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Fine Spectral Structures and Their Generation Mechanisms for Solar Radio Bursts Observed by AMATERAS

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The solar corona contains many particle acceleration phenomena that are caused by the interactions between the coronal magnetic field and plasma. Non-thermal electrons accelerated in the corona emit radio waves in the metric range. As a result, many types of solar radio bursts are observed. There are many types of complex fine spectral structures in the solar radio bursts. They are thought to be caused by some inhomogeneity of particle acceleration, wave generation, radio emission, and radio propagation processes. Hence, metric solar radio bursts are very important to understand coronal plasma processes such as the particle acceleration and wave-particle interaction.

The fine spectral structures of solar radio type-I bursts were observed by the solar radio telescope AMATERAS. The spectral characteristics, such as the peak flux, duration, and bandwidth, of the individual burst elements were satisfactorily detected by the highly resolved spectral data of AMATEAS with the burst detection algorithm that is improved in this study. The peak flux of the type-I bursts followed a power-law distribution with a spectral index of 2.9?3.3, whereas their duration and bandwidth were distributed more exponentially. There were almost no correlations between the peak flux, duration, and bandwidth. That means there were no similarity shapes in the burst spectral structures. We defined the growth rate of a burst as the ratio between its peak flux and duration. There was a strong correlation between the growth rate and peak flux. These results suggest that the free energy of type-I bursts that is originally generated by non-thermal electrons is modulated in the subsequent stages of the generation of non-thermal electrons, such as plasma wave generation, radio wave emissions, and propagation. The variation of the time scale of the growth rate is significantly larger than that of the coronal environments. These results can be explained by the situation that the source region may have the inhomogeneity of an ambient plasma environment, such as the boundary of open and closed field lines, and the superposition of entire emitted bursts was observed by the spectrometer.

Keywords: Sun, Solar radio burst, corona, wave-particle interaction, radio emission processes