MODELING OF TURBULENT ACCRETION SATURN'S SUBNEBULA AND FORMATION OF SATELLITES. A. B. Makalkin[1], V.A. Dorofeeva[2], and E.L. Ruskol[1], [1]Institute of Physics of the Earth Russian Acad. of Sci., B. Gruzinskaya, 10, 123995 Moscow, Russia, e-mail: makalkin@ifz.ru, [2]Vernadsky Institute of Geochemistry and Analytical Chemistry Russia Russian Acad. of Sci., 19, Kosygin Str, 119991 Moscow, Russia.

Introduction: Cassini-Huygens observations of Saturn system, including Titan, provide constraints on models of formation of Saturn and its regular satellites. In this work most of our attention is concentrated on the construction of model of the circumplanetary protosatellite disk of Saturn and consideration of the satellite formation in the disk. This work develops our preceding studies concerning conditions of formation of Galilean satellites in the Jovian subnebula [1, 2, and 3]. Recent models on the Saturn's subnebula [4] and on Jovian subnebula [5] consider constraints on volatile abundance in the regular satellites of Jupiter and Saturn.

Model and results: A two-dimensional numerical model of the protosatellite disk of Saturn (Saturn's subnebula) has been constructed. The model includes accretion of the gaseous and solid material from the surrounding region of the solar nebula on the Saturn's subnebula and accretion from the subnebula onto Saturn. The above accretion processes suggest the subnebula to be turbulent and heated by dissipation of turbulence in addition to radiation of young Saturn. It is shown that the main mechanism of energy transport in the subnebula is radiation. The opacity of the gas-dust medium of the subnebula is defined by composition of the solid component. We take into account temperature dependence of opacity below the water ice condensation temperature as well as at higher temperatures where organic compounds are responsible for opacity. Various degrees of gas depletion (or enrichment of solids) in the subnebula relative to the solar composition are considered in with regard to the observational constraints including the C/H ratio measured by the CIRS instrument aboard Cassini [6] new C/H data by Cassini. The radial and vertical distributions of temperature, pressure and density are obtained and the position of the water-ice condensation front is calculated. The model satisfies the restrictions from the mass of Titan and the present-day data on its chemical composition. The temperatures in the outer part of the subnebula (beginning from the Titan distance) are sufficiently low for stability of clathrate hydrates while their formation in the surrounding region of the solar nebula is more probable.

The rate of replenishment of protosatellite disks of Jupiter and Saturn by solid material due to the capture of planetesimals from the surrounding region of the solar nebula is evaluated. It is shown that in cosmogonically short time intervals 10^4–10^5 yr several large (10-100 km) bodies could be captured into the subnebula by two-body collisions, independently on gas inflow. The bodies play the role of seeds (embryos) in the process of satellite formation, which proceeds by accretion of subnebula's solid material onto these seeds. The main income of solid matter into the subnebulae from the feeding zones of the planets presumably resulted from the capture of dust particles and minor planetesimals (~20 m and less) through gas drag. We conclude that regular satellites obtained most of their material from the subnebulae, but satellite formation is impossible without capture of the seed planetesimals.

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