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Spectral Analysis of the Electron Density Fluctuation in the Solar Corona obtained by Radio Occultation Experiments using the Akatsuki Spacecraft

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Coronal radio occultation experiments were carried out using the Akatsuki spacecraft from June 6, 2011 to July 8, 2011. The radio waves were transmitted from the spacecraft toward the Earth and probed the plasma in the solar corona on the way to the ground station. Due to the movement of small-scale density irregularities across the ray path, the frequency and intensity of the received signal undergo temporal variations. The frequency fluctuation is proportional to the rate of change of the electron column density along the ray path. Based on the substantial interest in the acoustic waves in the corona, we examined the radial dependence of the characteristics of the waves, such as the period, the density amplitude and the energy flux, by wavelet analysis of the electron density fluctuations in the region from 1.5 to 20.5 R_S (solar radii) obtained by radio occultation.

The overall spectral fluctuations at 3.5-20.5 R_S have near power-law dependences over the frequency interval 10^{-3} Hz $< \nu < 10^{-1}$ Hz (periods of 10-1000 s) and those at closer heliocentric distances have prominent excess power above the background. By further investigation, quasi-periodic disturbances having periods of 100-3000 s were detected at 3.5-10.5 R_S, while periods exceeding 3000 s were also observed at 1.5-2.4 R_S. Our result suggests that quasi-periodic fluctuations occur also at closer distances than suggested by previous studies. It was also found that the coherence time of each event is typically comparable to its period. Amplitudes of the density fluctuations were estimated to be 0.2-40% of the background density in the maximum estimate and 0.02-1.0% in the minimum estimate depending on the assumption on the spatial scale of the density fluctuation. We also

estimated the energy fluxes of these sporadic events on the assumption that the observed fluctuations are manifestations of acoustic waves. The maximum estimates of the energy fluxes are about 10 erg cm^{-2} s^{-1}, which does not satisfy the coronal heating requirement, although we cannot directly compare the present estimate with the requirement at the bottom of the corona. The estimates are also much smaller than the previous theoretical prediction of acoustic wave fluxes secondary generated from Alfvén waves.