Magnetic interactions of sungrazing comets: the case of comet Lovejoy

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Résumé

Some comets, known as sungrazers, approach close enough to the Sun during their perihelion to orbit well inside the corona. This makes them prime candidates to probe the local coronal magnetic field as well as the plasma properties of the wind. In the case of the well known comet Lovejoy, it survived its perihelion passage, allowing for prolonged observations of its ionized tail. Several aspects of this event have been investigated, including the EUV emission (McCauley et al. 2013; Bryans & Pesnell 2012), UV spectroscopy (Raymond et al. 2018) and time-dependent chemistry of the plasma tail (Pesnell & Bryans 2014); the use of the tail morphology to probe the coronal magnetic field (Downs et al. 2013; Raymond et al. 2014); multi-fluid magnetohydrodynamic (MHD) modeling of the plasma tail (Jia et al. 2014); and analyses of the comet's orbit and dust tails (Sekanina & Chodas 2012). However, the potential impact of magnetic interactions between the comet and the Sun on solar activity during this event has not been studied yet. In this work, we report for the first time a tentative detection of a solar eruption induced by magnetic interactions. Based on a 3D magnetohydrodynamic solar wind solution calculated using the WindPredict-AW model (Réville et al. 2020, 2022 ; Parenti et al. 2022), we modeled the magnetic connectivity between comet Lovejoy and the Sun during the perihelion. Then, by considering the propagation of hypothetical Alfvén waves from the comet to the solar surface, we were able to assess the spatial and temporal correspondence of energy transfer by these Alfvén waves with the location of the flare. Finally, we used the numerically derived scaling law of Paul and Strugarek (2026) in the context of star-planet magnetic interactions to estimate the energy budget of this event. Ultimately, we conclude that the passage of comet Lovejoy could have acted as a perturbation for the trigger of the flare.

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