2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

The Plasma Charging for Object in Space: Multiple Time Scale Simulation

Wang Hong-Yu[12], Sun Peng[1]
[1]School of physical science and technology, Anshan Normal University[2] Shanghai Bright-Tech Information Corp. Inc.
e-mail:why@btitgroup.com

A solid object immersed in plasma will absorb the electric particles and be charged. Typically, the effect causes obvious charging voltage only while the plasma particle's kinetic energy is large. It usually takes place in high earth orbit or deep space plasmas. In this condition, the plasma density is very low and the charging current is very small. Then the charging characteristic time is very long compared to the plasma evolution time. For the space craft charging, the characteristic time can be several tens of minutes.

The charging process can be analyzed by Particle-In-Cell(PIC) methods. But the ultra-slow charging time period cannot be wholly traced in the PIC codes because the simulating steps number are too large. Typical the PIC time step in this condition are about microsecond, and the step numbers become 10^8 and can not be executed in real works.

By the similar law, the dust particles charging in space plasmas have the same problem: the charging time is about 10^{-1}second, and the simulating time step is about femtosecond. Then the PIC simulating step numbers become unattainable large.

We build a code framework based on PIC to process these problems. With the multiple timescale method, the PIC simulating can be accelerates more than 10^7 times. A "guess-jump-relaxing" process is used to get rid of the potential oscillations. The algorithms shows stable and smooth converging in the accelerating.

As some patches, the charge-leaking inside the media and the photoelectron emission are inserted into the framework. These processes are accelerated by a semi-implicit scheme to get rid of the overestimation.

Figure1: the charging voltage curve and the space potential of a sphere dusty particle which is being charged in space plasma. The simulating is accelerated about 10^8 times to get converge. The voltage evolution curve seems to be smoothing.