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Spacecraft Propulsion by Solar Radiation

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Abstract: **It seems to be very amazing if we use Solar wind for future propulsion of Spacecrafts. This project deals with the application of Solar wind which is a possible source of momentum that might be usable for spacecraft propulsion. It could be utilized by creating an artificial magnetosphere around the spacecraft. The result is that the force acting on the spacecraft is maximum when no plasma is injected. The physical reason is that although injecting plasma makes the magnetosphere larger and increases the force acting on the magnetopause; most of the momentum is transferred to the escaping plasma. This is in contrast that because of the increased force acting on the magnetopause, injecting plasma would increase the net thrust on the spacecraft.**

Keywords: **Magnetosphere, Magnetopause, Plasma, Propulsion.**

I. INTRODUCTION

The extent of human exploration in Deep Space has been increased in a past few decades. With the advent of the Manned mission to explore a deeper space Mars is our first destination. Accelerating spacecraft to velocities higher than what is attainable using chemical rockets would be desirable in this mission, for example in those that would explore the interstellar plasma and gas outside the heliosphere. To go beyond chemical rockets one needs either nuclear energy or, alternatively, one has to tap the energy or momentum from a natural source. A possible natural energy source is the solar radiation, which has already been used for producing electricity and powering an ion or plasma engine. So, with this mission we use basic laws from Newton's Second law of motion and use the principle of momentum to propel our Spacecraft.. This idea has been described below with an eye on the future.

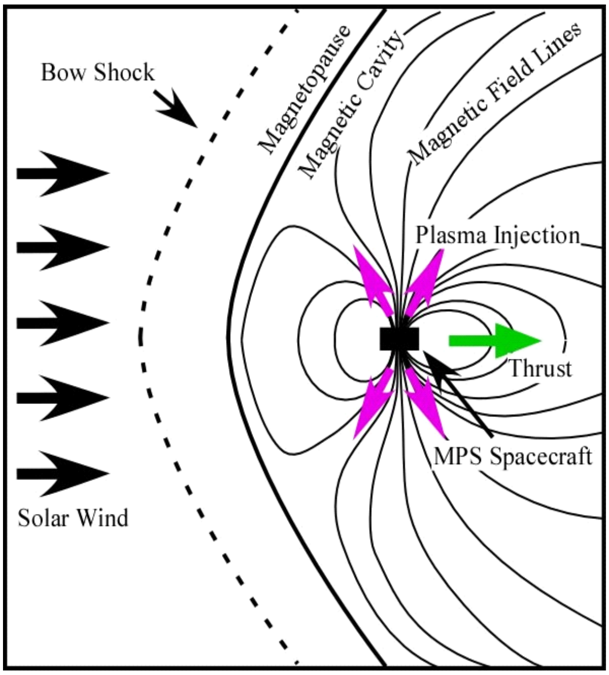
II. DESCRIPTION OF IDEA

The basic idea behind this to "replicate the magnetosphere functions of planetary systems to a smaller system of Spacecraft".

Solar wind is a possible source of momentum that might be usable for spacecraft propulsion. It could be utilized by creating an artificial magnetosphere around the spacecraft. Creating an artificial magnetosphere around a spacecraft using a magnet has been a possible way of extracting momentum from the solar wind for spacecraft propulsion. In addition to spacecraft propulsion, artificial magnetospheres might be interesting also as "toy" models of real magnetospheres. Whether these prospects prove fruitful or not depends crucially on how large force the solar wind exerts on the system and what are the scaling properties of the plasma contained in the magnetosphere with respect to its size, the strength of the magnetic field and the magnitude of the dipole moment. The purpose of this paper is to take the first steps towards understanding these questions in a broad sense using theoretical formulas and scaling laws.

III. WORKING

As momentum sources, either the solar radiation pressure or the solar wind dynamic pressure could be used. At any fixed distance r from the Sun, the solar radiation pressure is 5000 times larger than the solar wind dynamic pressure since both pressures decay as $1/r^2$. Still, because tapping momentum from the solar wind dynamic pressure does not require a solid structure but only a magnetic field, it is not clear a priori that a magnetic sail is inferior to a solar photon sail. From the spacecraft propulsion point of view, a drawback of a magnetic sail is that the solar wind is highly variable and the variations are unpredictable over mission time scales. How severe this problem is depends heavily on the type of the mission.



Consider a spacecraft with magnetic dipole moment M. In the vacuum case, the magnetic field at distance r from the spacecraft is

$B = (\mu_0 M) / (4\pi r^3)$

If no plasma is emitted from the spacecraft, this above expression is approximately valid everywhere inside the magnetosphere except for the distortion caused by the solar wind which we consider below. If plasma is emitted, however, the situation is more complicated, as the artificial magnetosphere then starts resembling the heliosphere rather than Earth's magnetosphere. To model this effect let us assume that the field is dipolar up to distance L from the spacecraft and that beyond L, the radial dependence is $1/r^b$ where $b <= 3$. In the heliosphere, b~2 in the polar regions and b–> 1 in the equatorial plane with increasing distance.

Thus, outside r = L the magnetic field is given by:

$B(r) = (\mu_0 M L^b) / (4\pi L^3 r^b)$

IV. CONCLUSION

This concept of propelling the Space craft is a very feasible approach as with no practical source we are viable to propel the mission spacecrafts even to our fourth planet or farther with heavy payloads.

In this project I had seen that to maximise the solar wind propulsive effect, no plasma should be injected from the spacecraft: the maximum force on the spacecraft is obtained when the magnetosphere is empty and the field is as dipola as possible.

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