



The Force-free Configuration of the Flux Ropes in Geomagnetotail

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Unambiguous knowledge of the magnetic field structures and electric current distributions are critical for understanding the origin, evolution and the dynamic properties of magnetic flux ropes. In this research, with the multi-point measurements of Cluster and the associated analysis methods, 16 cases of flux ropes in magnetotail are surveyed. It is found that, there is generally a core field in one flux rope; the axis-orientation is mainly within magnetic equatorial plane. Generally, the magnetic field gradient is weak near the axis center where the curvature radius is generally larger. Around the center part of the flux ropes, the current density is approximately field-aligned and about proportional to the strength of core field. The magnetic field strength and current density are becoming strong near the center. Statistically, $\sim 50\%$ of the flux ropes can be approximately described as force free configurations. For one flux rope, the force free structure is mainly concentrated on finite area around the center. The stronger the current density, the more force free the flux ropes are. The force free magnetic structure tends to appear in low beta portion, which is in agreement with the theoretic results. A quasi-force free index is presented to measure the force free nature.