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A New Feature of Field-Aligned Auroral Ion Beams Observed by Cluster

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Cluster measures 3D distributions in one spin of the spacecraft (4s). Field-aligned ion beams (H+, He+ and O+) are often observed accelerated out of the ionosphere. The escaping beams can be narrow in velocity space or more extended with a continuous range of velocities. Narrow velocity beams indicate the particles have been accelerated by a potential structure localized in space and beams with a wider velocity range indicate the potential structure is extended and distributed along the magnetic field. The Cluster ion composition experiment has now revealed a new feature showing some H+, He+ and O+ field-aligned beams are broken into many discrete beams each with its own velocity covering a wide velocity range. To interpret the discrete beams, the potential model requires existence of many narrow isolated potential structures along a magnetic field but there are currently no U-shaped theories or models that can explain how the discrete potential structures are formed or maintained. Our interpretation is that Cluster SC have actually crossed an auroral arc structure at a height of 3.5 RE and the discrete beams represent particles accelerated on different equi-potential contours of an aurora. While similar beams are observed in three of the four SC, the detailed features are not identical, indicating the beams have limited spatial scales and/or the dynamics include temporal variations. The distance between two discrete beams is estimated to be as small as $\sim$145-290 meters at the SC position. This dimension mapped to the ionosphere is $\sim$72-145 meters, which is a typical thickness of an auroral arc (Maggs and Davis, PSS 16, 205, 1968). The velocity of the beam increases as the SC moves toward the equator indicating that the auroral potential is higher at lower latitudes. This talk will discuss the new discrete beams and their interesting properties.