ORIGINS OF THE SOLAR WIND

NASA Grant NAG5-7992

Final Report

For the Period 1 January 1999 through 28 February 2002

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May 2002

Prepared for:

National Aeronautics and Space Administration
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The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

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Published Papers

1. Warren, H. P., and A. D. Warshall, "Temperature and density measurements in a quiet coronal streamer," ApJ, 571, 999-1007, 2002.

   This paper presented the differential emission measure analysis of SUMER observations of a coronal streamer. We found that

   - The coronal streamer is isothermal at all heights. This suggests that the loops comprising the streamer must have very flat temperature profiles.
   - The coronal streamer is "overdense" relative to the predictions of hydrostatic equilibrium at most heights. At the lowest heights the streamer is actually "underdense".
   - The SUMER temperature measurements are not consistent with those derived from simultaneous SXT observations. SXT indicates systematically higher temperatures as well as a strong temperature gradient. These SUMER measurements yield somewhat lower temperatures and no gradient in the temperature with height. Previous work has suggested that there may be a hot component to the streamer that is preferentially observed with SXT. Our analysis shows that high temperature emission lines would be observed with SUMER if this were true and thus discounts this possibility. We suggested that scattered light in SXT might produce spurious temperature measurements.
   - The temperature and density structure of this coronal streamer are very similar to "TRACE" active region loops (flat temperature profiles, overdense relative to uniform heating, and relatively cool temperatures).

2. Warren, H. P. and A. R. Winebarger, "Small-scale structure in the solar transition region," ApJ, 535, L63-L66, 2000.

   This paper presented the comparisons of a high resolution O VI spectroheliogram taken with SUMER with an MDI magnetogram. We found that

   - There are small-scale, loop-like structures that extend from the magnetic network into the inter-network regions, consistent with the findings of Feldman, Widing, and Warren [1999].
   - These small-scale structures, however, generally do not connect regions of opposite polarity. This result is inconsistent with earlier Skylab-era analysis which suggested that inter-network loops make a significant contribution to the emission observed at transition region temperatures.
   - Based on the preliminary analysis of TRACE C IV movies taken at the solar limb we conjectured that these small-scale structures were spicular.

3. Warren, H. P., "Measuring the physical properties of the solar corona: Results from SUMER/SoHO and TRACE," Solar Physics, 190, 363-377, 2000.

   This paper presented the analysis of co-temporal SUMER and TRACE quiet Sun data. I found that

- This region of the quiet corona was consistent with an isothermal plasma.
- The magnitude of the FIP effect was somewhat lower than has been measured previously. I obtained an absolute enrichment of 2.3±0.7 for the low-FIP elements.
- The TRACE observations of this region yielded systematically lower temperatures and emission measures.

4. Feldman, U., K. G. Widing, and H. P. Warren, "Morphology of the quiet solar upper atmosphere in the $4 \times 10^4 < T_e < 1.4^6$ K temperature regime," ApJ, 522, 1133-1147, 1999.

   This paper presented the analysis of high spatial resolution images of the coronal holes, the quiet Sun, and active regions taken with TRACE and SUMER. We found that:

   - Solar plasmas in the $4^4 < T_e < 1.4^6$ K temperature range consists if a hierarchy of isothermal loop structures.
   - In the quiet Sun the hottest loops (Te 1.4×10^6 K), which are also the longest among the quiet-Sun loop structures, form a canopy over the lower temperature loop structures.
   - At transition region temperatures there is an abundance of small-scale,loop-like structures. These structures generally appear to originate in the magnetic network and extend into cell-interior regions.

Presentations

1. Warren, H. P., and A. D. Warshall, "Temperature and density measurements in a quiet coronal streamer," AAS/SPD meeting, June 3, 2002.
2. Warren, H. P., "Observation and modeling of loops in the solar corona", Columbia University Plasma Physics Colloquium, February 15, 2002.
3. Warren, H. P., and A. D. Warshall, "Temperature, density, and abundance measurements in the quiet solar corona," Harvard-Smithsonian Center for Astrophysics Solar and Stellar Physics Seminar, October 15, 2001.
4. Warren, H. P., "Measuring the physical properties of the solar corona: Results from SUMER/SoHO and TRACE", The Physics of the Solar Corona and Transition Region Workshop, Monterey, California, August 23, 1999.

Papers in Preparation

There are two projects that were not completed before the end of the grant. These projects are similar in nature to other NASA sponsored research that I am working on and will be completed shortly.

1. Warren, H. P., "Temperature and density measurements in a coronal hole", to be submitted to ApJ. This work is an extension of the analysis of SUMER streamer data (Warren & Warshall 2002) to coronal hole spectra. Unlike the streamer, the coronal hole data we have analyzed suggest that the temperature is rising with height.

2. Warren, H. P., "The magnetic topology of an equatorial coronal hole," to be submitted to ApJL. This work compares outflow velocities measured with SUMER Ne VIII line profile measurements, coronal potential field extrapolations determined from MDI data, and high spatial resolution TRACE images.