Dependence of frequency drift rates on solar activity cycle for ordinary and micro type III bursts

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Type III burst is one of intense solar radio emissions and generally shows a large negative frequency drift. Some of the bursts originate above solar active regions and appear with solar flares. These type III bursts are hereafter referred to as ordinary type III bursts. On the other hand, type III bursts sometimes appear as clusters which are characterized by thousands of short-lived type III bursts lasting for a few hours or more than a week (type III storm). Morioka et al. (2007; 2015) proposed the term ‘micro type III bursts’, which are elements of a type III storm. They also suggested that micro type III bursts originate from coronal streamers and are not just weaker forms of the ordinary type III bursts.

Generation processes of type III bursts are thought that electron beams originally generated with magnetic reconnections excite Langmuir waves in the solar corona and/or interplanetary space, then the Langmuir waves are converted into electromagnetic waves, which are observed as type III bursts. It is generally considered that the frequency of type III bursts reflects the electron density in the solar corona and/or interplanetary space where the radio waves are generated. Their frequency drift rates (DRs) reflect the electron density distribution and the radial velocity of electron beams contributing to generation of type III bursts. The radial velocity of electron beams is determined by not only the velocity of electron beams but the inclination from the radial direction of the magnetic field along which the high-energy electrons propagate. It is also considered that the velocity of electron beams depends on both injected energetic electrons spectra and electron velocity distributions of background plasma (ex. Li and Cairns, 2014).

It is well known that density distributions of the solar plasma differ depending on solar cycle and the activity of solar surface area (e.g. Aschwanden and Acton, 2001; Wang et al., 2017). This implies that the DRs of type III bursts might show solar cycle dependence, and the DRs between ordinary and micro type III bursts might be different. Although the occurrence rates of type III bursts are known to show a positive correlation with solar cycle, our knowledge for solar cycle dependence of the DRs has been still limited (e.g. Zhang et al., 2018). Moreover, there has been no study that classifies types of type III bursts as ordinary or micro, and analyzes long-term variations of their DRs.

In this study, we have investigated occurrence features of DRs for ordinary and micro type III bursts separately to clarify their solar cycle dependences and investigate physical conditions of electrons contributing to generation of type III bursts. For these purposes, we made both statistical analyses of DRs of type III bursts and event analyses of inclinations of magnetic fields expected as type III burst source using a database of solar radio spectra for 10–80MHz (partly 70MHz) observed with the Nancay Decameter Array (NDA) of the Paris Observatory. The DRs were estimated at around 40MHz.

As the results, it is confirmed statistically beyond a 95% confidence interval(CI) that the DRs of micro type III burst around the solar maximum are nearly 1.1 times larger than those around the minimum, and that the DRs near the solar maximum of the ordinary type III bursts are nearly 1.2 times larger than those of micro type III bursts. On the other hand, it is also confirmed that there are not significant differences in the DRs of ordinary type III bursts between the solar maximum and minimum, and in the DRs near solar minimum between ordinary and micro type III bursts.

In the presentation, we will show both statistical and event analyses on solar cycle dependence of the DRs for both ordinary and micro type III bursts precisely and will also imply discuss expected background plasma features relating to generation of type III bursts.

Keywords: Sun, radio burst, micro type III, long-term variation