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Seiche Motions in Ice-Covered Lakes: Theory and Observations

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In the context of general theory of ocean waves under an ice cover (flexural-gravity, internal, edge flexural-gravity, Kelvin, Poincare) [Muzylev, 2006, 2008, 2010] the theory of seiche motions in ice-covered lakes is developed. The ice is considered as thin elastic plate of uniform thickness, with constant values of Young's modulus, Poisson's ratio, density, and compressive stresses. The water is considered to be homogeneous, inviscid, non-rotating, and incompressible. Boundary conditions are such that the normal velocity at the bottom and coastal line are zero, and at the undersurface of the ice the linearized kinematic and dynamic boundary conditions are satisfied. The problem is examined without the hydrostatic approximation.

We have obtained common dependence for the period of seiche motions under an ice cover from eigen values of the normal modes of lake's oscillation (the extension of the well-known Merian's formula).

Three-year repeated measurements conducted in a shallow arctic lake Vallunden (Van Mijenfjorden, Svalbard) demonstrated very good agreement between the developed theory and the observational data.