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Deciphering the nanojet phenomenon through observations and numerical simulations

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The two leading theories on the coronal heating problem are based on the dissipation of magnetohydrodynamic (MHD) waves, and the myriad of nanoflare-sized bursts on the order of 10^{24} erg from small-scale magnetic reconnection events driven by braiding. It is unclear how much heating is contributed by MHD waves and reconnection, and a direct observational signature to coronal reconnection could not be established until the discovery of nanojets.[1]

Nanojets represent component magnetic reconnection in a braided field, thus clearly identifying the reconnection-driven nanoflares from similar intensity bursts produced by other mechanisms. However, due to their small scales (<1500 km in length, <500 km in width) and short timescales (<25 s), their ubiquity and driving mechanism are still an open question. In this talk, we present Interface Region Imaging Spectrograph (IRIS) and Atmospheric Imaging Assembly (AIA) observations of nanojets in different structures, including loops and flares.[2,3] The variety of structures and environments support nanojets being a general result of component reconnection, that can also produce low-amplitude transverse MHD waves.[3]

To understand the nanojet generation mechanism, we present results from a parameter investigation using 3D MHD numerical simulations (with non-adiabatic effects) of coronal flux tube tectonics. Our numerical results provide support to the interpretation of nanojets being the result of small-angle reconnection, where the localized heating and field line separation accelerated by magnetic tension combine to give the characteristic hot and transverse jet-like features.[4] This talk summarises the nanojet research from both an observational and numerical modelling perspective, where the results serve as a pathfinder for next-generation instrumentation that has identified nanojets as a key target for detection to achieve their scientific goals.

References
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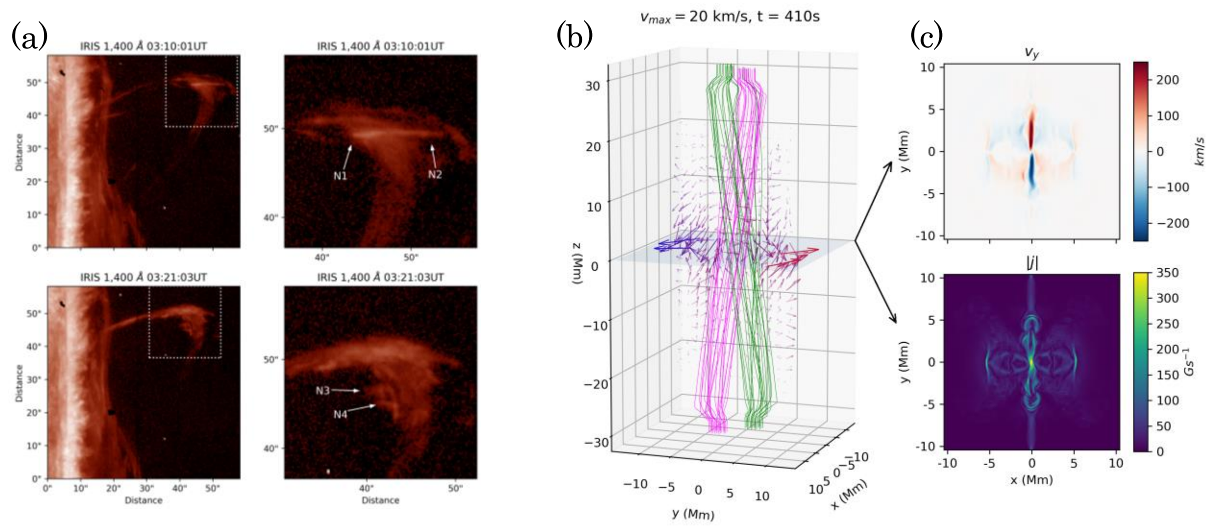

Figure 1. The four left panels (a) show IRIS observations of nanojets (N1-N4) in a coronal loop from [2]. Panel (b) shows an example of the field line configuration of the two flux tubes (in green and magenta) during the reconnection event in the nanojet numerical modelling setup, with velocity vector arrows showing the direction of the flows between the flux tubes. Panel (c) shows the corresponding cross-section of the transverse velocity (v_y) and current density (|j|) at the apex (z = 0 Mm), with jet-like features resembling the observed nanojets.