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Differentiation of the medium-sized icy satellites

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Abstract

The numerical model of differentiation of the medium sized icy body is developed. We use it for chosen satellites of Saturn and Uranus. Depending on the time of accretion the satellite could not differentiate at all, partly differentiate or fully differentiate. The partial differentiation leads to a special form of global convection. We believe that some surface features could be a result of this convection.

1. Introduction

Many medium-sized bodies of the Solar System are built from volatiles (e.g. water ice) and silicates. The densities of ice and silicates are different, so these bodies could be a subject of differentiation on the silicate core and the icy mantle.

2. Differentiation and two modes of convection

We develop a numerical model that includes: thermal conductivity, phase transition (melting), heat generation due to short and long lived radioactive elements and convection. Two types of convection are possible: solid state convection in the ice layer with moderate values of the Rayleigh number [e.g. 1] and convection in the melted part of the body with very high values of the Rayleigh number. This second type is possible if the body is (at least partly) melted. The melting leads also to differentiation of the body. Especially interesting is partial differentiation that results in the origin of 3 layers in the interior of the body: undifferentiated upper layer, icy layer and silicate core. It could result in special form of global solid state convection. We believe that some surface features on some satellites of Saturn and Uranus could be a result of this type of convection.

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References

[1] Czechowski L., Two models of parameterized convection for medium-sized icy satellites of Saturn. Acta Geophysica, 54, 3, 280-302.