

## Insight to correlation in the humps of the heat capacity of Ne crystal and amorphous ABS polymer

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The low-temperature dependence of the heat capacity of Ne cryocrystals was analyzed [1]. A hump appears as a local maximum in the heat capacity curve in coordinates  $C/T^3$  vs  $T$  at  $T_{max}$ . It was observed that with increasing molar volume from 12.39 cm<sup>3</sup>/mole to 13.39 cm<sup>3</sup>/mole, the  $T_{max}$  shifts to lower temperatures from 8.11 to 6.72 K. A universal empirical relation as well the parabolic dependence of the  $\Delta^*=f(D, T/T_{max})=1-D(1-T/T_{max})^2$  was proposed to describe the excess (non-Debye) heat capacity at low temperatures. It was shown that the value of the universal function depends on both the magnitude of the heat capacity anomaly and the temperature at which the hump occurs, but remains universal and independent of molar volume for noble gas cryocrystals. This study provides new information about the origins of the hump in the heat capacity for crystals as a manifestation of the first van Hove singularity [1].

The very same empirical relation  $\Delta^*$  was also used for analyzing the low-temperature dependence of the heat capacity of acrylonitrile-butadiene-styrene (ABS) polymer and its composite with thermally reduced graphene oxide [2]. The hump or “boson peak” appears near  $T_{max} = 3.52$  K. We showed that for both ABS polymer and its composite, as well as for a number of other substances of a crystalline and amorphous nature, the manifestation of the boson peak anomaly in the heat capacity is also well described by the empirical function  $\Delta^*$ .

For Ne cryocrystals, in the close vicinity of  $T_{max}$  the left and the right brunches of  $\Delta^*$  for all molar volumes studied are almost symmetrical and can be well described by a quadratic dependence. At low frequencies, the phonon spectrum rises proportional to  $\omega^2$  as formulated in the Debye model. At higher frequencies, the real spectrum of crystals exhibits van Hove singularities, where the spectrum changes discontinuously which leads to the appearance of the hump in the heat capacity dependence  $C/T^3$  vs.  $T$  as well the parabolic dependence of the  $\Delta^*=f(D, T/T_{max})$  with universal  $D = 3$  for Ne cryocrystals. The case of ABS and its composite with graphene oxide showed  $\Delta^*=f(D, T/T_{max})$  with  $D \neq 3$ . This fact confirms that “hump” in the heat capacity of crystals and disordered solids such as polymers have a different nature.

1. M. S. Barabashko, A. I. Krivchikov, (2025). About the hump in the low-temperature isochoric heat capacity of Ne cryocrystals. *Low Temperature Physics*, 51(2), 157-161.

2. D. Szewczyk, A. I. Krivchikov, M. S. Barabashko, A. V. Dolbin, N. A. Vinnikov, R. Basnukaeva, G. Chajewski, A. Jeżowski (2023). Universal behavior of low-temperature heat capacity of acrylonitrile-butadiene-styrene thermoplastic polymer and its composite with graphene oxide. *Low Temperature Physics*, 49(5), 593-593.

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