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A New Branch of Internal Inertial-Gravity Waves in Rotating Flows: Interactions, Selection Rules, Refraction and Roll-Up into Vortices CHUNG-HSIANG JIANG, PHILIP MARCUS, UC Berkeley — In most atmospheric and oceanographic applications, the Coriolis parameter f is much less than the Brunt-Vaisala frequency N, and internal gravity waves with frequency ω exist when $f < \omega \leq N$. However, in many astrophysical applications, such as protoplanetary disks where planets form, there are large regions close to the disk's mid-plane where $N < f$. In those regions a new branch of internal inertial-gravity waves exists with $N < \omega \leq f$. These waves have selection rules that determine when their nonlinear interactions can produce harmonics. Collimated beams of these waves travel in straight lines when N and f are constant, but in in regions where either varies with location, the waves refract and the beams bend. Bent, collimated beams of these new waves are ubiquitous in our numerical simulations of protoplanetary disks. When the refraction and bending are large, we find that large amplitude waves "break" and spawn vertically-aligned vortices with Rossby numbers less than unity.

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