Stability of subsurface ocean in Pluto

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NASA's New Horizons spacecraft made its close flyby of the dwarf planet Pluto on July 14, 2015. The LORRI imaging system aboard spacecraft has acquired global images and unveiled a diverse range of landforms, from rugged mountainous region to extremely smooth plains, indicating geological processes that have substantially and recently modified the surface. Combining that accurate determinations of the mean radii of Pluto suggests that Pluto is a sphere, Pluto had or has a relatively warm interior (maybe an ocean) for the most part of its history.

Nitrogen (N_2) ice, higher volatility (melting point of 63 K in vacuum) than water ice, has been known from ground-based spectroscopy and the New Horizons has confirmed that N_2 (and CH_4) ice is enriched in the bright smooth plains, e.g., Sputnik Planum (SP). The ALICE, ultraviolet imaging spectrograph, has observed Pluto’s nitrogen-rich atmosphere as far as 1,600 kilometers above the surface of the planet, demonstrating that nitrogen is volumetrically dominant on Pluto. In parallel, water ice is widely distributed on Pluto, in particular, on rugged mountainous region having relatively older age than SP. It implies that Pluto is covered by huge amount of water ice and few-km thickness nitrogen presents above water ice “bedrock” based on the molecular abundances in the Solar System. High volatility of nitrogen ice can lead to melting and rapid thinning of the ice shell (and forming an internal nitrogen ocean) and can drive tectonics on Pluto even if radiogenic heating is expected to be rather low at present and tidal heating is not efficient.

Here we are going to show the results of numerical simulation for the thermal history in Pluto, and this dwarf planet far away from the Sun has a potential to harbor an ocean and thin solid nitrogen crust might be able to support 2-3 km height ragged mountains even few-km thickness.

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