Fig. 2. In the spot ($\bar{2}2\bar{1}$), note that the bands are not regular, they are perturbed. If one calculates the structure factors for *abab*... and for ...*bcbcbc*..., the values remain the same for most spots. For some, like ($\bar{2}2\bar{1}$), for example, there is a difference of phase only, and it is this difference which produces the perturbation. The difference in spreading of the bands of Figs. 2 and 3 is due to the thickness of the crystals, which can thus be determined with an accuracy of $\pm$ one layer of carbon atoms. There are obvious differences between Fig. 4 and Figs. 2 and 3, due to perturbations similar in principle to those of Fig. 2, and from the appearance of supplementary spots of indices ($01\frac{3}{4}$) or ($1\bar{1}\frac{3}{4}$), for example.

I wish to thank Prof. J. Weigle, under whose guidance this work was done.

JEAN HOERNI

Institute of Physics,
University of Geneva.
July 1.

[1] Lipson and Stokes, *Proc. Roy. Soc.*, A, **181**, 101 (1942).
[2] Kossel and Moellenstedt, *Ann. der Phys.*, **36**, 113 (1939).
[3] McGillavry, *Physica*, **7**, 329 (1940).

Order–Disorder Transition in Beryllium Oxyacetate Crystals

WE have postulated that the weak transition which occurs in cubic crystals of beryllium oxyacetate at about 40° C. is a kind of order–disorder transition due to the simultaneous rotation of carboxyl oxygen atoms around the carbon-to-carbon bonds[1].

In order to see whether the postulate really fits the case, we have investigated the crystal structures of this substance in detail at different temperatures. The results seem to favour it, and a brief account of our investigations will be given below.

As has been described in the previous communication, crystals of this substance at temperatures above the transition range give a number of diffuse spots with considerable intensity. The Laue part of the scattering, however, should give the averaged structure. The structure factors $F(hk0)$ were calculated with two models, namely, (i) the carboxyl oxygen

atoms lying on the (110) planes ; and (ii) the oxygen atoms being statistically with equal weight one half on each side of the (110) planes. The results show that the observed structure factors obtained from the photographs taken at 60° $\pm$ 1° C. can be satisfactorily interpreted in terms of model (ii). The electron density projection along the [001] axis shows the electronic clouds of the carboxyl oxygen atoms appearing on both sides of the (110) planes, though not resolved.

As for the room temperature modification, satisfactorily good agreement between the observed (16° C.) and calculated structure factors $F(hk0)$ could not be obtained with a best set of parameter values, and it was proved that any refinement of parameter values or the introduction of the anisotropic temperature factors could not improve the calculated $F(hk0)$ values. It is suggested, therefore, that the ordered state might be attained at a still lower temperature.

The observed intensity ratio of the two reflexions ($\bar{1}35$) and ($\bar{3}15$) at room temperature (16° C.) is found to be 100 : 15, while with a perfect ordered structure this ratio should be 100 : 6. We have examined this intensity ratio $I_{\bar{1}35}/I_{\bar{3}15}$ at different temperatures with oscillation photographs taken with [110] as axis of rotation, using a low-temperature camera similar to that designed by Ubbelohde and Woodward[2]. It was observed that the ratio varies markedly with temperature and becomes about 100 : 6 at $-40°$ C.

We have introduced a well-known long-range order parameter s to account for this change. The s-values obtained from the intensity ratios are plotted against temperature (see graph). With the value $s = 0.74$ at 16° C., as obtained from the curve, all the calculated structure factors $F(hk0)$ show a better agreement with the observed ones.
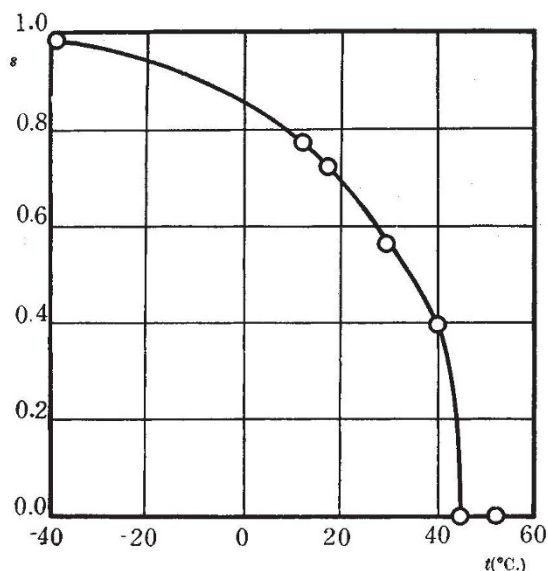
Details of the work, including theoretical treatment, will be published elsewhere.

T. WATANABÉ
Y. SAITO
H. KOYAMA

Department of Physics,
University of Osaka.
June 10.

[1] Watanabé, T., and Saito, Y.; Seki, S., Momotani, M., and Chihara, H., *Nature*, **163**, 225 (1949).
[2] Ubbelohde, A. R., and Woodward, I., *Proc. Roy. Soc.*, A, **188**, 358 (1947).

Lead Isotopes and the Age of the Earth

MY analysis[1] of the method of estimating the age of the earth's crust from lead isotope ratios has been attacked by Holmes[2].

Meanwhile, the paper by F. G. Houtermans[3] has come to my notice, and E. C. Bullard and J. P. Stanley[4] have published an entirely new analysis. The last is far the most satisfactory, but the same difficulties survive ; they are present in all the analyses, though stated and interpreted in different ways by the various authors. Mine is the only one that makes any use of the lead-208 data ; and though it can be improved, the possibility of using these data is worth keeping in mind.

Three of Holmes's points can be dealt with briefly. His (6) is obtained by misinterpreting natural logarithms as logarithms to base 10 ; consequently