 cm. The third harmonic was used for $DC^{12}N$ and the fourth harmonic for $HC^{12}N$ and $HC^{13}N$, with all frequency measurements being made at the frequency of the fundamental. The observed line frequencies are given in Table I.

TABLE I. Observed line frequencies.

Molecule	Frequency (Mc/sec)
$HC^{12}N$	$88{,}631.4\pm0.5$
$HC^{13}N$	$86{,}340.1\pm0.5$
$DC^{12}N$	$72{,}415.0\pm0.5$

The $HC^{12}N$ and $HC^{13}N$ frequencies differ by approximately 30 Mc from the values previously reported;[1] this difference possibly is due to an error by the earlier workers in the identification of frequency marker pips, which could give an error of exactly 30 Mc.

The errors given are probable errors and are expected to be made smaller by further work.

These measurements form part of a determination of the velocity of light and were undertaken after it was pointed out by Professor D. H. Rank that the previous microwave measurement of the $HC^{12}N$ frequency was inconsistent with his result for the rotational constant. The determination of c is discussed by Rank in his accompanying letter.

The above frequencies lead to slight changes in the previous listed[1] bond distances. The new values for the internuclear distances as determined from the various isotopic combinations are given in Table II. In addition, a computational error seems to have been involved in the bond distances previously derived from