



Iranian Journal of Physics Research, Vol. 21, No. 4, 2022



The probable excitation mechanism of kink oscillations of coronal loops

A Abedini and A Dehghan Anari

Department of Physics, University of Qom, Qom, Iran

E-mail: a.abedini@qom.ac.ir

(Received 06 February 2021 ; in final form 25 July 2021)

Abstract

Oscillations in various structures of the solar atmosphere, such as transverse (kink) oscillations of coronal loops, can be used in seismology. Transvers kink oscillations of coronal loops are often accompanied by solar flares. Despite the intensive study of kink oscillations of coronal loops in recent years, the excitation mechanism of these oscillations are still not known. In this paper, we aim to clarify the excitation mechanisms of transverse oscillations of coronal loops. For this purpose, first 458 oscillation events were identified by the Atmospheric Imaging Assembly (AIA) onboard the Solar Dynamics Observatory (SDO) during its first ten years (2010–2019) with the use of the Helioviewer, JHelioviewer and Heliophysics Events Knowledgebase (HEK). Then, the association of these oscillation events with probable mechanism for exciting the kink oscillations such as flares, lower coronal eruptions and plasma ejections, and coronal mass ejections bursts were listed. Finally, about 138 suitable kink oscillations out of 485 oscillations with high-amplitude, long oscillation period and visible through the naked eye that were accompanied with other probable excitation mechanism of kink oscillations, were selected. This statistical analysis of the transverse oscillation coronal loops showed that that 102 of these 138 oscillation events (74 %) were associated with lower coronal eruptions or plasma ejections. About 38 oscillations out of 138 transverse oscillations (27.5%) were associated with coronal mass ejections/eruption. Also, 65 events (47 %) were associated with flares. The required speed of hypothetical drivers of transverse oscillations were calculated. The magnitude values of calculated speeds for shock wave of flares were found to be lower than 500 ± 100 km/s in 87% of the cases. Also, the magnitude values of speeds for lower coronal mass eruption/ejection were obtained to be lower than 500 ± 125 km/s in 94% of the cases. The magnitude values of these speeds are acceptable for lower coronal mass eruption/ejection. But, such low speeds do not favor the association of the oscillation excitation with a shock wave of flares, as usually assumed. Also, statistical analysis of start time and time difference of hypothetical drivers of transverse oscillations showed that there is no clear correlation between them. The results of this study indicated that shock wave of flares cannot be the main cause of transverse oscillations of coronal loops. So, this analysis shows that the most probable excitation mechanism of the kink oscillations of coronal loops are eruptions or plasma ejections rather than the blast shock waves ignited by flares.

keywords: sun, corona- sun, transvers (kink) oscillations of coronal loops, excitation mechanisms of transverse kink oscillations of coronal loops

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