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Flux Transfer Events in the Northern Hemisphere Polar Cusp Under Strong IMF Bx

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The location, shape, and size of the magnetospheric polar cusps are heavily influenced by upstream solar wind conditions. The effects of dominant IMF Bz and By components on the cusp are now well known. However, the effect of a strong IMF Bx component on the structure of the polar cusps is relatively unexplored. We present a case study of data recorded by the four Cluster spacecraft during a crossing of the northern hemisphere high altitude cusp in the winter season of 2018, when the IMF is directed southward and sunward. The Cluster spacecraft traverse the high-altitude cusp with separations between several hundred km and 1.5 Earth radii between each spacecraft, and travel at a roughly constant latitude with changing MLT. We study these observations in conjunction with those of the ground based SuperDARN radars.

Each spacecraft observes many flux transfer type events within the cusp, although some events are not seen on all 4 spacecraft. The magnetic field orientation often varies significantly during each distinct passage through individual flux tubes, clearly departing from the background magnetic field direction expected in the northern hemisphere high altitude cusp. A number of these events show bidirectional electron flux signatures typical of those expected on recently reconnected open northern hemisphere flux tubes. However, some flux tubes appear to be populated only by antiparallel moving electrons, while others show an isotropic distribution of electrons and ions. The SuperDARN STO radar site observes Poleward Moving Auroral Forms (PMAFs), consistent with the interpretation that Cluster observes open flux tubes, however the directions of convecting flux tubes seen by Cluster are not always consistent with the SuperDARN picture. We consider whether the influence of the strong IMF Bx results in the relocation of the dayside reconnection site to high northern latitudes, allowing Cluster to encounter a mix of open flux tubes in the northern cusp, each of which may be connected to either the Northern or Southern polar ionosphere. The latter configuration may be particularly supported if reconnection near the cusp results in southern hemisphere open field lines being driven anti-sunward into the northern cusp as a result of enhanced sheath flows overcoming their magnetic tension at these latitudes.