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CRITICAL PHENOMENA IN SbSI

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Résumé. — Des phénomènes critiques ont été trouvés dans SbSI. Particulièrement, on a observé une opalescence critique (diffusion Rayleigh) en proximité de la transition de phase.

Abstract. — Critical phenomena are reported for SbSI. In particular it is observed that critical Rayleigh scattering (critical opalescence) occurs near the phase transition.

Near the ferroelectric phase transition of SbSI \((T_c = 292 \, \text{OK})\) a considerable increase of the Rayleigh light scattering is reported, in addition to the soft ferroelectric mode which is observed. This is interpreted as evidence that, besides a one-phonon excitation (soft mode), light is also scattered by a collective phonon excitation (phonon density fluctuations) which appears in the scattered spectrum as a diffusive mode centered about zero frequency. The total integrated Rayleigh light intensity diverges as \(I \propto T^\chi\), \(\chi\) being the static susceptibility. We find \(\chi \propto |\varepsilon|^{-\gamma'}\), \(\varepsilon = (T - T_c)/T_c\), with \(\gamma' = 1.36 \pm 0.14\), which is in excellent agreement with the value obtained from the clamped dielectric constant,

\[
\gamma' = 1.40 \pm 0.15.
\]

Analysing previous results for the spontaneous polarization (order parameter) \(P_s \propto |\varepsilon|^{\beta}\) we find for the exponent \(\beta = 0.36 \pm 0.04\), and from the Bragg intensity of the (082) X-ray line \(I_b \propto P_s^2\), the exponent \(\beta = 0.28\). Both of them are in agreement with the exponent of the soft mode frequency

\[
\omega_s \propto |\varepsilon|^{\beta}, \quad \beta = 0.34 \pm 0.03.
\]

The thermal conductivity was previously reported to behave in a unique manner near \(T_c\). A critical exponent is found for its singular part \(\lambda \propto |\varepsilon|^{-\alpha}\) with \(\alpha = 0.66 \pm 0.10\). We also find that the specific heat data (which are of limited accuracy) are not contradicting a logarithmic singularity.

All these exponents are in striking deviation from the mean field values. It is concluded that this is due to critical behaviour (i.e. the fluctuations of the order parameter are large compared with the mean value), and that the critical regime extends to large values of \(|\varepsilon|\) in SbSI. The Lyddane-Sachs-Teller relation in its usual form is found to be disobeyed for SbSI. This is to be expected for the critical regime. The obtained critical exponents are compared with different available models, but at present the accuracy of the data does not permit a definite assignment. The dependence of the linewidth of the critical Rayleigh line on \(|\varepsilon|\) can well be explained in terms of the divergence of the thermal conductivity and the specific heat; its absolute value agrees within a factor four with the calculated one.

A more detailed account of these results will be found in the Proceedings of the Nato Advanced Study Institute of Structural Phase Transitions and Soft Modes, Geilo, Norway, 13-20 April 1971, and in the Proceedings of the International Conference on Light Scattering in Solids, Paris, 19-23 July 1971 (Flammarion Press, Paris).