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Enhancement of turbulence by elliptical instability with background rotation

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We address the question of stability of the Euler flow with elliptical streamlines in a rotating frame, interacting with uniform, external magnetic field perpendicular to the plane of the flow. Our motivation for this study is of astrophysical nature, since many astrophysical objects, such as stars, planets and accretion disks are tidally deformed through gravitational interaction with other bodies. Therefore, the ellipticity of the flow models the tidal deformations in the simplest way. The joint effect of the magnetic field and the Coriolis force is studied here numerically and analytically in the limit of small elliptical (tidal) deformations ($\zeta \ll 1$), using the analytical technique developed by Lebovitz & Zweibel (2004). We find that the effect of background rotation and external magnetic field is quite complex. Both factors are responsible for new destabilizing resonances as the vortex departs from axial symmetry ($\zeta \ll 1$), however just like in the non-rotating case, there are three principal resonances leading to instability in the leading order. The presence of the magnetic field is very likely to destabilize the system with respect to perturbations propagating in the direction parallel to the magnetic field, if the basic vorticity and the background rotation have opposite signs (i.e. for *anticyclonic* background rotation).

We present the dependence of the growth rates of the modes on various parameters describing the system, such as the strength of the magnetic field (h), the inverse of the Rossby number ($\mathcal{R}_v$), the ellipticity of the basic flow (ϵ) and the direction of propagation of modes (ϑ). Our analytical predictions agree well with the numerical calculations.