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Magnetized Jets Driven By the Sun: The Structure of the Heliosphere Revisited

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The classic accepted view of the heliosphere is a quiescent, comet-like shape aligned in the direction of the Sun's travel through the interstellar medium (ISM) extending for thousands of astronomical units (AUs). Here, we show, based on magnetohydrodynamic (MHD) simulations, that the tension (hoop) force of the twisted magnetic field of the Sun confines the solar wind plasma beyond the termination shock and drives jets to the north and south very much like astrophysical jets. These jets are deflected into the tail region by the motion of the Sun through the ISM similar to bent galactic jets moving through the intergalactic medium. The interstellar wind blows the two jets into the tail but is not strong enough to force the lobes into a single comet-like tail, as happens to some astrophysical jets. Instead, the interstellar wind flows around the heliosphere and into the equatorial region between the two jets. As in some astrophysical jets that are kink unstable, we show here that the heliospheric jets are turbulent (due to large-scale MHD instabilities and reconnection) and strongly mix the solar wind with the ISM. The resulting turbulence has important implications for particle acceleration in the heliosphere. The two-lobe structure is consistent with the energetic neutral atom (ENA) images of the heliotail from IBEX where two lobes are visible in the north and south and the suggestion from the Cassini ENAs that the heliosphere is "tailless."