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How accurately can we reconstruct the IMF upstream of Saturn's bow shock from measurements downstream?

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Abstract

Using potential theory, the draped magnetic field across a bow shock can be characterised at steady state by solving analytically. Here we are interested in the reverse: using data measured by Cassini in the magnetosheath and using the inverse of the model to reconstruct the magnetic field to that of the Interplanetary Magnetic Field (IMF). The method is statistical and aims to see how well the global magnetic field in the kronian vicinity matches with an ideal model that applies to any magnetised planet encountering solar wind. The method is first tested via case studies using Earth data. Cluster spacecraft measure a string of magnetic field components in the magnetosheath over a chosen timeframe. This is then fed into the model and reconstructed. The resulting data is compared to appropriately time-shifted data taken by ACE. For all cases, the IMF data reproduced from magnetosheath data are of acceptable magnitude and fluctuation. For most cases, there is a good correlation in the reconstructed *y* and *z*-components with ACE's data of *y* and *z* respectively. The *x*-component, however, does not match up. Because Saturn does not have an upstream monitor, a different statistical approach is used. We know what the average and most probable orientation of the magnetic field upstream of the bow shock: ~0_{o} for the meridional (out of equatorial plane) angle and a double peak of ~90^{o} and ~270^{o} for the azimuthal (in equatorial plane) angle. The input is over three years' data in the magnetosheath and these are reconstructed using the model. The reconstruction shows realistic magnitude and fluctuation. The data (as x, y and z-components) are then used to evaluate the meridional and azimuthal angles. We find a match in the meridional angle with a tighter peak at 0_{o} and significantly less dispersed distribution than that of the magnetosheath (before reconstruction). The azimuthal angle, however, shows a double peak at ~20^{o} and ~210^{o} when inputting measurements from the dawn flank and ~150^{o} and ~330^{o} from the dusk flank. This is unsurprising as the azimuthal angle is very dependent on the *x*-component of the magnetic field and confirms that the *x*-component does not agree sufficiently with the ideal model. Further work involves investigating reasons for the component's significant departure from the ideal model.