Polarization Characteristics and Depolarization Processes of Zebra Pattern in Type IV Solar Radio Bursts

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Abstract

Zebra pattern (ZP) is one of the spectral fine structures superimposed on the broadband type IV continuum, which has a characteristic spectral pattern with a number of parallel drifting stripes. Since these spectral fine structures reflect their emission mechanisms, we can obtain information from their characteristics about physical processes such as particle acceleration, excitation of electrostatic waves and their conversion to electromagnetic waves. Polarization of emission is important to know its emission mechanism. However, how these structures are generated is yet to be solved. In this study, we aim to reveal the generation mechanism of ZP by investigating their polarization characteristics.

In Kaneda et al. (2015, ApJL), we analyzed polarization characteristics of a ZP event and suggested from its frequency dependence that the ZP was originally generated polarized in the O-mode and was partly converted into the X-mode near the emission source. In order to examine these results, we analyzed totally 21 ZP events observed with AMATERAS, a solar radio telescope developed by Tohoku University in the frequency range of 100-500 MHz (Iwai et al., 2012). The analysis was made focused on three aspects: degree of circular polarization, temporal delay between the two polarization components and the wave mode of emission. We derived these three parameters using highly resolved spectral data from AMATERAS. As a result, we found the following characteristics; degree of polarization in the range of 5-70%, temporal delay of 0-70 ms and the dominance of O-mode emission (14 in 21 events), and that these characteristics of ZP were rather different from event to event. Furthermore, we found the positive correlation (R=0.66) between the degree of polarization and the delay. The dispersive character and the positive correlation between the degree of polarization and the delay implies the difference in physical mechanisms at a certain stage of the generation of ZP emission. Based on the obtained results, possible generation mechanisms of ZP will be discussed.