

FIG. 2. Decay scheme for the ground state of Sr^{85} .

states other than the 514-keV level in Rb^{85} does not occur with appreciable intensity. A partial decay scheme of Sr^{85} summarizing these results is shown in Fig. 2.

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² L. S. Cheng and J. D. Kurbatov, *Phys. Rev.* **79**, 237 (1950).

³ M. A. Waggoner, *Phys. Rev.* **82**, 906 (1951).

⁴ Rose, Goertzel, Spinrad, Harr, and Strong, *Phys. Rev.* **83**, 79 (1951).

Studies on the Linearity of a Scintillation Gamma-Ray Spectrometer

V. O. ERIKSEN AND G. JENSSEN

Joint Establishment for Nuclear Energy Research, Kjeller, Norway
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THE linearity between pulse-height and absorbed energy in $\text{NaI}(\text{Tl})$ crystal has been carefully investigated during the last two years. Johanson¹ has reported a linear relationship in the region 0.4–6 Mev. Pringle and Standil² have found that the relationship is not strictly linear in the region 0.05–0.4 Mev. We have made some measurements in the region 0.05–0.5 Mev, and are finding a linear relationship in this region.

A single-crystal scintillation spectrometer has been used. One clear $\text{NaI}(\text{Tl})$ crystal, supplied from Harshaw Chemical Company, 20 mm thick and 30 mm in diameter was employed in conjunction with an EMI-5311 photomultiplier tube. Mirrors of thin mica coated with silver or aluminium to ensure high reflection were used. Just a slight oxidation of the mirrors caused considerable variation in the peak widths.

The crystal was kept in a glass tube cemented on to the surroundings of the photocathode and filled with paraffin. The crystal had been carefully polished with flannel or velvet in a dry atmosphere. The paraffin was dried with metallic Na.

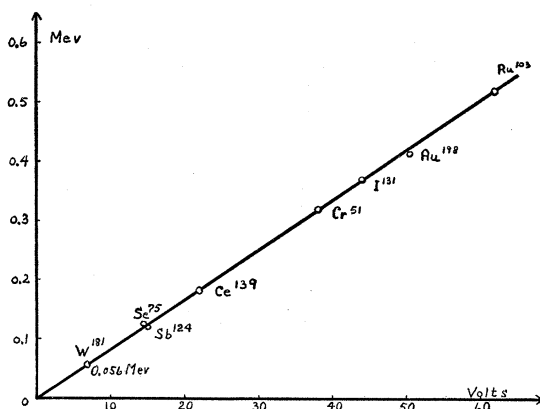


FIG. 1. Pulse-height as a function of gamma-ray energy.

The amplifier was type 1008 delivered by Cole, Ltd. No pre-amplifier or cathode-follower was used. A ten-channel pulse-height analyzer was used for the pulse-height analysis. The stability of the apparatus was very good; for the high voltage it was better than ± 0.5 per thousand.

The counter was surrounded by a 5-cm-thick shield of lead.

Nuclides with 7 different gamma-rays in the region 0.1–0.5 Mev were used.³ The activity of the sources varied between 10^{-8} – 10^{-9} curie. The collimated rays had an angular width of about 5° .

Figure 1 shows the linearity between pulse-height and energy of the various gamma-rays.

¹ S. A. E. Johanson, *Arkiv Fysik*, B2 (1950).

² Pringle and Standil, *Phys. Rev.* **80**, 762 (1950).

³ Gamma-ray energies are according to *Nuclear Data* (National Bureau of Standards Circular 499, 1950).

Heat Capacity and Lattice Defects of Silver Chloride

KOICHI KOBAYASHI

Chemical Institute, Faculty of Science, Tohoku University,
Sendai, Japan

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THE magnitude of the heat of activation for the formation of lattice defects in AgCl crystal, ΔH , has hitherto been in doubt. Previously, I had measured the heat capacity of AgCl from room temperature to 500°C to calculate the thermodynamic relations on some chemical reaction¹ and found an abnormal increase in the heat capacity curve in the vicinity of the melting point.

Berry² has concluded that the defects in AgBr crystal are of Frenkel type. I assume that Frenkel defects may dominate in AgCl by analogy with the result on the lattice behavior of AgBr and by consideration of the ionic conductivity measurements on AgCl , in spite of Mitchell's conclusion.³

If the concentration of the Frenkel defect, n/N , is expressed by the equation,

$$n/N = C \exp(-\Delta H/2RT), \quad (1)$$

the excess heat capacity ΔC_p per mole should be given by

$$\Delta C_p = [C(\Delta H)^2/2RT^2] \exp(-\Delta H/2RT). \quad (2)$$

So, ΔH may be obtained by the relation between $\log(T^2\Delta C_p)$ and $1/T$. For the heat capacity contributed by the perfect lattice of AgCl , I assume

$$C_p = 11.21 + 6.57 \times 10^{-3}T - 3.2 \times 10^{-6}T^2 \text{ cal/mole } (T:^\circ\text{K}), \quad (3)$$

which was obtained by extrapolation of the heat capacity data in the range 300 – 400°K , as given in the previous paper.¹ ΔC_p was estimated as the deviation from the expression (3) of the measured heat capacity which was shown in Table II of the previous paper.¹ Figure 1 shows a plot of $\log(T^2\Delta C_p)$ versus $1/T$ in the range 600 – 724°K , indicating that the resultant points fall well on a straight line in the range from 600 to 700°K and deviate upwards above this. The slope of this straight line determines ΔH to be $35,200$ cal/mole. This value is 20 percent larger than that for AgBr derived by Teltow.⁴ The contribution of C_p of the perfect lattice to ΔH is quite sensitive, and a variation of 0.1 cal/mole (6 percent in ΔC_p) at 700°K corresponds to 1 kcal in ΔH , but by this treatment the plot at 600°K deviates from the linear relation.

From this ΔH we may estimate n/N at any temperature. We find n/N to be 7.5×10^{-3} at 724°K , 4.3×10^{-4} at 600°K , and 1.6×10^{-10} (4×10^{12} per cc) at 300°K . The integrated value of the excess enthalpy at 724°K is 220 cal/mole and the corresponding entropy is 0.31 eu. The value of C in Eq. (1) is obtained as 1.08×10^3 ; on the other hand, C for AgBr is estimated as 1.6×10^4 from the work of Christy and Lawson.⁵ The fact that C is exceedingly large seems to indicate that the defects in silver halide are of the Schottky type, but I shall not discuss this problem further.

The deviation of the plots above 700°K from the linear relation seems to be associated with an increase in ΔH , or a small con-