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Solar wind interaction and magnetic inflation for small scale artificial magnetosphere around a magneto-plasma sail

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Magneto-plasma sail is one of the next generation flight systems to the deep space[1,2]. The propulsive force is obtained from interaction between the solar wind and the artificial magnetosphere created around the spacecraft. Previous hybrid and Hall simulations have suggested that a magnetosphere with a spatial scale comparable to the ion inertia length is necessary for effective interaction with the solar wind. On the other hand, realistic size coil of a few meters in radius is expected to create only an electron scale magnetosphere of a few kilo meters large or less. To solve this problem, magnetic inflation via plasma injection from the spacecraft has been proposed[3]. However the interactions of the electron-scale magnetosphere with the injection plasma and the solar wind are still poorly understood.
Two dimensional full particle-in-cell simulations have been performed to investigate the magnetic inflation and the solar wind interactions for the small scale artificial magnetospheres. The magnetic inflation processes is characterized by the gyration motion of the injected ions. Ion rich regions are formed at the turning around position of the injected ions and electrons flow into this position carring the field lines of the original magnetosphere. As a result, the magnetosphere is deformed effectively when the spatial size of the original magnetosphere is comparable to the ion gyration radius. For the electron scale magnetosphere, the inflation process is confined to the smaller region before the ion gyration point as a result of the interaction between background electrons and the injected ions.
The solar wind interactions and the resulting gain of the propulsive force for the electron scale and the deformed magnetospheres will also be discussed by comparison to that for the ion scale magnetosphere.

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