Eigenspectra of active region long period oscillations

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Abstract

We studied the oscillatory dynamics of two ARs: NOAA 11327 and NOAA 11726 using two different methods of pattern recognition. After processing the data, we found that the axes and the inclination angle of the ARs oscillate in time. These oscillations are interpreted as the second harmonic of the standing long-period kink oscillations (with the node at the apex) of the magnetic flux tube connecting the two main sunspots of the ARs. In addition, we discovered that the lengths of the pattern axes in the ARs oscillate with similar characteristic periods and these oscillations might be ascribed to standing global flute modes. In both ARs we have estimated the distribution of the phase speed magnitude along the magnetic tubes (along the two main spots) by interpreting the obtained oscillation of the inclination angle as the standing second harmonic kink mode. After comparison of the obtained results for fast and slow kink modes, we conclude that both of these modes are good candidates to explain the observed oscillations of the AR inclination angles, as in the high plasma β regime the phase speeds of these modes are comparable and on the order of the Alfvén speed. Based on the properties of the observed oscillations, we detected the appropriate depth of the sunspot patterns, which coincides with estimations made by helioseismic methods. We also studied the oscillatory dynamics of some active regions. We found the spectra of the long-period oscillations of the ARs. There are not only the fundamental harmonics but also the set of higher harmonics in these ARs.