Turbulent convection and magnetically-driven flows in Europa's subsurface ocean.

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Jupiter's icy moons (Ganymede, Callisto, Europa) have been the focus of recent space missions and telescope observations, which have suggested the existence of liquid oceans beneath the outer layer of ice. However, the fact that water can remain liquid under the ice crust is not fully understood. The classic explanation is that the disintegration of silicate mantle rocks provides a significant radiogenic heat flux from the seafloor. The associated thermal convection modifies heat transfer in the ocean and therefore has an impact on the thickness of the ice crust, possibly influencing the generation of water plumes at the surface [1]. Two other effects have proved important for ocean dynamics : tidal forces [2] and Jupiter's magnetic influence on the conducting ocean, which generates a substantial jet of a few cm/s near the equator and consequent ohmic heating [3]. This magnetohydrodynamic effect could be partly responsible for the dynamics of the cracks visible on Europa's surface. This jet could rival that due to convection within a certain range of parameters.

Using direct numerical simulations of Europa's subsurface ocean, we will discuss how the nonlinear coupling of thermal convection with magnetohydrodynamic effects impacts the resulting zonal flow and heat transport in the ocean. Emphasis will be placed on the generation of turbulence in the flow, and on how this turbulence modifies the spatial distribution of heat flux within the ocean. In the perspective of upcoming JUICE and CLIPPER space missions data, these realistic nonlinear direct numerical simulations aim to provide a model that is directly comparable with observational data. In particular, our DNS could provide informations on turbulent dissipation in the ocean, thought to be linked to the structures observed at the surface and the thickness of the ice.

Références

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