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Discovery of Transverse MHD Waves

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We report discovery of the magnetohydrodynamic (MHD) waves propagating along magnetic flux tubes in the solar photosphere. We identified isolated strong peaks in the power spectra of the magnetic flux, the velocity, and the intensity. The observation is performed with the spectro-polarimeter of the Solar Optical Telescope aboard the Hinode satellite. The oscillation periods are located in 3-6 minutes for the pores and in 4-9 minutes for the intergranular magnetic elements. These peaks correspond to the magnetic, the velocity, and the intensity fluctuation in time domain with root-mean-square amplitudes of 4-17 G (0.3%-1.2%), 0.03-0.12 km s(-1), and 0.1%-1%, respectively. Phase differences between the LOS magnetic flux (phi B), the LOS velocity (phi v), and the intensity (phi I) have striking concentrations at around -90 degree for phi B - phi v and phi v - phi I, and around 180 degree for phi I - phi B. Here, for example, phi B - phi v = -90 degree means that the velocity leads the magnetic field by a quarter of cycle. We suggest that the observed fluctuations are due to longitudinal (sausage-mode) and/or transverse (kink-mode) MHD waves. The observed phase relation between the fluctuations in the magnetic flux and the velocity is consistent with the superposition of the ascending wave and the descending wave reflected at chromosphere/corona boundary (standing wave). Even with such reflected waves, the residual upward Poynting flux is estimated to be 2.7 x 10 (6) erg cm(-2) s(-1) for a case of the kink wave. Seismology of the magnetic flux tubes is possible to obtain various physical parameters from the observed period and amplitude of the oscillations. Discovery of the MHD waves in the photosphere would revolutionize the research on the acceleration and heating of fast solar wind and heating of the quiet sun corona.

Keywords: MHD wave, Alfven wave, coronal heating, solar wind, kink mode, sausage mode