'Magnetic Connectivity and Coronal Waves: From Chromosphere to Solar Wind (MagCon)' Abstracts

Talks

Interactions between fast Down-flows and Fan-shaped Jets above a Penumbral Light Bridge using the Goode Solar Telescope

Authors

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Abstract

We present the analysis of high-resolution Hα observations of fan-shaped jets above a penumbral light bridge (LB) subject to external disturbance through fast down-flows in active region (AR) 12683 using data from the Goode Solar Telescope (GST) and the Atmospheric Imaging Assembly (AIA) on board the Solar Dynamics Observatory (SDO). Jets are observed with an occurrence rate of 5-6 min, reaching heights of 7-14 Mm above the LB with ascent speeds of 70 km s^{-1} and nearly parabolic trajectories. Associated bright fronts are seen as evidence of shock wave heating. We report the discovery of linear dark condensations of 0.45 Mm thickness that propagate ahead of the jet and shock, which we suggest is matter being compressed in front of the shock. Fast down-flows of 40-80 km s^{-1} reach the South end of the LB with the same periodicity as the jets. The jets and associated small-scale linear structures exhibit horizontal motion, differential with height, along the LB axis at speeds of 35-55 km s^{-1} away from the interaction site. This speed is consistent with a magnetic field of 40-100 G. We propose that the fast down-flows triggers oscillatory magnetic reconnection at the footpoint of the LB, which in turn drive the jets and the horizontal dynamics along the LB. We suggest that the linear fine-structure is the result of perpendicular compressions and rarefactions of reconnected field lines flowing out of the oscillatory reconnection site at Alfvénic speeds.

Modelling Small-Scale Torsional Alfven Waves in Coronal Loops

Authors

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Abstract

Torsional Alfvén waves are a promising mechanism for transporting energy through the solar atmosphere, with implications for coronal heating and solar wind acceleration. Recently, signatures of torsional Alfvén waves have been observed with the Daniel K. Inouye Solar Telescope. We present three-dimensional magnetohydrodynamic simulations of coronal loop threads, using the PLUTO code, driven by a combination of transverse kink and torsional wave drivers. We consider two plasma regimes representative of active region (AR) and quiet Sun (QS) conditions by varying temperature and density. Synthetic observables of the Fe XIII 1074.7 nm coronal emission line are produced using the pyCELP forward-modelling framework to enable direct comparison with spectroscopic observations. In the QS regime, torsional motions arise directly from wave driving, though their `observed' amplitudes are substantially reduced by line-of-sight integration effects, yielding signatures consistent with recent DKIST observations. In contrast, the AR regime exhibits red-blue asymmetries even in the absence of an imposed torsional driver, which may be misinterpreted as the m=0 torsional Alfvén wave. In the AR setup, the apparent torsional motions arise from strong phase mixing and the development of turbulent plasma dynamics that generate shear flows and localised vorticity between loop threads, where emission is strongest. Our results support the identification of torsional Alfvén wave signatures in the quiet Sun. However, caution in should be taken when extracting torsional wave signatures from spectroscopic observations in active regions.

Fast Magnetoacoustic Wave Behavior within Gravitationally Stratified, Magnetically Inhomogeneous Media

Authors

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Abstract

The nature of MHD waves within inhomogeneous media is fundamental to understanding and interpreting wave behaviour in the solar atmosphere. We investigate fast magnetoacoustic wave behaviour within magnetically-inhomogenous, gravitationally-stratified media containing magnetic null points. These null points are found where separatrices cross, splitting the domain into regions of different magnetic connectivity. Interactions between fast magnetoacoustic waves and null points are of great interest, both in the observation and numerical simulation communities, with recent observations of these interactions including Srivastava et al. (2019), who presented multiwavelength SDO-AIA observations of the formation of an X-point in the solar corona, concluding that the subsequent forced magnetic reconnection was a consequence of these wave-null interactions. We vary a scale height parameter to model the null point as being at different atmospheric heights, allowing us to consider both null points lower down in the solar atmosphere, which are much more abundant, and null points higher in the corona, such as those observed by Kumar et al. (2024). We find that the addition of gravitational stratification fundamentally changes the nature of the system, including breaking the symmetry, and that that there are two main competing effects: the stratified-density profile acts in opposition to the strong magnetic field close to the dipoles, creating a system replete with refraction. The system is investigated using both numerical simulation and a semi-analytical WKB solution and we find strong agreement between both. The results show a fundamental difference between the stratification-free and stratified cases, with significant unexpected behaviour, including the presence of cusps in the wavefront, which we investigate using the WKB solution to demonstrate that these cusps form at caustics, and we contextualise these results in the theoretical understanding of fast magnetoacoustic waves. Our results also demonstrate the accumulation of wave energy at the null point, potentially contributing to wave heating of the solar corona.

Solar Wind Turbulence Properties and its Connection to Source Regions: Coronal Holes vs Active Regions.

Authors

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Abstract

The solar wind is a nearly collisionless plasma that exhibits turbulent dynamics at several heliospheric distances. Although the turbulent nature of the solar wind has been studied for decades using in-situ and remote-sensing measurements from a fleet of spacecraft missions, it is still unclear whether there is a simple and direct connection between the turbulence properties measured in a plasma parcel and its source region in the Solar surface. Moreover, it is still uncertain whether the source region or the radial evolution is the more relevant parameter to define the state and type of turbulence of a plasma parcel at a given heliospheric distance, or if it is a more complex combination of both. To tackle these questions, we focus on two types of source regions, namely Coronal Holes and Active Regions. Using data from the European Space Agency mission Solar Orbiter we build a catalogue of possible connection events between the source regions and plasma parcels. We combine the well-established connectivity tool (IRAP) and set data thresholds on composition and plasma measurements from the Heavy Ion Sensor and Proton Alpha Sensor of the Solar Wind Analyser suit on board Solar Orbiter. With this catalogue, we explore and characterise differences in the energy containing scale, spectral shape and energy cascade rates for the two types of source regions as a function of heliospheric distance. We observe larger energy containing scale and steeper spectrum for active regions compared to coronal holes. Our results support the idea that turbulence properties of a plasma parcel preserve the signature of its origin.

Posters

Spatially Coherent and Intermittent Alfvénic Fluctuations in Polar Spicules

Authors

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Abstract

Alfvénic fluctuations are widely considered a key mechanism for transporting energy from the lower solar atmosphere into the corona, with spicules acting as dynamic conduits for this transfer. We investigate transverse and Doppler velocity fluctuations in tall, quiet-Sun polar spicules observed in the Si IV 1394~\AA\ line by the Interface Region Imaging Spectrograph. Fourier analysis in both time and space is used to characterize the distribution of wave power across frequency and spatial scales. The temporal power spectra show broadband fluctuations extending to ~10 mHz, with enhanced power in the 3–5 mHz range. Spatial Fourier analysis of Doppler velocity fluctuations reveals inertial-range behavior with spectral slopes of ~ -1.3, shallower than the canonical values of -5/3 and -3/2 expected for homogeneous strong MHD turbulence, but comparable to those found in simulations of reflection-driven turbulence in the solar corona. Velocity increment probability distribution functions exhibit non-Gaussian behavior, with kurtosis exceeding 3 at small spatial scales. The spatial coherence of the fluctuations is quantified through cross-correlation analysis, yielding perpendicular correlation lengths of $L_{\perp} \approx 2.3–3.0 Mm for bandpass-filtered (3–5 mHz) signals, and smaller values when the full frequency range is considered.