Project Details

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Topic: Magnetic Origins of the Corona and Inner Heliosphere

Project Title:
Constraining Solar Magnetograph Measurements Using the Observed Interplanetary Field and EUV and White-Light Coronal Images

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Summary:
Background

Reliable measurements of the photospheric magnetic field are essential both for a better physical understanding of the solar corona and for improved space weather predictions. Uncertainties in these measurements make it difficult to predict accurately the occurrence of high-speed wind streams and CMEs at Earth. Extrapolations of magnetograph measurements generally underestimate the interplanetary magnetic field (IMF) strength by factors of 2--4. In addition, we have recently shown that magnetograms underestimate the amount of minority-polarity flux inside active region plages and coronal holes, raising the possibility that ephemeral regions (ERs) may be a major contributor to coronal and solar wind heating.

Objectives

Our objectives are: (1) To understand why extrapolations of photospheric field maps tend to greatly underestimate the radial IMF strength (the "open flux problem"), focusing on the possible roles of Zeeman saturation, line weakening, zero-point calibration errors, open flux outside dark coronal hole areas, and transients/CMEs. (2) To develop procedures for modifying the magnetic synoptic maps so as to improve the agreement with the observed EUV and white-light coronal structures, as well as with in situ measurements of IMF structure and solar wind variations. (3) To determine whether the rate of ER emergence inside active regions and coronal holes is sufficient to provide a major or even the dominant contribution to coronal heating.

Methodology

(1) Using correlation analysis, we will compare the open fluxes, dipole strengths, and total fluxes derived from MWO, WSO, KPVT/SPM, SOLIS, GONG, MDI, HMI, and SPOT synoptic maps with each other, and the open fluxes with the observed radial IMF strength (from OMNIWeb, PSP/FIELDS, and SO/MAG). Agreement between the total fluxes measured by different observatories does not imply that their dipole strengths and open fluxes are in agreement, and a major source of the open flux problem may be errors in the dipole strengths. An important new idea to be examined is that the measured field strengths depend sensitively on where the magnetographs sample the line profiles. The contribution of CMEs will be estimated using the Richardson--Cane ICME catalog. (2) We will apply PFSS and PFCS extrapolations to the photospheric field maps to derive the configuration of coronal holes and streamers and compare the results with AIA, EUI, LASCO, SECCHI, WISPR, SoloHI, and Metis observations. The magnetic maps will be adjusted so as to improve agreement with the coronal, IMF, and solar wind observations, e.g. by adding or subtracting flux from the polar regions. This procedure will allow us to investigate systematic sources of error in the magnetograms and their dependence on the phase of the solar cycle. (3) Using AIA and EUI images taken in different EUV passbands, we will compare the looplike fine structure inside unipolar network and plages with that in quiet regions, to test the hypothesis that the rate of ER emergence is the same over the entire solar surface and independent of solar cycle phase.

Relevance to FST #4 Objectives and Potential Contributions to the Team

The objectives of this proposal are relevant to two of the main FST #4 objectives: "Understand how magnetic connectivity evolves from the photosphere to the inner heliosphere" and "Understand how the magnetic field drives coronal and heliospheric structure and dynamics." Measures of success are the same as those suggested in B.5, Sect. 5.2 ("Improved modeling of the solar corona....") Our basic objective is to improve space weather predictions by identifying the main sources of error in magnetic synoptic maps.

The PI and Co-I will contribute more than 35 years' experience in using photospheric field measurements to understand better the physics of coronal holes, coronal streamers, IMF variations, and solar wind streams.

Publication References:

no references