# The dependence of surface tidal stress on the internal structure of Europa: On the possibility of cracking of the icy shell

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The exploration by the Galileo spacecraft has revealed that Europa has numerous lineaments on its icy surface. These lineaments have been considered to be cracks generated by the tide because they exhibit a particular alignment consistent with the tidal deformation. In this study, the possibility of the cracking at the icy shell by the diurnal tidal stress is evaluated by investigation about the dependence of surface diurnal tidal stress on the internal structure of the satellite.

The interior model of the satellite is a four-layered structure: the metallic core, the rocky mantle, the water ocean, and the icy shell. The internal density profile must satisfy the constraints of the total mass, the surface radius, and the axial moment of inertia of the satellite.

For such internal structure, the surface diurnal tidal stress is calculated using the formulation of Takeuchi and Saito. The obtained stress tensor is transformed into an effective stress in order to apply the failure criterion of von Mises.

The calculation gives two results.

First, the effective stress at a reference point (the anti-Jovian point at the peri-Jove) tends to decrease with thickening of the shell, and does not depend on the core radius and the H2O depth (i.e. the shell plus the ocean). These dependence and independence can be interpreted in terms of two effects: the gravitational potential perturbation at the bottom of the shell and the elastic support by the shell.

Second, the value of this effective stress ranges from 0.095 to 0.161 MPa under the constraints given in the present model. Since this range does not exceed the uniaxial tensile strength of ice at low temperature, the diurnal tide is not sufficient to break the shell. The distribution pattern of the surface cracks is, however, consistent with the tidal deformation. This evidence indicates two possibilities: existence of background stress overlapped on the tidal stress and/or stress concentration at preexisting micro-cracks. The candidates of the background stress are long-term deformations by non-synchronous rotation and/or true polar wander.