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Phase transitions and kinetics of metastable amorphous ice modifications

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Frozen water is a basic component of matter in the Solar system. It is not only present on earth but can be found on planets like Mars and a vast number of the planets' satellites, e.g., the moons of Jupiter and Saturn [1].

The thermodynamic conditions, i.e., pressure and temperature, to which water is subject at those satellites vary appreciably allowing, in accordance with water's phase diagram, the formation of a variety of crystalline phases of different densities [2]. However, it is discussed that the accumulation of water could have been accomplished by a condensation process from planetary nebula, thus, leaving at very low temperatures ($T < 100$ K) the condensate in a metastable amorphous state. As it has been shown throughout recent years, amorphous solid water exhibits equally a vast number of structures [3,4]. These structures span densities of 31 molec./nm^3 up to 41 molec./nm^{3}and, in conformity with the properties of the crystalline counterparts, they can be converted into each other by applying pressure or/and temperature changes.

To give a comprehensive description of the current state of the Solar system it is of essential importance to understand its past evolution. Obviously, such a description depends vitally on the phase transition properties of the elements and compounds present, and, therefore, on the phase behaviour of the water condensate.

We will show, based on results from neutron and x–ray scattering techniques, that in the case of the amorphous solid water modifications a classification of the sample state by the thermodynamic parameters pressure and temperature and the sample properties in its stationary state is not sufficient. It is of essential importance to access experimentally information on the energy landscape explored by the metastable structure.

References:

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