Effect of the Planetary Magnetic Field on the Shape of Gas Giants' Polygons Based on Fluid Instabilities Principle

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In a region close to Jupiter and Saturn's poles, massive cyclones reorganize themselves to create a polygonal pattern. We hypothesized that the formation of the polygonal pattern from the cyclones may have resulted from the Lorentz force of both planets' magnetic fields due to an appearance of ionized hydrogen and helium gas in their atmospheres and the phenomenon's position located near the poles. In addition, fluid instabilities concepts and Coriolis force can be used to describe how gases flow through the atmosphere. Thus, to construct a simulation based on the flow of gases in the atmospheres of both planets, the Navier-Stokes equation was modified concerning a polar coordinate and combined with the influence of the Lorentz force. Initially, the magnetic field's intensity was varied in the Rossby wave simulation to examine atmospheric behaviors and vortex characteristics. The simulation's results were matched with those of a laboratory experiment in which a magnetic field was used to drive the flow of ions in a rotating tank comprising ionized salts to mimic Jupiter and Saturn's atmospheres. According to the observations, the size and location of vortexes appeared to be influenced by the strength of the magnetic field. The vortexes moved toward the center and shrank in size as the magnetic field's density increased. Additionally, due to the fluid's instability, the number of vortexes gradually decreased over time. These two aspects fit the atmospheric occurrence and could further explain and predict how the atmospheres of Jupiter and Saturn will behave.

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