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Tidal Dissipation Within the Jupiter Moon Io – A Numerical Approach

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Satellite images and recent Earth-based observations of the innermost of the Galilean moons reveal a conspicuous pattern of volcanic hotspots and paterae on its surface. This pattern is associated with the heat flux originating from tidal dissipation in Io's mantle and asthenosphere. As shown by many analytical studies [e.g. Segatz et al. 1988], the local heat flux pattern depends on the rheology and structure of the satellite's interior and therefore could reveal constraints on Io's present interior. However, non-linear processes, different rheologies, and in particular lateral variations arising from the spatial heating pattern are difficult to incorporate in analytical 1D models but might be crucial. This motivates the development of a 3D finite element model of a layered body disturbed by a tidal potential.

As a first step of this project we present a 3D finite element model of a spherically stratified body of linear viscoelastic rheology. For validation, we compare the resulting tidal deformation and local heating patterns with the results obtained by analytical models. Numerical errors increase with lower values of the asthenosphere viscosity. Currently, the numerical model allows realistic simulation down to viscosities of 10^{18} Pa s. Furthermore, we investigate an adequate way to deal with the relaxation of false modes that arise at the onset of the periodic tidal potential series in the numerical approach.

Segatz, M., Spohn, T., Ross, M. N., Schubert, G. (1988). Tidal dissipation, surface heat flow, and figure of viscoelastic models of Io. Icarus, 75(2), 187-206.