SO/PHI data request form

Quiet Sun atmospheric heating through flux cancellations

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Science case (stay on one slide):

Please also state, why is PHI needed; why is the science unique?

Magnetic flux cancellation is one of the most important processes observed in the quiet Sun. It is responsible for a significant fraction of the total internetwork flux that is removed from the solar surface, 25% according to Gosic et al. 2016 (based on Hinode/NFI measurements) and even 41% according to Anusha et al. 2017 (based on SUNRISE/IMaX observations). Cancellations have been associated with localized brightenings and jets in chromospheric and transition region lines (Guglielmino et al. 2010; Ortiz et al. 2014, 2016).

Magnetic flux cancellation is believed to be the signature of magnetic reconnection in high layers, but the actual field topology and the height of energy release are not well known. Interestingly, this process may help explain the chromospheric heating of quiet Sun internetwork regions. Using SST and IRIS observations, Gosic et al. (2018) recently showed that the cancellation of internetwork fields also gives rise to strong small-scale brightenings in Ca II 8542 and SJI 2796/1400 A. Local temperature enhancements of up to 2000 K were detected in some cases in the temperature minimum region/low chromospherer by means of inversions. It was concluded that these events can explain the observed heating locally, but not globally because of too few cancellations. However, there is the possibility that many cancellation events were not detected in the internetwork due to insufficient polarimetric sensitivity.

Thus, the goals of this observing program are: (1) determine the rate of flux cancellation events in the quiet Sun internetwork at unprecedented sensitivity; (2) assess the influence of these events in the upper layers, focusing on their contribution to the chromospheric heating of the quiet Sun; and (3) resolve the azimuth ambiguity to distinguish Omega or U-loop magnetic configurations and understand the physical mechanism behind cancellations.

We will use the high polarimetric sensitivity of PHI to detect much weaker signals than has been possible until now. Also, the large field of view of PHI will allow us to cover several supergranular cells and increase the statistics. By combining the PHI observations with simultaneous EUI measurements at similar spatial resolution and cadence we will be able to cover the whole atmosphere seamlessly. Coordination with IRIS will reveal the chromospheric/transition region counterparts of these cancellation events, at the highest spatial resolution achievable nowadays. In summary, the dataset to be acquired will be unique in terms of its long duration, stability, and full coverage of the layers involved in magnetic cancellation events. All these are critical aspects to study the challenging quiet Sun internetwork.

Requirements/data (use additional slide if needed)

Besides best guess requirements, you may also list minimum requirements on the data

- Type of solar feature: Quiet Sun
- HRT or FDT: HRT
- Physical parameters needed (available: B_LOS, vector B, v_LOS, I_c, raw data): Vector B, v_LOS, I_c
- Total length of observation: 1 hour
- Cadence (maximum 1 dataset/min): 1 dataset/min
- Pointing needs (disc centre, limb, active region location, particular μ): Disk center (tracking on)
- Orbit needs (spatial resolution/co-rotation/angle to Earth/angle to other spacecraft): Observations within perihelion window, for highest spatial resolution, angle to Earth between, say, 20 and 50 deg.
- Total number of datasets: 60 full datasets
- Full frame 2k x 2k or partial frame 1kx1k, 0.5kx0.5: 2k x 2k
- Full resolution or 2x2, 4x4 binned data: Full resolution
- noise level (default 10^{-3}): 10^{-3}
- Co-observations with other instruments: EUI observations, plus IRIS measurements, for seamless coverage of atmosphere. Hinode/SP or ground-based telescope (SST, DKIST) required for azimuth ambiguity resolution.
- Possible datasets: 2022-03-22T09:40-T10:40 and 2022-03-17T00:00-T00:30 (second one a bit too short)