Adaptive Mesh PIC and PIC-Vlasov Hybrid Methods for Space Electrodynamic Tether and Anomalous Transport Modeling

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Original PIC method becomes computationally expensive or even fails when applied to certain physical problems that require detailed phase space resolution or low statistical fluctuations. In present work we discuss two such cases – with partially absorbing internal boundary and internal plasma source, respectively. Interestingly enough both problems originate from the area of space plasma propulsion.

The first problem requires accurate calculating of electrical current as collected by a bare wire in space. This particular task is tightly linked to the problem of a moving plasma probe [1,2]. When the wire extends for a considerable length across the Earth's magnetic field and is biased to a substantial voltage ~10-100V, it becomes a so-called electrodynamic tether, and a viable accelerator (or decelerator) of a spacecraft. Recent calculations [3] using variable grid PIC method have demonstrated luck of domain expansion to cover the whole region of the disturbed plasma background. The distorted zone stretches sidewise along the magnetic field, and there is a broad region of void plasma in the wake. To capture strong non-homogeneity we have combined RRC adaptive grid [4] and PIC methods.

The second problem is a self-consistent calculation of the anomalous transport in the Hall effect thruster. The reduced Bohm-like transport was observed in experiments [5], and was a subject of PIC study [6]. Our recent hybrid PIC-Vlasov simulations [7] show reduced transport, and possible energy dependence of the diffusion coefficient, which we continue to investigate in the present work.

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