Study of Coherent Quantum Fluctuation Competed with the Long-Ranged Ferroelectric Ordering

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【Outline of survey】

The cooperative excitation of atoms and/or molecules plays the leading role in the macroscopic properties of solid materials. The detailed knowledge of the dynamics of cooperatively-excited states is indispensable to design novel properties of materials needed for the new advanced technology. As an example of the cooperative excitation, we know the *phonon states* excited thermally in crystalline solids as the lattice vibrations with the translational symmetry. The concept of phonons has played historically quite important role in the solid state physics. Very recently, however, a peculiar property has been reported in the perovskite dielectrics and its oxygen-isotope exchanged crystal at low temperature region below 4 K, where any of thermally excited states would be frozen. We newly have to take into consideration the effect of the quantum fluctuation to explain the physical origin of these phenomena, for example the cancellation of the ferroelectric order in $SrTi^{16}O_3$ reported below 4K. In the present research project, we concentrate on elucidating the dynamic property of the quantum fluctuation in dielectrics and ferroelectrics where the quantum fluctuation competes with the long-ranged ferroelectric order. As the actual purpose of the research, we are going to elucidate the dispersion relation between the frequency and wavelength of the *coherent quantum fluctuations* as a new elementary excitation in solids.

【Expected results】

The dispersion relation of the *coherent quantum fluctuation* in dielectrics will give us the fundamental understanding of the new phenomena; for example, the cancellation of the ferroelectric order in the low temperature, the ferroelectric phase transition induced by the substitution of the oxygen isotope, the gigantic enhancement of dielectric constant by irradiation of UV light and so on. The description of these new phenomena would give us a basement of the material design applicable for the new advanced technology. A new stage of the solid state physics will be produced by expanding our understanding into the *coherent quantum fluctuations* as a new elementary excitation in solids.

【References by the principal researcher】

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・Masaki Takesada, Toshirou Yagi, Mitsuru Itoh and Shin-ya Koshihara,"Gigantic Photoinduced Dielectric Constant of Quantum Paraelectric Perovskite Oxides Observed under a Weak DC Electric Field", J.Phys.Soc.Jpn. **72** (2003) pp.1-4

【Term of project】 FY 2005 -2009	【Budget allocation】 76,300,000 yen

【Homepage address】 http://phys.sci.hokudai.ac.jp//LABS/yagi.html