Multi-Instrument Differential Emission Measure (DEM) of the Solar Corona

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Thermal plasma in the solar corona, while often modeled as isothermal, is decidedly multi-thermal, ranging from ~1-2 MK in the quiescent corona to ~30-50 MK in intensely flaring loops. It is difficult to obtain a well-constrained differential emission measure (DEM) from a single instrument, whose wavelength coverage invariably provides sensitivity to only a limited range of plasma temperatures. Recently, we developed a new technique using combined extreme ultraviolet (EUV) and soft and hard X-ray (SXR, HXR) data from the EUV Variability Experiment (EVE) onboard the Solar Dynamics Observatory (SDO) and the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI), respectively, to obtain a self-consistent DEM that is strongly constrained across the full range of coronal plasma temperatures (<2 to 50 MK). An accurate, precise determination of the plasma temperature distribution enables not only studies of plasma heating and thermal plasma evolution, but can also provide strong constraints on the non-thermal accelerated electron population, including the low-energy cutoff which is typically determined only as a loose upper limit.

We adapt this new technique to combine EUV data from EVE with SXR data from the GOES X-ray Sensor (XRS) and the X123 -- a new SXR spectrometer flown on two recent SDO/EVE calibration sounding rockets and scheduled to fly on the Miniature X-ray Solar Spectrometer (MinXSS) NASA CubeSat -- to examine both the coronal DEM and composition during quiescent (non-flaring) times with varying activity levels; the X-ray data provide crucial constraints on the high-temperate extent of the DEM, the elemental abundances, and any potential non-thermal emission. The resultant DEM, with abundances, can also be used to predict the SXR emission in the poorly-observed ~1-5 nm wavelength band, knowledge crucial for understanding solar-driven dynamics in Earth's upper atmosphere (ionosphere, thermosphere, mesosphere). We compare these EVE+X123 results with those from a parallel technique to derive DEMs from imaging data from the Atmospheric Imaging Assembly (AIA) onboard SDO, and we discuss the implications for plasma heating, both during flares and in the quiescent corona. This research is supported by NASA contracts NAS5-98033 and NAS5-02140, and NASA Heliophysics Guest Investigator Grant NNX12AH48G.