Physical properties of Pluto's ice shell inferred from its viscoelastic relaxation

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This study attempts to constrain physical properties of the ice shell of Pluto in terms of viscoelastic deformation. Images taken by New Horizons suggest that Pluto has a global subsurface ocean underneath an ice shell. One rationale of this argument is that a giant basin, Sputnik Planitia, is located near the tidal axis with Charon. If there is no ocean, such a basin would be located near a pole, but this is not the case. This curious situation can be easily explained if the crust underneath the basin is locally thin and the ocean is locally thick, resulting in a positive gravity anomaly. Nevertheless, such topography at the base of the ice shell would relax gradually over time via viscous flow. We can constrain the viscosity of the ice shell from the fact that the timescale of viscous relaxation is longer than the age of this big basin. Numerical simulations of viscoelastic deformation of the ice shell of Pluto following the procedure adopted by Kamata & Nimmo (2017) indicate that the relaxation timescale longer than 1 Gyr requires the basal viscosity > 10^{18} Pa s. This result indicates that the reference viscosity of Pluto's ice shell is several orders of magnitude higher than that of terrestrial ice sheets or temperature of Pluto's ocean is very cold.

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