Thermodynamics and relaxation properties of $Rb_{1-x}(NH_4)_xH_2PO_4$ type proton glasses

S.I. Sorokov, R.R. Levitskii and A.S. Vdovych

Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine, 1 Svientsitskii Str., 79011 Lviv, Ukraine, E–mail: sorok@mail.lviv.ua

We propose a cluster approach for investigation of thermodynamics and relaxation properties (Glauber dynamics) of proton glasses. Within the two-particle cluster approximation and in the framework of the replica symmetric approach we study a simple proton glass model with essential competing short-range and weak long-range interactions for hypercubic lattices. It is shown that the imaginary part of the susceptibility exhibits a low-temperature peak which corresponds to the system transition to a non-ergodic state. The phase diagram for different interaction parameters and random internal field is plotted. We propose a pseudospin model for proton glasses of the $Rb_{1-x}(NH_4)_xH_2PO_4$ type, which takes into account the energy levels of hydrogens (deuterons) around the PO_4 group, long-range interactions between the hydrogen bonds, and an internal random deformational field. We derive a system of equations for the state parameters for the regions which are in the ferroelectric and antiferroelectric states, as well as in the proton glass state. We obtain a qualitative description of the temperature behavior of Edwards-Anderson parameter and dielectric permittivities of $Rb_{1-x}(NH_4)_xH_2PO_4$, $Rb_{1-x}(ND_4)_xD_2PO_4$, $K_{1-x}(NH_4)_xH_2PO_4$, $Rb_{1-x}(NH_4)_xH_2AsO_4$ compounds. Origin of the low-temperature peak in the imaginary part of the dielectric permittivity in the proton glasses is discussed.