Role of kinetic ion orbits in edge plasma flows for a single-null divertor tokamaks*

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The ion distribution function in the H-mode pedestal region and outward across the magnetic separatrix has the potential of having a substantial non-Maxwellian character owing to the large banana orbits, steep gradients in temperature and density, and neutral-ion charge-exchange. Because the sign of the radial shift of banana-regime ion orbits depends on the sign of the velocity along the B-field, kinetic effects can produce asymmetries in the toroidal and polodial mean flows. An assessment of the magnitude and character of such flows is made using the 4D (2r,2v) version of the TEMPEST continuum gyrokinetic code that utilizes a collision model (Coulomb or Lorentz) to calculate the ion distribution in a single-null tokamak geometry throughout the pedestal/scrape-off-layer regions. The ion distribution function, mean density, parallel velocity, and energy radial profiles are shown at various radial and poloidal locations. The collisions cause neoclassical energy transport through the pedestal that is then lost to the divertor plates along the open field lines outside the separatrix. The resulting heat flux profiles at the inner and outer divertor plates are presented and discussed, including asymmetries that depend on the B-field direction. Also examined is the effect a radial electric field exhibiting a deep well just inside the separatrix, which reduces the width of the banana orbits by the well-known squeezing effect.

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