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Spatial variation of periods of ion and neutral waves in a solar magnetic arcade.

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By means of numerical simulations we present a new insight into the propagation of waves in a magnetic arcade embedded in the solar atmosphere and impact of the latter on the observed wave-periods. We consider a 2D approximation of the gravitationally stratified and partially-ionized lower solar atmosphere consisting of ion + electron and neutral fluids that are coupled by ion-neutral collisions. We find that in the solar photosphere, where ions and neutrals are strongly coupled by collisions, magnetoacoustic-gravity and acoustic-gravity waves have periods ranging from 250 s to 350 s. In the chromosphere, where the collisional coupling is weak, the wave characteristics strongly depend on the magnetic field configuration. Above the foot-points of the considered arcade, the plasma is dominated by vertical magnetic field along which ion slow magnetoacoustic-gravity waves are guided. These waves exhibit a broad range of periods with the most prominent periods of 180 s, 220 s, and 300 s. Above the main loop of the solar arcade, where mostly horizontal magnetic field lines guide ion magnetoacoustic waves, the main spectral power reduces to the period of about 180 s and longer wave-periods do not exist. The obtained results demonstrate unprecedented, never reported before level of agreement with the recently reported observational data of Wisniewska et al. (2016) and Kayshap et al. (2018). We demonstrate that the two-fluid approach is indeed crucial for a description of wave-related processes in the lower solar atmosphere, with energy transport and dissipation being of the highest interest among them.

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