New Condition for The Rossby Wave Instability

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Recent observations have revealed the protoplanetary disks having non-axisymmetric structures, but the origin is still unknown. The Rossby wave instability (RWI) is one of the candidates of the origin. The RWI is a hydrodynamic instability in differential rotation disks, which forms non-axisymmetric large-scale vortices when disk profiles have a rapid radial variation. Previous works propose each of the necessary condition and the sufficient condition for the RWI. However, we are ignorant of the *necessary and sufficient* condition for the RWI.
In this work, we perform linear stability analyses of the RWI for barotropic flow on a wide parameter space. We calculate parameters for marginally stable states to the RWI. We find that the co-rotation radius is located at the background vortensity minimum with large concavity if the RWI is marginally stable. This allows us to check the stability against the RWI easily. We newly derive the *necessary and sufficient* condition for the RWI in semi-analytic form. It is expected that the new condition is available except when the width of the radial variation is much less than the scale height of the disks. The new condition and method will be useful for interpretations of observations and non-linear numerical simulations.

Keywords: protoplanetary disk, hydrodynamic instability, linear stability analysis

