III. SOLID STATE PHYSICS

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A. CRITICAL POINT FLUCTUATIONS

Technical Report No. 111, "Critical Point Fluctuations", introduced the notion of macroparameters in contrast to microparameters. In particular for crystals the former are the invariants of the translational group of the system. An investigation has been started to elucidate the connection of these parameters with those describing the state of long and short range order obtained from x-ray studies.

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B. VACUUM SPECTROGRAPH

Most of the parts of the vacuum spectrograph have been completed and will shortly be assembled. Measurements are in progress on experimental gun designs for the x-ray tube. It is expected that the x-ray tube design will shortly be completed and the final tube constructed.

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C. THEORY OF LIQUID HELIUM

We are continuing to study the thermodynamics of the λ-point phenomena in liquid helium. We have previously discussed the fact that the λ-point can be considered as a critical point in the sense of the general theory of phase transitions (1). The theory distinguishes between the "normal case" and the "exceptional case". In the exceptional case the thermodynamic variables may be divided into two independent classes such that the critical phenomena are associated with the interaction of the variables in the first class. The compliance coefficients involving the variables belonging to this class become infinite at the critical point; while the compliances involving the remaining set of variables stay finite. Thus the singular behavior of Rochelle salts may be described to a very good approximation by the interaction of just one strain and one polarization variable, while the other strain-coordinates, (entropy, etc.), exhibit no singularities. A similar situation seems to exist in helium.

This division into two cases, normal and exceptional, has been criticized on the grounds that in nature one never has completely independent sets of variables. (There is in fact a small coupling in the Rochelle salts case.) This criticism refers to the fact that the formalism predicts a distinct difference between the normal and exceptional cases with respect to the appearance or non-appearance of infinities so that on the surface it seems as if the "nearly exceptional" case would be quite different from the (non-realizable) exactly exceptional case.

We have shown by a closer examination that this is not so, that there is in fact a gradual transition from the nearly exceptional to the exceptional case, as one might expect physically. The unavoidable "washing out" of infinities, inherent in the fact that measurements are averages over finite intervals, will cause the nearly exceptional case to be experimentally indistinguishable from the exactly exceptional case.

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Reference

(1) L. Tisza, "On the General Theory of Phase Transitions" (written for the N.R.C. Symposium at Cornell University).

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