**CORELESS WATER ICE PLANETS.** P. Futó[1] [1] Department of Physical Geography, University of West Hungary, Szombathely, Károlyi Gáspár tér, H-9700, Hungary (dvision@citromail.hu)

**Introduction:** Different super-Earth types have been described, which are considered by the astrophysical and cosmochemical conclusions. Most of these are terrestrial objects likely, but many planets may exist with a significant amount of the water content in their structure. Such planet types are the so-called icy super-Earths or water planets. Icy super-Earths could formed outside the snow line of the protoplanetary disks, where the ices have an important role in the planet formation. The increasing solid fraction of ices in the disk composed mostly of $H_2O$.In this cold region, a super-Earth planet can retain the water content during the formation, and it may include water in major fraction of its total mass. In this case, water ice will be a top layer (above the silicate mantle and metallic core). The ice II ice III are major compounds for the ice shell of icy moons such as Jupiter's Ganymede [1]. One type of the surface layer in a deep water ocean that may exist on the icy planets for the case of adequate atmospheric features. These are the ocean planets [2] and they orbit in the habitable zone around the main-sequence G- and K-stars.For a water planet, planet interior models provide a basic composition that is tipically assumed to be iron, silicate (mainly silicate-perovskite) and different water ice phases. However, I expect that water ice planets with no metallic core may also exist and their silicate interior consisted of fully-oxidized metal-rich minerals.

In order to describe of the plausible compositions, we suggest an interior structure model for the water ice planet without metallic core.

**Modeling:** I focused on coreless water planets and provided a detailed models for the interior of a $5M_\oplus$ planet with an internal composition of 75% by mass silicate mantle and 25% water ice shell.

I have used two hypothesis for the formation of the coreless terrestrial planets,which is constituted by Elkins-Tanton and Seager [3]. They described two types of processes that yield coreless planetary interior. In the first case, the coreless planet made from material that oxidized fully before accretion. According to the second possibility, the planet accretes from water-rich and metal-rich materials. However, before the metal-rich material would sink and constitute a metallic core, the iron components reacts with water to form iron oxide. If this process is relatively fast, oxidized iron is trapped in the mantle, therefore a core unable to form. Expectly, both processes may occur in the cool regions of protoplanetary disks.For comparison, we have also calculated structure model for a water planet with 32.59% by mass metallic core, 42.41% silicate mantle and 25% water ice shell. We used equation of state (EOS) to the descriptions of physical parameters for the planetary interior. The selected EOS was the Vinet [4,5] because it is the most suitable equation for extrapolation to high pressures. The utilized zero pressure densities of main compounds are: 8.3 g/cm$^{-3}$ (iron), 4.26 g/cm$^{-3}$(silicate-perovskite) and 1.46 g/cm$^{-3}$ (water ice VII) respectively. Ice VII and ice X constitute mostly the water ice belt. Ice VII transforms with continous transition into ice X at 62 GPa and 300 K [6]. Furthermore, I have modeled the case which as an water ocean constitute the layer on the top. At the parameterization of ocean layer, I considered the temperature-dependence of pressure as a function of depth.

**Results of the structural analysis:** For the 5 $M_\oplus$ water ice planet with 32.59% by mass core, 42.41% silicate mantle and 25 % water ice shell,the calculated radius of metallic core is 0.81 $R_\oplus$, the radius of silicate mantle is 1.31 $R_\oplus$ and the total planetary radius is 1.73 $R_\oplus$ (Fig. 1).. In case of the 5 $M_\oplus$ coreless water ice planet, the obtained silicate interior's radius is 1.51 $R_\oplus$ and the total planet radius is 1.86 $R_\oplus$ (Fig. 2). It can be seen that the total raduis of coreless icy planet will be slightly larger than that of icy planet with core. The thick silicate mantle of coreless water ice planet composed of post-perovskite.

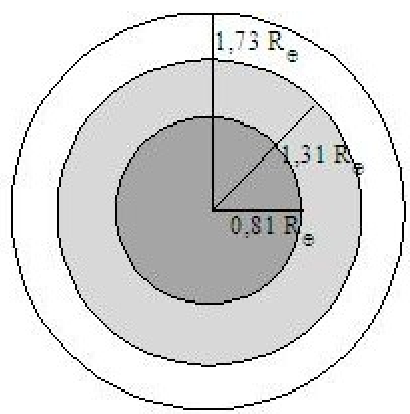


**Figure 1.**Schematic model for the differentiated water ice planet with metallic core,silicate mantle and ice-belt,respectively.

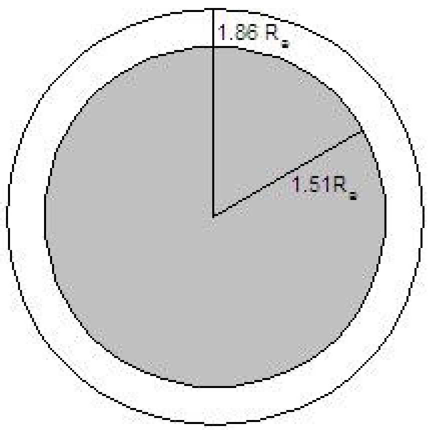


**Figure 2.**Structure model for the 5 Earth-mass coreless water ice planet with thick silicate mantle and ice-belt.

A 93 km deep water ocean covers the surface of the water planet under 288 K surficial temperature and $10^5$ bar atmospheric pressure. Underneath the water ocean, the ice exists in a higher pressure phase that composed of iceVI.
At the same time, planets that have larger/thickker mantles will have higher interior temperature. Thus, in the interior of smaller massive coreless water ice planets the water ice layer can be in melted state.

**Discussion:** Outside the snow-line of protoplanetary disks, water ice planet's formation with no core is more frequent probably than that have metallic core. This depends on the chemical properties of the formational enviroment and coreless water ice planet's formation might be caused by the dominant metal-oxidization before the accretion or before the sinking in the mantle. Such planets will be recognizable by compositional analysis using the precise observational data. In the near future, numerous observational data will be available for interpreting the compositions and structural modeling of low-mass exoplanets based on their mass and radius measurements.

**References:** [1] Fortes A.D.,Wood J.G.,Alfredsson M,et al.(2005) *Journal Appl. Cryst.***38:**612-618.[2] Léger A.,Selsis M.,Sotin C,et al.(2004) *Icarus* **169:**499-504.[3] Elkins-Tanton, L. T., Seager S., 2008, *Astrophysical Journal,* **688**, 628.[4] Vinet P. et al.1987. *J.Geophysical Research*,**92,**9319[5] Vinet P. et al.1989. *J.Phys.Cond.Matter*,**1,**1941 [6] Hemley R.J.,Jephcoat A.P.,Mao H.K.et al.(1987) *Nature*,**330:**737-740.