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Long-term evolution of thermal plasma in quiet and eruptive corona

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Plasma diagnostics is important for understanding the physical processes in various coronal phenomena, such as active regions, flares, coronal loops, coronal mass ejections, hot channels, bright points, etc. These structures have a wide temperature range from below one million K to over 30 MK. To observe the full thermal dynamic features of coronal structures, imaging in multiple narrow-band (EUV and soft X-ray) channels that are sensitive to different plasma temperatures are needed. The Atmospheric Imaging Assembly (AIA) onboard the Solar Dynamics Observatory (SDO), for example, is one of such instruments. It has been observing the Sun in ten visible, UV, and EUV channels since 2010 and provides us with unique dataset for detailed studies of coronal structures.

These multi-narrowband images of corona allow us to quantitatively study the multi-thermal nature of corona plasma through analysis of differential emission measure [1] (DEM). Such type of plasma diagnostics is critical for understanding energy release in corona and long-term evolution of large-scale coronal structures. Here we present the improved DEM calculation [2,3], and a database of coronal plasma observed during a full solar cycle by SDO/AIA. The results include the long-term evolution of the (EM-weighted) temperature maps of both quiet and eruptive corona, thermal evolution of coronal structures (active regions, coronal loops, coronal holes, and hot loops during filament eruptions), and their important roles in the evolution of corona.

We also present a new flare detection code (RFD) based on AIA 94 images and a new database of solar flares and small activities during 2010-2020. The database provides us with essential info for both statistical studies and case studies. The flare activities detected in quiet regions may reveal new clues for solving the coronal heating problem. The preliminary results are compared with other statistical works [4-6].

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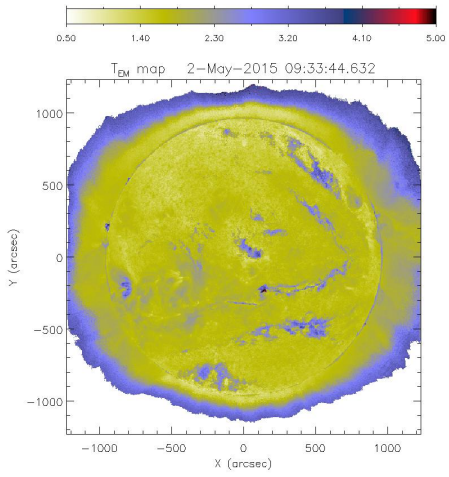

Figure 1. Temperature map of corona on May 2, 2015. The EM-weighted T at each pixel is obtained from the DEM results that are calculated using images taken in six SDO/AIA EUV channels and the modified Sparse DEM code.

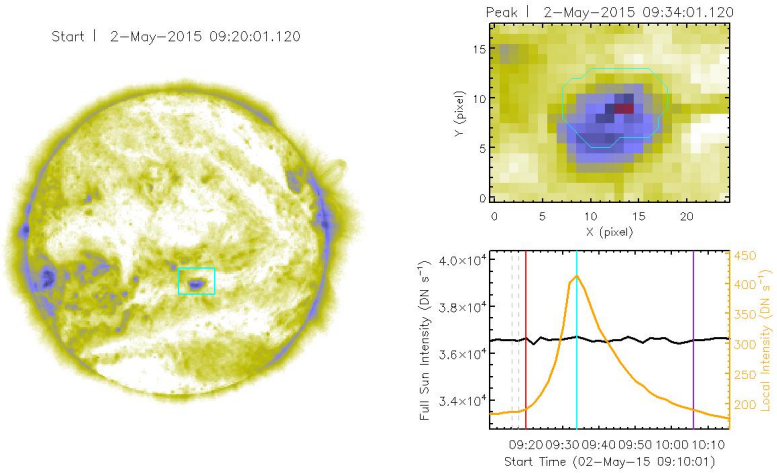

Figure 2. SDO/AIA 94 Å image (rebinned image, left), the location and light curve of one of the flares detected by the RFD code (right). The small flare can not be detected from the full sun light curve (black curve).