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Broad-band Spectroscopy of Nanoconfined Water Molecules

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We have performed broad-band spectroscopic investigations of vibrational and relaxational excitations of water molecules confined to nanocages within artificial beryl and mineral cordi-erite crystals. Signatures of quantum critical phenomena within the H_2O molecular network are registered in ber-yl. In cordierite, a density functional analysis is applied to reconstruct the potential energy landscape experienced by H_2O molecules, revealing a pronounced anisotropy with a potential well of about 10 meV for the molecular dipole moment aligned along the b-axis. This anisotropy leads to a strongly tempera-ture dependent and anisotropic relaxational response of the dipoles at radiofrequencies with the activation energies corre-sponding to the barriers of the rotational potential. At $T \approx 3$ K, we identify signatures of a transition into a glassy state com-posed by clusters of H_2O dipoles. Rich set of anisotropic and temperature-dependent excitations are observed in the te-rahertz frequency range which we associate with rotation-al/translational vibrations.