磁気フラックスロープ内部の宇宙線密度と異方性

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Cosmic ray density and anisotropy in a magnetic flux rope

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During geomagnetic storm periods, galactic cosmic ray intensity often decreases. This is a well known phenomenon called Forbush decrease. Forbush decrease is interpreted as exclusion of cosmic ray due to magnetic turbulence on downstream side of an interplanetary shock wave. It is also pointed out that Forbush decrease can be caused by a passage of an ejecta from the sun, which drive a shock wave. However there are few models of cosmic ray behavior in an ejecta. Lately an anisotropy of cosmic ray during Fobush decrease was found by muon observations. The observation was compared with cosmic ray anisotropy model. In the model, a particle flux is given by F=CVn-Kgrad(n) in a definition of an anisotropy vector. In this expression, it is assumed implicitly that cosmic ray can be treated as a fluid, in other words, Larmor radius for a cosmic ray particle is much smaller than a spatial size of an ejecta which is often observed as a magnetic flux rope. However, Larmor radius of a cosmic ray particle detected by muon detecters in a typical interplanetary magnetic flux rope is interestingly as the same order as a size of the magnetic flux rope. This implies that the fluid approximation of cosmic ray may not be valid in the magnetic flux rope. In this study, we model cosmic ray behavior in the magnetic flux rope without the fluid approximation. The model is based on an equations of motion for cosmic ray as a particle. We have found that there is strong anisotropy in the magnetic flux rope and that the anisotropy depend strongly on cosmic ray rigidity. It is inferred that a magnetic field outside the magnetic flux rope also affect the anisotorpy inside it.