Coronal loop seismology using damping of standing kink oscillations by mode coupling

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Kink oscillations of solar corona loops are frequently observed to be strongly damped. The damping can be explained by mode coupling so long as loops have a finite inhomogeneous layer between the higher density core and lower density background. The damping rate depends on the loop density contrast ratio and inhomogeneous layer width. The theoretical description for mode coupling of kink waves has been extended to include the initial Gaussian damping regime in addition to the exponential asymptotic state. Observation of these damping regimes would provide information about the structuring of the coronal loop and so provide a seismological tool. We consider three examples of standing kink oscillations observed by SDO/AIA for which the general damping profile (Gaussian and exponential regimes) can be fitted. Determining the Gaussian and exponential damping times allows use to perform seismological inversions for the loop density contrast ratio and the inhomogeneous layer width normalised to the loop radius. The layer width and loop minor radius are found separately by comparing the observed loop intensity profile with forward modelling based on our seismological results. The seismological method which allows the density contrast ratio and inhomogeneous layer width to be simultaneously determined from the kink mode damping profile has been applied to observational data for the first time. This allows the internal and external Alfvén speeds to be calculated, and estimates for the magnetic field strength can be dramatically improved using the given plasma density. The kink mode damping rate can be used as a powerful diagnostic tool to determine the coronal loop density profile. This information can be used for further calculations such as the magnetic field strength or phase mixing rate.