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Transport

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Modulation of galactic cosmic rays in a north-south asymmetrical heliosphere

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Observations made with the two Voyager spacecraft confirmed that the solar wind decelerates to form the heliospheric termination shock. Voyager 1 crossed this termination shock at 94 AU in 2004, while Voyager 2 crossed it in 2007 at a different heliolatitude about 10 AU closer to the Sun. These different positions of the termination shock confirm the dynamic and cyclic nature of the shocks position. Observations from the Voyager spacecraft inside the heliosheath indicate significant differences between them suggesting that apart from the dynamic nature caused by changing solar activity there also may exist a global asymmetry in the north-south (polar) dimensions of the heliosphere, in addition to the expected nose-tail asymmetry. This relates to the direction in which the heliosphere is moving in interstellar space and its orientation with respect to the interstellar magnetic field. The effects of this north-south asymmetry on the modulation of galactic cosmic rays are investigated, using a numerical model which includes all four major modulation processes, the termination shock and the heliosheath. When comparing the modulated spectra between polar angles of 55 and 125 at the same radial distances we find that effects of asymmetric modulation are insignificant up to 60 AU from the Sun but become increasingly more significant with larger radial distances to be a maximum inside the heliosheath. How large these effects can become depends obviously on the extent of the geometrical asymmetry and the assumed local interstellar spectrum at lower energies.