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Pressure Balance at the Heliosphere Boundary and in the Local Interstellar Cloud

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The pressures exerted by the solar wind from the inside and the interstellar medium from the outside control the size and shape of the heliosphere. Magnetic fields and cosmic rays play important roles to varying extents on both sides. We will assess the pressure balance by assembling the relevant component pressures in the (inner) heliosheath inside the heliopause, in the Very Local Interstellar Medium (VLISM, interstellar medium affected by the presence of the heliosphere or outer heliosheath), and in the Local Interstellar Cloud (LIC) unaffected by the heliosphere. We take the cosmic ray pressure from Voyager observations, which don't show substantial gradients beyond the heliopause. The remaining pressure on the heliopause from inside is due to thermal and suprathermal ions in the subsonic solar wind, obtained from IBEX and INCA ENA observations and Voyager in situ measurements at the higher energies.

Besides cosmic rays, the pressure in the undisturbed LIC is composed of magnetic field pressure taken from IBEX Ribbon observations and related modeling. Thermal and turbulent pressures are based on H and He neutral and ion densities from pickup ion and interstellar gas flow observations, combined with the temperature and turbulent speed from absorption-line observations. The total LIC pressure in its rest frame is almost 40% lower than the pressure inside the heliopause, whereas adding the full ram pressure based on the LIC velocity relative to the Sun exceeds that pressure substantially. We estimate the likely effective pressure on the heliopause by combining the compressed interstellar magnetic field, as measured by Voyager, and the compressed and heated interstellar plasma, resorting to results from global heliospheric modeling. An interesting result of these pressure comparisons is that the effective ram pressure on the heliopause is somewhat larger than the combined magnetic field, thermal, and turbulent pressure in the LIC, which points to the importance of the LIC ram pressure for the shape of the heliosphere. We also compare the LIC pressure with the gravitational pressure on the galactic disk at the location of the Sun.