Radial distribution of compressive waves in the solar corona revealed by radio occultation observations using Akatsuki spacecraft

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Abstract

Coronal density fluctuations at heliocentric distances of 1.5-20.5 R_S (solar radii) were explored by radio occultation experiments using the Akatsuki spacecraft in 2011. The radio waves transmitted from the spacecraft probed 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 of the received signal undergoes temporal variation. The frequency deviation is proportional to the rate of change in the electron density integrated along the ray path.

We detected quasi-periodic disturbances, which are considered as signatures of compressive waves, by wavelet analysis of the frequency time series. The wave period ranges from 100 to 2500 s, and the coherence time, which is a measure of the length of the wave packet, tends to be similar to the wave period. The amplitude of the fractional density fluctuation increases with radial dependence, from 0.1-1% at 1.5 R_S to 10-100% at 5 Rs. At farther distances the amplitude shows a tendency to saturate or decrease. The estimated amplitudes suggest that nonlinearity of the wave field and the resultant wave breaking are potentially important.

Wave energy fluxes were estimated on the assumption that the observed periodic fluctuations are acoustic waves. A radial increase of the energy flux is clearly observed, suggesting that the waves are generated in the extended corona. It is possible that Alfvén waves propagated from the photosphere undergo dissipation in the extended corona through generation of acoustic waves.