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Dynamics, structure and signatures of the sector region in the outer heliosphere: a turbulent sea of bubbles

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All current global models of the heliosphere are based on the assumption that the magnetic field in the heliosheath connects back to the Sun. In particular, models of transports of galactic cosmic rays (GCR) assume the heliospheric current sheet is laminar as well. The sectored magnetic field due to the flapping of the heliospheric current sheet compresses across the termination shock and may reconnect in the heliosheath, driving the anomalous cosmic rays and producing a sea of elongated magnetic bubbles. These magnetic islands/bubbles will be convected with ambient flows as the sector region is carried to higher latitudes filling the heliosheath. We present a three-dimensional MHD simulation with very high numerical resolution that captures the north-south boundaries of the sector region.

We show that due to the high pressure of interstellar magnetic field a north-south asymmetry develops such that the disordered sectored region fills a large portion of the northern part of the heliosphere with a smaller extension in the southern hemisphere. We present particle-in-cell simulations that capture the development and dynamics of the bubbles. A number of Voyager observations are consistent with the bubble picture of the heliostheath, including flow enhancements, magnetic field compressions, and strongly-altered transport properties. The magnetic field outside the sector will be laminar connecting back to the Sun. We expect then that the diffusive nature will be very different inside vs outside the sector region. Under this new scenario, the heliopause will not be the traditional thought tangential discontinuity separating the heliosphere from the interstellar medium, but more like a porous membrane. A porous heliosphere might allow GCRs to enter more easily into the heliosphere. Once they enter inside the sector region they get trapped in the magnetic bubbles slowly making their way into the heliosphere. If they diffuse into the unipolar region they quickly escape into the heliosphere.

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