Plasma instabilities driven by pickup ions of ring-beam velocity distributions in the outer heliosheath

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The stability of the pickup ions in the outer heliosheath has been studied by many researchers because of its relevance to the energetic neutral atom (ENA) ribbon observed by the Interstellar Boundary EXplorer. However, previous studies are primarily limited to pickup ions of near 90° pickup angles, the angle between the pickup ion injection velocity and the background, local interstellar magnetic field. Investigations on pickup ions of smaller pickup angles are still lacking. In this paper, linear kinetic dispersion analysis and hybrid simulations are carried out to examine the plasma instabilities driven by pickup ions of ring-beam velocity distributions at various pickup angles between zero and 90°. Parallel propagating waves are studied in the parameter regime where the parallel thermal spread of the pickup ions falls into the Alfvén cyclotron stability gap. The linear analysis results and hybrid simulations both show that the fastest growing modes are the right-hand helicity waves propagating in the direction of the background magnetic field, and the maximum growth rate occurs at the pickup angle of 82°. The simulation results further reveal that the saturation level of the fluctuating magnetic fields for pickup angles below 45° is higher than that for pickup angles above 45°. So, the scattering of pickup ions at near zero pickup angles is likely more pronounced than that at near 90° pickup angles.