Method and apparatus for removing orbital space debris from near Earth orbit using the Solar Wind: Platform for Redirecting and Removing Inert Space Material (PRRISM)

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ABSTRACT

The interplanetary magnetic field (IMF) together with solar plasma, flows outward from the sun at two distinct speeds and in a toroidal pattern that is sometimes referred to as the Parker spiral. As the solar wind approaches Earth, a complex system of reconnection begins near the polar cusps. Scientific measurements from Hawkeye and Imp 8 have shown that the flow beneath the magnetopause is turbulent through the polar cusps. This paper will discuss PRRISM as a means to remove small and medium size debris particles without having to operate in the same orbit, thus minimizing the chance of a collision that would create more debris. The discussion will focus on the available mass, dynamic pressure, and force available from the solar wind and also the mass, dynamic pressure, and force available at the exit of the polar cusps. Estimates were made on the density and speed within the polar cusps under the normal flow patterns based on previously obtained science data. This concept utilizes an electromagnetic wave antenna aimed at the polar cusps to create a more streamlined and laminar flow as the normal solar wind passes into the polar cusp. Turbulence is minimized and the density is increased to improve the available force through the polar cusp. It can be shown that the available estimated force is magnitudes greater than the force needed to remove small pieces of space debris. Alternative approaches would include multiple satellites or an antenna placement on the international space station. Under normal conditions the solar wind interacts with the Earth's geomagnetic field in a very complex reconnection process. Consequently, turbulence occurs with flow moving in different directions within the cusp including an upward flow as evidenced by ionospheric ions present higher up in the cusp. Placing a dedicated satellite at about 10 Earth radii upstream of the polar cusp and integrated with a solar plasma Sensor and a space debris Sensor, PRRISM would operate similar to a missile intercept solution; where the solar plasma "the missile" would be timed to intercept the space debris "the target". In this scenario the electromagnetic wave antenna would be operated based on known solar plasma parameters and timed to intercept specific debris particles. This electromagnetic wave would create a sufficient pressure force through either or both of the polar cusps for a duration long enough to redirect and remove the targeted debris. It is understood that multiple solutions as well as international cooperation will be required. This paper proposes a solution to the more dangerous smaller debris, especially with the growing commercial interest in space operations, including passenger travel in low Earth orbit.