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Statistical analysis of the ion pitch angle distribution in the inner magnetosphere

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It is known that energetic particles are drifting around the Earth in the inner magnetosphere and many researchers have been studying their pitch angle distribution (PAD) and its cause in order to know some physical mechanisms occurred along their drift path. Various PADs, (e.g., normal, isotropic, head-and-shoulder, and butterfly types) have commonly identified by previous studies. In particular, for the butterfly PAD, there are several proposed generation mechanisms such as ”particle injection and drift effect” [Konradi, 1973], ”drift shell splitting + magnetopause shadowing” [West et al., 1973], ”drift shell splitting + negative radial flux gradient” [Sibeck et al., 1987], ”ring current effect” [Ebihara et al., 2008], and ”multiple pitch angle scattering effect” [Shibahara et al., 2010].

In this study, we focus on the high-energy ions (10-200 keV) in the inner magnetosphere and conduct a statistical analysis of the PAD by classifying disturbance level and particle energy. We examine which of the generation mechanisms of the butterfly PAD mentioned above is the most plausible. We use the particle flux data measured by the CAMMICE/MICS instrument (1.0-200 keV/q) onboard the Polar satellite and select the event when the Polar satellite traversed the magnetic equatorial plane during 1996-2002.

For high energy ions (>= 50 keV), we find that normal, butterfly, and isotropic PAD can be seen respectively on the whole dayside, around midnight, and between the region where the normal and butterfly PADs were found. On the other hand, low-energy (˜ 10 keV) ion PAD shows a quiet different characteristic. We classify the butterfly PAD into the ”M-type” butterfly which looks like a smooth bowl and ”U-type” butterfly which has a deep bite-out at 90 degree pitch angles, and find that most of the butterfly PAD is ”M-type” but ”U-type” butterfly can be seen on the night side in low-energy (˜ 10 keV) ion. There are only a few butterfly PAD events in the pre-noon region, leading us to say that generation mechanisms except ”magnetopause shadowing” theory should have a strong effect. In this presentation, we will show the statistical analysis results of the pitch angle distribution in the inner magnetosphere and discuss the generation mechanisms of the butterfly PAD.

Keywords: inner magnetosphere, pitch angle distribution