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Vorticity dynamics of revolving wings: The role of planetary vortex tilting on the stability of leading-edge vortex NATHANIEL WERNER, HOJAE CHUNG, Pennsylvania State Univ, JUNSHI WANG, GENG LIU, University of Virgina, JOHN CIMBALA, Pennsylvania State Univ, HAIBO DONG, University of Virgina, BO CHENG, Pennsylvania State Univ — This work investigates the radial vorticity dynamics and the stability of leading-edge vortices (LEVs) in revolving wings. Previous studies have shown that Coriolis acceleration plays a key role in stabilizing the LEV; however, the exact mechanism remains unclear. This study tests a new hypothesis based on the curl of the Coriolis acceleration in the vorticity equation, which corresponds to the radial tilting of the planetary vortex (PVTr). The PVTr could reorient planetary vorticity into radial vorticity that reduces the strength of the LEV, preventing the LEV from growing and becoming unstable. To test this, an in-house immersed-boundary-method-based flow solver was used to generate velocity and vorticity fields of revolving wings of different aspect ratio (AR = 3, 5, 7) and Reynolds number (Re = 110, 1400). It is found that the PVTr consistently negates the LEV vorticity for all the AR and Re investigated, although its effect is outweighed by other 3D effects at Re =1400. It is also found that the strength of the PVTr increases along the wing span until approximately a chord length from the wing tip. The averaged magnitude of PVTr within the LEV and the dependency of its relative strength on the aspect ratio and Reynolds number are also investigated.

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