Contribution ID: **132** Type: **Poster**

Kinetic trajectory simulation method for plasma-wall interaction of multi-component, electronegative, and dusty plasmas

Monday, 7 November 2022 16:10 (20 minutes)

The kinetic simulation method has been employed to study the plasma-wall interaction mechanism in various plasma conditions: multi-component plasmas, electronegative plasmas, and dusty plasmas. The negative species are considered to enter the sheath region from presheath side with truncated Maxwellian distribution, and the ions satisfy the Bohm and Bohm-Chodura conditions. The sheath conditions have been extended for the cases considered and various plasma-wall transition properties (space charge density, sheath potential, phase-space trajectory, and particle flux towards the wall) are found to be affected. The simulation model is applicable to various situations of interest in divertor region as well as in bounded plasmas. The presence of magnetic field and electrode biasing significantly alters the scale length of the Debye sheath region and Chodura layer as well. The dust charging, magnitude of ion drag force, and levitation of charged dust grains in the transition region depend on the biasing voltage and size of the grains. The dust particle acquires a negative charge at the particle injection boundary and becomes positively charged close to the electrode due to electron depletion in the Debye sheath region. The stable levitation distance, dust charge, and required electric field at that point have been estimated for the varying negative voltage applied to the electrode.

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Session Classification: Poster Session I (DEMOs & Next Step Facilities)

Track Classification: Divertors for DEMO and Next-Step Facilities