RECENT PROGRESS IN STUDYING KINK OSCILLATIONS OF CORONAL LOOPS

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Since kink oscillations of coronal magnetic loops were observed by TRACE in the end of the last century, this phenomenon continues to attract ample attention of solar physicists. In the first theoretical interpretation of this phenomenon the simplest model of a coronal loop was used. In this model a coronal loop is considered as a straight magnetic cylinder, all equilibrium quantities being constant inside and outside the cylinder, and having jumps at the cylinder boundary. The magnetic field lines are assumed to be frozen in the dense photospheric plasma. The progress of theory of coronal loop kink oscillations was related to the consideration of more sophisticated models. In these models such effects as the density variation along and across the loop, the loop curvature, the variation of the loop radius and the deviation of the loop cross-section from circular has been taken into account.

The majority of the observed coronal loop kink oscillations were polarized in the horizontal direction. However recently oscillations polarized in the vertical direction have been also observed. To describe these two types of oscillations a coronal loop was modelled by a half torus with the small radius much smaller than the large radius. On the basis of this model it was concluded that the frequencies of the horizontal and vertical oscillations are practically coincide.

We considered another model of a curved coronal loop where the loop is modelled by a thin magnetic flux tube with the enhanced density inside that is embedded in a potential two-dimensional magnetic field. We found that, in this model, the frequencies of the horizontal and vertical oscillations are substantially different. We showed that the previously obtained result that the frequencies are practically coincide is directly related to the fact that it was obtained on the basis of a model where the loop cross-section is circular everywhere. In general, banding of the magnetic tube results in that the look cross-section is elliptic with the the ratio of the ellipse axes varying along the loop. It is this variation of the shape of the loop cross-section that causes the difference of frequencies of the horizontal and vertical oscillations.

Up to now only two-dimensional models of coronal loops have been studied. We developed a three-dimensional model where the look axis not only have non-zero curvature, but also non-zero torsion. Using the asymptotic methods we derived the governing equations for kink oscillations of such a loop. This equation was used to study the properties of kink oscillations. In particular, we showed that, depending on the direction of observation, the fundamental mode of oscillations can produce observational signatures corresponding to the first overtone.