

Self-Localized States as Precursors of a Strong First-Order Structural Phase Transition

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A peculiarity of the fluorescence lifetime before the strong first-order phase transition (e.g. melting) was observed in the experiment [1]. The critical decrease of the lifetime starting from 30K below T_c was considered as a precursor of the phase transition. As a possible origin of the precursor the local increase of the vibrational fluctuations associated with the phase transition was suggested. This increase can be interpreted as the activation of the localized phonon and self-localized intrinsic modes, which may appear besides nucleation of a new phase.

In present study, a general phenomenological theory of the mechanism of rise of the strongly first-order structural phase transition precursor is proposed. Self-localization or momentary highly excited vibrations are due to the specific sort of non-linearity in the dynamical equation [2-4]. We introduce the coupling term into the Hamiltonian of a structural element of the system. We use a kind of structural characteristic parameters (e.g. order parameter, orientation of molecules *etc.*) as coupling variables, whose contribution to the dynamic equation is non-linear. This non-linearity in the vicinity of phase transition allows for not only nucleation of another new phase, but also for the dynamical structural defects of the self-localized state type, which can be interpreted as the precursors. The theory predicts precursors of the phase transition both below and above the transition point i.e. in both directions of the transition.

1. T.Shigenari, E.Kojima, Y.Ino and K.Abe, Phys. Rev. Lett. **66** (1991) 2112
2. A.M.Kosevich and A.S.Kovalev, Sov. Phys. JETP **67** (1974) 1793
3. A.J.Sievers and S.Takeno, Phys. Rev. Lett. **61** (1988) 970
4. O.A.Chubykalo, A.S.Kovalev and O.V.Usatenko, Phys. Letters A **178** (1993) 129