Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2019-41-AC2, 2019


Annales Geophysicae Discussions

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

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Received and published: 14 July 2019

The authors are grateful to the referee for the careful reading and insightful comment. We hope we can have better discussion with the referee about his/her concerns. Here is our reply:

About the general comments:

Our concept differs with the original electric sail design in the following ways: 1. Size and maneuverability. 2. The physical model of the way the spacecraft interact with the background plasma / solar wind. 3. The range/quantity of the plasma the space-



craft can interact with, hence the amount of beneficial momentum the spacecraft can harvest. 4. The tethered balls are designed to effectively lower the potential of the whole structure, hence improve the power efficiency. We are concerned with the original design with the numerical/physical model of the way the spacecraft/tether interact with the plasma. We think a global dynamic electro-magnetic field simulation is more realistic, because the depletion of electron around the spacecraft would yield a global effect. That is what we had been doing in the past few years, but we experience numerical problems and cannot have a stable and presentable result. We can share some facts of the simulation here: the power efficiency is much better, in at least one order of magnitude; as the simulation scale is limited by about tens of kilometers, the field was always significantly affected by the boundary conditions; the magnitude difference between the vicinity of the spacecraft and the far away regions is always a problem; we found the force the spacecraft experienced is oscillating, even in an absolutely stable solar wind, which is understandable, because of Langmuir oscillation, and this is only achievable by a realistic field solver. The original idea of long thin lines has the following difficulty except for the size: 1. It is not realistic to maintain a constant voltage on a thin and long conducting line, let alone in a conducting environment (plasma). 2. The assumption that the current only comes from the single particle trajectory collision of the electrons is not well grounded. 3. If we put charge in a conductor, the charge automatically distributes to the tipping points of the conductor, as we dealt with in our paper. Of cause, our concept is still a preliminary proposal, and some number in the original paper does not look good, such as the power assumption, but we also pointed out the power efficiency can be improved by increasing the effective radius, which still have a large room. Actually we have modified this part in response to the first referee. One important reason for our seeking of publication is: This work is not officially supported, as the students graduated, the concept will simply die. We also hope the concept could attract attention of experimental scientists, because proof of concept experiment is simple, just blow a charged ball with a plasma. The ideas of braking, artificial particle beam momentum delivering, cosmic jet surfing, etc., are still

worth sharing.

As for the specific concerns: 1. Not all electron come from the solar wind will be intercepted by the structure. In our case, the effective radius is different from the collisional radius of the electron trajectory, because the effectiveness is for the potential, not for interception of the electron. The space is still very much empty. 2. Yes we could explore more in this direction. One of our concerns is that it is hard to set a cut-off limit for the potential, for it is now more likes a Coulomb one. 3. Please see the general explanation. 4. The effective radius we used in the original paper is a little too small. We have modified the manuscript with a larger effective radius and better power efficiency in responce to the first referee. 5. We do use a simpler assumption that all particles comes from the incoming direction of the solar wind with the same speed (hence no temperature). This could affect the single particle model, but eventually, only the potential, the current, and the distribution of the potential matter. 6. We have discussed this in the last paragraph of the introduction, which seems to be not a problem.

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