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Saturn's Diffuse Core from Ring Seismology

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Gravity field measurements only weakly constrain the deep interiors of Jupiter and Saturn, stymieing efforts to measure the mass and compactness of these planets' cores, crucial properties for understanding their formation pathways and evolution. However, studies of Saturn's rings by Cassini have revealed waves driven by pulsation modes within Saturn, offering independent seismic probes of Saturn's interior. The observations reveal gravity mode (g mode) pulsations that indicate that a part of Saturn's interior is stably stratified by composition gradients, and the g mode frequencies directly probe the buoyancy frequency within the planet.

We compare structure models with gravity and new seismic measurements from Cassini to show that the data can only be explained by a diffuse, stably stratified core-envelope transition region in Saturn extending to approximately 60% of the planet's radius. This predominantly stable interior imposes significant constraints on Saturn's intrinsic magnetic field generation. The gradual distribution of heavy elements required by the seismology constrains mixing processes at work in Saturn, and it may reflect the planet's primordial structure and accretion history.