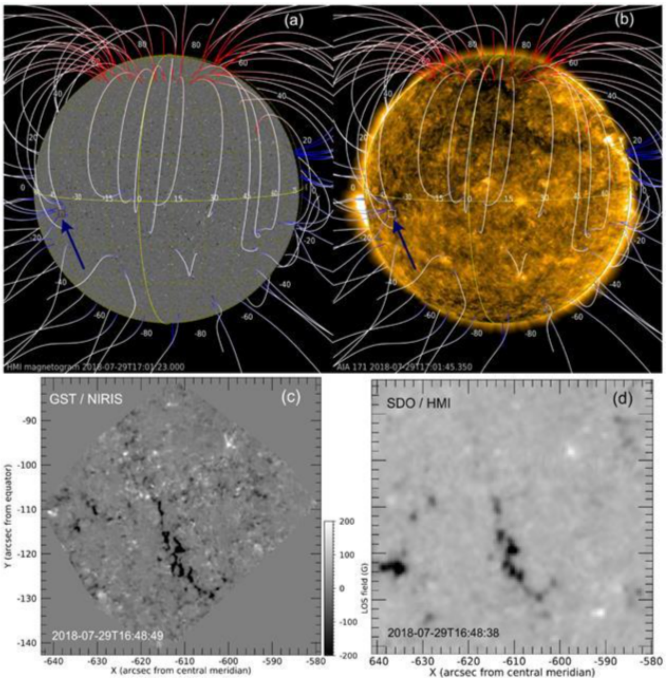
Solar Coronal Holes at High Resolution: How Previously Unseen Activity May Power the Fast Solar Wind

Manolis Georgoulis[1], Qin Li[2], Jeongwoo Lee[2], Haimin Wang[2], Nour Raouafi[1]

[1]Johns Hopkins APL, Laurel , United States, [2]New Jersey Institute of Technology , Newark, United States



Solar coronal hole magnetic fields are known to extend beyond the inner solar corona to mesoscales and further out, to regions of nascent solar wind. The associated wind speeds are above 500 $\mathrm{km\,s^{-1}}$, corresponding to fast streams that can even be geoeffective if located at appropriate western heliographic longitudes. How fast solar wind is powered beyond the hydrodynamic and thermodynamic limit is an elusive problem, however, with magnetic activity being the only possibility but with insufficient knowledge on specific mechanisms. Recent works motivated by the Parker Solar Probe mission indicated that magnetic reconnection can account for the fast solar wind but with mostly qualitative arguments. We focus on a small coronal patch, $\sim 80''$ across, observed simultaneously by the Helioseismic and Magnetic Imager (HMI) onboard the Solar Dynamics Observatory (SDO) and the ground-based Near-Infrared Imaging Spectrometer (NIRIS), part of the Goode Solar Telescope (GST) at the Big Bear Solar Observatory. The spatial resolution is a factor of ~ 4 higher for NIRIS data. The photospheric magnetic structure is dominated by a network magnetic feature. The configuration is studied at photospheric and chromospheric altitudes and the chromosphere above the network feature is dominated by hundreds of spicules per hour of observation that give rise to Alfvénic pulses but with further unknown origin. An existing but overlooked methodology can associate lower-limit energy releases with disappearing magnetic flux, in apparent magnetic flux cancellation episodes. Applying this simple approach to SDO/HMI and GST/NIRIS nearly simultaneous, coaligned magnetograms at similar observational cadence reveals striking differences: an unsigned flux ratio of 2.1 in favor of the NIRIS data results in a factor of 5.4 difference in the apparent released energy due to magnetic flux cancellation and in a flux replenishment rate of the order tens of minutes for NIRIS, rather than hours for HMI, magnetograms. This results in power densities above $10^6\ \mathrm{erg\,cm^{-2}\,s^{-1}}$ calculated for NIRIS data, seemingly capable of sustaining a hot corona, accounting for spicule activity and powering the fast solar wind. HMI magnetograms and their lower sensitivity are found insufficient and hence misleading to explain the observed small-scale activity. The result opens new research avenues and is expected to lead to breakthroughs when projected Parker magnetic footpoints in the Sun are sampled by magnetographic observations in the low solar atmosphere. This research has received partial support by NASA's Living With A Star program (contract NNN06AA01C) that funded the design, implementation and operations of the Parker Solar Probe Mission at the Johns Hopkins Applied Physics Laboratory.