The role of Jupiter's heating and self-shadowing in shaping its circumplanetary disk

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At the very end of its growth, Jupiter became surrounded by a disk composed of gas and dust, where the Galilean moon presumably formed. It is supposed that satellitesimals formed by streaming instability and grew by pebble accretion. Once the satellitesimals reacedh a significant size, they undergone an inward type I migration by gravitational interaction with the disk. In the early stages of the circumplanetary disk, the migration of satellitesimals occurred over so short timescales that most bodies fell onto Jupiter, suggesting that the Galilean moons formed later during the disk's evolution. Other studies suggest that the moons sequentially formed and migrated inward. This suggests that the moons were trapped in mean motion resonances, halting their migration. In the coming years, the ESA mission JUICE and NASA mission Europa-Clipper will study the Galilean moons composition and provide hints on their formation conditions.

In this context, we aim to model the evolution of a 2-dimensional circumplanetary disk around Jupiter. To do this, we have constructed a quasi-stationary circumplanetary disk model that takes into account viscous heating, accretion heating, and heating of the upper layers of the circumplanetary disk by Jupiter. The latter depends on the shape of the photosurface of the disk, the surface where the disk becomes optically thick. The thermal structure is determined by a grey atmosphere radiative transfer model. We show that the heating of the disk's photosurface by Jupiter induces disk self-shadowing effects, which locally reduce the disk temperature. The resulting temperature variations can be up to 100 K relative to the surrounding disk temperature. Consequently, the circumplanetary disk can produce transient colder regions that can last up to 10 kyr.

The alternance of hot and cold regions in the Jovian circumplanetary disk has then profound implications for the formation conditions of the Galilean moons.