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PRELIMINARY ASSESSMENT OF A SOLAR WIND SHIELD BASED ON A PLASMA-INFLATED ARTIFICIAL MAGNETOSPHERE

Abstract

Particle radiation from the Sun is one of the main obstacles to safe interplanetary human missions. Since the early 60s, various protection methods have been proposed to this purpose. One of the most attractive concepts involves the creation of an artificial magnetosphere around the spacecraft, similar to what occurs naturally around the Earth. In principle, this could be done by using a magnet placed on the spacecraft in order to produce the magnetic field necessary to the deflection of solar wind particles; however, the large magnetic dipole moment required to create an artificial magnetosphere strong enough to shield the spacecraft makes this solution unfeasible.

A promising workaround to circumvent the need of a large onboard magnetic moment is represented by the inflation of the magnetic "bubble" with a plasma injected from the spacecraft. The effect of the plasma injected into the magnetosphere is to "freeze" the magnetic field lines in the plasma so that they are effectively carried away with the flow, thus enlarging the size of the magnetosphere.

In this paper we introduce an analytical model to describe the dimensions of the mini-magnetosphere as a function of the parameters of both the solar wind and the injected plasma. The model is used to assess the feasibility of a large scale experiment in a vacuum chamber, namely facility IV10 of Alta Spa; with a diameter of 6 m and a length of 10 m, such facility would allow for the creation of a mini-magnetosphere with minimal residual interference from the conducting walls of the vacuum vessel, thus leading to direct experimental assessment of the effectiveness of the radiation shield.