Title: Dynamics of icy satellites with a liquid phase

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Abstract: Jupiter's moon Europa has a young surface with a plethora of unique terrains that indicate recent endogenic activity. Morphological models and spectral observations suggest that it possesses an internal ocean as well as shallow pockets of liquid water within its outer ice shell. Presence of water in a chemically rich environment and a longterm energy source ensured by tidal heating, make Europa one of the best candidates for habitability, for which the material exchange between the surface and the ocean is critical. In this thesis, we investigate internal melting and subsequent meltwater evolution within Europa's ice shell by using a two-phase formalism developed for this context. Results of a parametric study for a temperate ice shell indicate that the time scale of water transport by porous flow is governed by the ice permeability, while the ice viscosity affects the solution wavelength. We then consider a polythermal ice shell with two melting scenarios: (i) In a tidally-heated convecting ice shell, melting occurs mainly in its lower half and all the meltwater is immediately transported to the underlying ocean. (ii) Contrarily, shear motions on a tidally-activated fault can induce melting as shallow as three kilometers below the surface. This meltwater pocket can remain gravitationally stable for at least 600 kyr if the underlying ice layer is not volumetrically heated.

Keywords: Europa, tidal heating, ice melting, water-ice mixture, two-phase flow