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Thermodynamic functions and phase diagram of water and high-pressure ices: Implication to an outer water-ice shell of Ganymede

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Water and water ice are important components of many space objects. Astrophysical and spectroscopic research shows that Solar system giant planets' satellites (Europa, Ganymede, Callisto, Titan & Enceladus), small transneptunian planets, asteroids and comets contain considerable amount of water and ice. «Galileo» and «Cassini-Huygens» missions show that liquid water could possibly exist under outer ice shells of Jupiter and Saturn satellites. Water oceans also hypothetically exist on Triton, Pluton and icy objects of Kuiper belt.

Phase composition numerical modeling is the main method of internal structure and chemical evolution research for mentioned objects. Available physicochemical models of icy satellites' internal structure are based on geophysical and geochemical data obtained by space missions on one hand, and on thermodynamic data and equations of state on considered minerals and water phases on the other.

This research attempts to summarize experimental and theoretical data on water and ices Ih, II, III, V, VI, VII, VIII, X phase diagram and their thermodynamic properties. Based on mathematical processing of equations of state for high-pressure ices and experimental data on phase transitions in water-ices system, phase equilibrium is being modeled and thermodynamic functions values (Gibbs free energy, enthalpy, entropy and volume change) for most phase transitions are computed.

Based on geophysical (mass and moment of inertia from recent Galileo gravity measurements), geochemical (composition of chondrites) and thermodynamic (phase diagram of water and ices) constraints internally consistent models of Ganymede constitution are built. Total thickness of an outer water-ice shell of Ganymede is estimated.