Characterizing the Background Corona with SDO/AIA

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Abstract

Characterizing the nature of the solar coronal background would enable scientists to more accurately determine plasma parameters, and may lead to a better understanding of the coronal heating problem. Because scientists study the 3D structure of the Sun in 2D, any first-of-eight includes both foreground and background material, and thus, the issue of background subtraction arises. By investigating the intensity values in and around an active region, using multiple wavelengths collected from the Atmospheric Imaging Assembly (AIA) on the Solar Dynamics Observatory (SDO) over an eight-hour period, this project aims to characterize the background as smooth or structured. Different methods were employed to measure the true coronal background and create minimum intensity images. Those were then investigated for the presence of structure. The background images created were found to contain long-lived structures, including coronal loops, that were still present in all of the wavelengths, 131, 171, 193, 211, and 335 Å. The intensity profiles across the active region indicate that the background is much more structured than previously thought.

Introduction

The magnetic field extends from the Sun's atmosphere, extending over a million kilometers into the solar corona. In the lower solar corona, at temperatures between 1 million and 10 million K, the magnetic field dominates. In the upper solar corona, at even higher temperatures, the effect of solar rotation becomes dominant. The magnetic field in the lower solar corona is important to the transport of plasma.

AIA, one of three instruments on board SDO, collects high-resolution full-disk images of the corona in seven extreme ultraviolet band passes, each centered on distinct spectral lines. These coronal emissions are formed in plasma at temperatures greater than 1 million K. Each line-of-sight view of the Sun's atmosphere contains a sunspot, a coronal hole, or a portion of the quiet Sun. The images taken by the AIA coronal channel reveal the structure of the magnetic field.

Method

Eight hours of AIA data at a two-minute cadence were downloaded from the Virtual Solar Observatory at 25 wavelengths channels, 131, 171, 193, 211, and 335 Å beginning on February 16, 2014 at 15:01 UT and ending on February 18, 2014 at 01:21 UT. The active region (AR 1997) was selected at disk center in order to reduce both projection and background effects. Choosing an active region at disk center also reduced the ambiguity of the geometry of the loops. Using the line of sight was shortest, and therefore, there was less foreground material to contaminate the intensity measurements.

Results

Contrary to expectations, the loops were still present in the minimum images. Usually, such features appear and disappear within a few hours. However, the coronal loops were still present in all five wavelengths after eight hours. When the intensity values were plotted through the active region (Figure 4), the intensity profiles, not smoothly varying intensity profiles, were seen. Figure 5 shows results from the Difference Emission Measure (DEM) method plotted along the same diagonal cut showing the temperature of the plasma in this region. This method uses information from the intensity along this cut in different AIA channels in conjunction with the instrument response function to make the best guess of the temperature of the plasma.

It is important to accurately determine the coronal background in order to correctly determine plasma parameters such as temperature and density. Accurately locating these parameters may lead scientists to a better understanding of the coronal heating problem.

Future work will examine these long-lasting background loops in more detail to see if there is something special about them that could explain their longer lifetime, e.g., if they have a different temperature profile to other loops, if they are located in a particular area, or, if the magnetic field at the footpoints is doing something different to the rest of the region that might not be visible to simpler methods.

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