

Temperature and Differential Emission Measure Evolution of a Limb Flare on 13 January 2015

M. Bröse¹, A. Warmuth¹, T. Sakao², Y. Su³

1 Leibniz-Institut für Astrophysik Potsdam (AIP), Germany.

2 Institute of Space and Astronautical Science (ISAS), Japan AerospaceExploration Agency (JAXA) 3-1-1, Yoshinodai, Chuo-ku, Sagamihara, Kanagawa 252-5210, Japan.

3 Key Laboratory of Dark Matter and Space Astronomy, Purple Mountain Observatory, Chinese Academy of Sciences, 10 Yuanhua Road, Nanjing 210023, China.

Introduction

Gradual phases in solar flares can last much longer, than expected from cooling models. By deriving

DEM Reconstruction

• The DEM outputs are displayed as EM and EMweighted temperature maps.

Thermal Evolution in Subregions

• SAF and loops show very different plasma conditions.

spatially resolved temperature and density maps, we investigate how different parts of an M5 flare event on 13 January 2015, namely coronal loops and the supra-arcade fan (SAF), evolve in time. SAFs are faint irregular regions of hot plasma observed above flare arcades.

Observations and Methods

- Event: M5 limb flare on 13 January 2015.
- Sets of EUV images (AIA/SDO) are used to reconstruct temperatures with a differential emission measure (DEM) code.
- The emission measure (EM) in different temperature bins is studied as a function of location and time.



250

200

150

100

850 900

- The quickly expanding SAF narrows in the gradual phase and remains as a hot region directly above the loops.
- The EM maps show branches of alternating high and low values at the SAF's upper boundary.
 - 1.1e+007 1.3e+007 1.6e+007 3.0e+006 5.6e+006 8.2e+006 EM-weighted T [K] 13-Jan-2015 04:22:12 UT 13-Jan-2015 05:00:36 UT 250 200 200 150 150 100 100 1000 1100 1200 900 1000 1100 1200 X (arcsec) X (arcsec) 13-Jan-2015 06:00:12 UT 13-Jan-2015 07:59:24 UT 250 250 200 200 150 100 100
- The temperature in the SAF stays above 5 MK for hours in the gradual flare phase.
- Measured cooling times in loops and SAF are significantly longer than predicted.



1.0e+030 6.1e+031 1.2e+032 1.8e+032 2.4e+032 3.0e+032 EM [cm⁻⁵]



Time: 06:03:01 UT



850 900 950 1000 1050 1100 1150 1200

Time: 04:41:37 UT





Time: 05:02:01 UT

950 1000 1050 1100 1150 1200

Time: 07:54:49 UT

171 A







Reconstructed EM-weighted temperature and EM maps.

Cargill Model

 Theoretical cooling model, which includes radiation and conduction as cooling mechanisms (Cargill et al., 1995).



Selected subregions and corresponding DEM evolution in the 'Total Area' (a), 'Averaged Loops' (b), and 'Averaged SAF' (c). White lines indicate the times of the flare peaks (GOES).

Results

- The thermal evolution differs across the extended flare structure.
- The cooling times based on the DEM method are significantly longer than predicted by the Cargill model.
- Continuous heating likely occurs in both loops and SAF during the gradual flare phase.

Flare evolution observed in a cool (171 Å) and in a hot (94 Å) AIA channel. The flare consists of loops with sharp boundaries and the SAF, a rather diffuse region above it.

- Assumes a single isothermal loop.
- In previous studies, it was applied to spatially unresolved data.
- In this project, it is applied to subregions within the flare structure.

References

Su et al. 2018, ApJ, 856, L17 (DEM code) Cheung et al., 2015, ApJ, 807, 143 Ryan et al., 2013, ApJ, 778, 68 Cargill et al.,1995, ApJ, 439, 1034

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