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Ice: a strongly correlated proton system PIERRE PUJOL, Ecole Normale Superieure Lyon, ANTONIO CASTRO NETO, Boston University, EDUARDO FRADKIN, University of Illinois at Urbana-Champaign — We discuss the problem of proton motion in Hydrogen bond materials with special focus on ice. We show that phenomenological models proposed in the past for the study of ice can be recast in terms of microscopic models in close relationship to the ones used to study the physics of Mott-Hubbard insulators. We discuss the physics of the paramagnetic phase of ice at 1/4 filling (neutral ice) and its mapping to a transverse field Ising model and also to a gauge theory in two and three dimensions. We show that H3O+ and HO- ions can be either on a confined or deconfined phase. We obtain the phase diagram of the problem as a function of temperature T and proton hopping energy t and find that there are two phases: an ordered insulating phase which results from an order-by-disorder mechanism induced by quantum fluctuations, and a disordered incoherent metal phase (or plasma). We also discuss the effects in the proton motion introduced by the lattice vibrations (phonons) and its effect on the phase diagram. Finally, we suggest that the transition from ice Ih to ice XI observed experimentally in doped ice is the confining-deconfining transition of our phase diagram.

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