# Quantum Dynamics of the Jahn-Teller Complexes Investigated by Ultrasonic Technique

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Ultrasonic technique provides an experimentalist the temperature ($T$) or magnetic field (**B**) dependences of the dynamic elastic moduli of the investigated crystal. A crystal doped with small amount of the Jahn-Teller (JT) ions contains the subsystem of non-interacting with each other JT complexes. The main features of the complexes can be described in the framework of molecular model which proposes to consider the JT ion and the nearest neighbours. Each complex is characterised by the adiabatic potential energy surface (APES) which extrema points (global minima and saddle points) define the ground and excited states and the probabilities of the transitions between them. As a thermodynamic ensemble, the JT subsystem is described by a distribution function and its relaxation time τ. Ultrasonic technique makes it possible to determine the dependence of τ on $T$ or **B.** Sturge [1] discussed three mechanisms of relaxation: thermal activation ($\tau_a^{-1} = \tau_0^{-1}\exp(-V_0/T)$), tunneling through the potential energy barrier ($\tau_t^{-1} = bT$), and two-phonon mechanism ($\tau_R^{-1} = bT^3/\Theta^2$). Our investigation of $A^{II}B^{VI}$:3d crystals (tetrahedral complexes in both cubic and hexagonal matrices) and doped crystals with fluorite structure (cubic complexes) have shown that the form of experimental curves can be completely interpreted in terms of the mentioned mechanisms and depends on quantum parameters describing the complex (see, e.g., [2] and references therein). It means that the form of the temperature dependence of ultrasonic attenuation and phase velocity (or dynamic elastic moduli) is an analogy of fingerprints of the definite JT complex in the given crystal and can serve as an indicator of the presence of the complexes, like anomalies caused by them in optical or EPR spectra.

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[1] M.D. Sturge: in *Solid State Physics* Vol.20 (Academic Press, New York, 1967) 91-211.
[2] M.N. Sarychev et al.; *JETP Letters* **113** 47 (2021).