Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2019-41-RC2, 2019

Annales Geophysicae Discussions
Open Access
EGU

Interactive comment on "Long Range Plasma Momentum Coupling by High Voltage Static Electric field and Deep Space Exploration" *by* Kokwei Chew et al.

Anonymous Referee #2

Received and published: 3 July 2019

General comments

The authors suggest an "improved" electric sail design which is more compact than the original tether-based electric sail and thus could provide potential benefit in terms of manoeuverablity. Unfortunately, it seems to me that the power budget estimations are not correct, and even if they were correct, the power requirement is so high that the concept is hardly competitive against the original electric sail (with moderate voltage, as originally proposed, or perhaps with increased voltage: if we are ready to increase voltage to MV in this concept, the same could be done with the original concept as well) and electric propulsion. Because of these fundamental problems, I cannot recommend

Printer-friendly version

Discussion paper

the paper for publication.

Specific comments

1) By Eq. (4) I get much larger currents than those in Table 2. If I assume 10 eV electron temperature in the solar wind so that v=1.8e6 m/s, I get 7 kA current. This would lead to 7 gigawatts of power consumption at 1 MV potential.

2) One could obtain a estimate without simulation by simply solving at which value of r the V(r) of Eq. (2) has the value V_1 and calling this r the maximum impact parameter. I am not sure but the result might even be expressable analytically in terms of Lambert's W function.

3) I think it would be sensible to compare this system with the ordinary E-sail geometry where V0 has the same value as here. The present design is more compact, but I would guess that the ordinary electric sail model has lower power versus thrust ratio, because of the mathematical forms of the thrust and OML current expressions for cylindrical and spherical cases. The cylindrical case yields less electrons being collected, per unit of thrust produced, because the attracted electron flux converges in only one dimension rather than two.

4) Even if the power estimate of 1e5 W would be right, it corresponds to very high power versus thrust ratio, several orders of magnitude higher than the electric sail.

5) At line 101, it is not true that all electrons arrive from the solar wind direction, because in the solar wind, the electron thermal speed is usually larger (by factor of four or five, say) than the bulk speed. Hence electrons arrive from all directions. Probably this does not change the form of equation (4), though.

6) The spheres are at ends of tethers. If the tethers are bare, there will be enormous electric field on their surface, much larger than on the surface of the sphere. If they are insulated, the insulator must be relatively thick, perhaps $\sim$1 cm, in order to withstand 1 MV voltage. Such insulation might add considerable weight.

Interactive comment on Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2019-41, 2019.

Printer-friendly version

Discussion paper