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How did planets like Jupiter and Saturn get their stripes? Professors at the University of South Florida St. Petersburg and Ben-Gurion University of the Negev in Israel believe they have answered the long-standing puzzle and in the process discovered a new law of physics.

USF associate professor Boris Galperin, a physical oceanographer, working with Semion Sukoriansky and Nadejda Dikovskaya of Ben Gurion University, has identified the physical law that governs the atmospheric turbulence that results in the dark lines in the outer layers of the giant gaseous planets of Jupiter and Saturn and the ice planets of Neptune and Uranus.

"This new law," they write in a summary of their work, "is of fundamental importance not only in the theory of two-dimensional turbulence but also in atmospheric sciences and planetology."

Even amateur astronomers with inexpensive telescopes have long been aware that the markings on the largest planets in our solar system are caused by trains of clouds transported by organized, steady atmospheric currents. On earth, turbulence caused by solar heating and the collision of wind currents with land masses disrupts atmospheric flows. The resulting loss of energy prevents the formation of circulating, global cloud bands. In the thin atmospheres of gas giants, however, energy dissipation is small, and some of the sun's energy is gradually collected in stable, global jets that trap clouds and form planetary stripes.

For a long time, scientists have suspected that the interaction between planetary rotation and large-scale turbulence governs the banded circulations on giant planets. Galperin and Sukoriansky quantified this phenomenon, found an equation that characterizes the distribution of energy among different scales of motion and arrived at simple formulae that characterize basic energetic characteristics of giant planets' circulations.

The model helps explain the paradoxical observation that the outer planets have stronger atmospheric flows, even though the energy provided by the sun to maintain such flows decreases with increasing distance from the sun. The researchers have found that the atmospheres of distant planets dissipate even less energy than their warmer sisters.

Energy loss is driven in part by small-scale turbulence caused by the sun's heat. Therefore, while the outer planets receive less energy from the sun, they keep more of the energy they receive. This finding explains why Neptune has the strongest atmospheric circulation of all the gas giants even though it is the farthest of the bunch from the sun. "If the dissipation is small, even a miniscule forcing can spin up a very strong circulation over a long time," write Galperin and Sukoriansky.

In developing their calculations from which they reached their conclusion, they derived a mathematical equation from which the total kinetic energy of atmospheric circulation on giant planets can be derived. The equation relates the amount of energy in these atmospheric currents to the planet's radius, the speed at which it turns, and the number of jets.

The scientists' findings are outlined in their article, "Universal Spectrum of Two-Dimensional Turbulence on a Rotating Sphere and some Basic Features of Atmospheric Circulation on Giant Planets," which is published in the September issue of "Physical Review Letters," the top scientific journal for the physical sciences.