Alpha Beta Coordinates of Neptune's Magnetic Field

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Abstract—
Alpha, Beta coordinates, representing magnetic field lines, are very powerful in studying particle motion and plasma phenomena. However, for a long time these coordinates could only be determined for a few simple magnetic configurations, because of mathematical difficulties. Recently, based on the point of view of magnetic field geometry, T. S. Huang developed a new approach to define the Alpha, Beta coordinates for a general magnetic field with a form in spherical harmonics. As a prelude to studying the motion of the particles and plasma configuration of the Neptunian magnetosphere, this new approach is used to set up the Alpha, Beta, frame for Neptune's magnetic field.

The encounter of Voyager II with Neptune revealed a very complicated magnetosphere and a magnetic field whose data has some eighty coefficients. Using T.S. Huang's approach, the Alpha, Beta coordinate is defined from the $V = 0$ potential surface. On this surface a bi-normal line (on which B is constant) is selected for alpha(0). This line is far from the region of the magnetic source, where the higher order poles (quadrupoles and octupoles) drop off and only a dipole remains. Then by scaling this bi-normal line from 0 to 2p, the Beta for each principal line is obtained. To obtain a values for other bi-normal lines, we integrate the magnetic flux over the surface; thus scaling of the principal and bi-normal lines for the appropriate Alpha's and Beta's is given.

Results of this work are: (1) The principal and bi-normals associated with specific Alpha and Beta values on the $V = 0$ equi-potential surface; (2) Mapped field lines from the $V = 0$ equi-potential surface to space, and (3) The contours of Alpha and Beta on the northern and southern hemispheres.