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Study of a microflare observed with SUMER and TRACE

C. Gontikakis[1] *and A. R. Winebarger*[2]
[1]Research Center for Astronomy and Applied Mathematics, Academy of Athens, Greece
[2]NASA Marshall Space Flight Center, Huntsville, USA

Abstract: We study a GOES-A1 class microflare, observed in active region NOAA 8541 on May 15, 1999 with data from TRACE, SUMER and MDI. In TRACE filtergrams of 171 Å and 195 Å, the microflare appears as two interacting, 15 Mm long, loops. SUMER observated the microflare in, Si II 1533 Å (chromosphere), C IV 1548 Å, 1550 Å (transition region) and Ne VIII 770 Å, (corona). In an area adjacent to the microflare we observe, for the first time on the solar disk, a region where the lines intensity ratio 1548A/1550A equals to 4 which means that resonant scattering dominates the emission process. The SUMER spectral lines are blue shifted, indicating upflows due to chromospheric evaporation, as well as red shifted, indicating, cooling downward motions. The Si II 1533 Å profiles are self-reversed due to opacity effects.

1 Introduction

Microflares have with X-ray peak emission 10^{-4} to 10^{-3} times the emission of regular flares. They present a duration of a few minutes, and sizes of 1 to 1000 Mm^2, [1]. During flares, several assumptions usually adopted for transition region plasmas, such as spectral lines excited by collisional processes, low opacity, as well as Gaussian shape of spectral profiles, do not necessarily hold. Our SUMER spectral observations, supported by TRACE images, can raise some of these issues while suggesting physical mechanisms at work during this microflare.

2 Observations

TRACE observed NOAA AR 8541 in 171 Å, (see Fig. 1a), 195 Å, 1600 Å, 1215 Å and in White Light with a cadence of 1 minute. SUMER scanned the active region from East to West and recorded the microflare at three consecutive slit positions with a 30 second exposure time. The lines selected were Si II 1533 Å ($10^{4.1}$ K), C IV 1548 Å, 1550 Å (10^5 K), Ne VIII 770 Å ($10^{5.8}$ K) and Si I continuum between 1526.7 Å and 1528 Å (low chromosphere) where we show the lines formation temperatures in brackets. The SUMER data treatment includes flatfield, geometrical distortions, dead time and local gain corrections. A reference velocity was computed using chromospheric lines. We also used MDI full disk magnetograms to identify the interacting magnetic features.

3 SUMER spectra

SUMER was rastering the active region when, by chance, the instrument slit was pointed on the microflare. The microflare has the form of a small very bright feature, of $\simeq$8 arseconds size, at the West footpoint of the loop observed with TRACE (Fig. 1b). Some of the observed profiles of the chromospheric line Si II are self-reversed due to opacity effects (Fig. 1c). Such profiles have been observed only at the limb [2]. The profiles of the Ne VIII line are composed by a strong intensity narrow component mostly blueshifted and a low intensity broad component which is mostly redshifted (Fig. 1e). The Transition Region C IV 1548 Å is 56 times brighter than the average active region and, for most profiles, the SUMER detector gets over-exposed. The non over-exposed C IV profiles (Fig. 1d), show

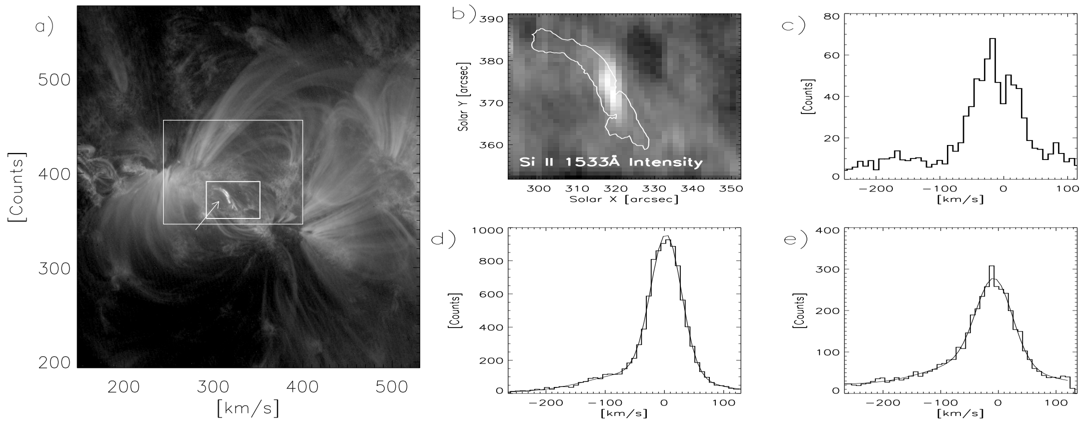

Figure 1: Panel a) NOAA 8542 active region seen in TRACE 171 Å. The arrow points to the microflare, the large frame indicates the SUMER raster f.o.v and the small frame indicates the f.o.v. of panel b). Panel b), Si II intensity with TRACE loop isocontours. Panels c), d), and e) show individual microflare profiles of Si II 1533 Å, C IV 1548 Å and Ne VIII 770 Å respectively. In panels d),e) the straight line is a double Gaussian fit. Panels b) to e) show SUMER data.

two Gaussian components. A large intensity, narrow spectral component and a low intensity, broad and blueshifted ($\simeq$50 km s^{-1}) component. From the over-exposed profiles we can only deduce a strongly blueshifted component ($\simeq$ -200 km s^{-1}) of the plasma as a reliable information.

In an optically thin plasma, dominated by electron collisions, the C IV doublet of 1548 Å and 1550 Å line intensity ratio 1548/1550 is close to 2. In a region adjacent and south of the microflare the lines intensity ratio is 1548/1550$\simeq$ 4. This is the case where resonant scattering is more important than collisional excitation. The reason for the increase of the resonant scattering is the high photon flux originating from the microflare over a low electron density solar pore seen in the White Light.

4 Conclusions

We present simultaneous observations of a microflare with TRACE and SUMER. With TRACE we analyze the morphology and time evolution while with SUMER the spectra from different temperature plasmas of the solar atmosphere. With SUMER spectra we measured blueshifts in the chromosphere (Si II line), the transition region (C IV lines), and the corona (Ne VIII) indicating that coronal evaporation is in action. Redshifts indicate cooling material that falls back on the solar surface. Redshifts and blueshifts are measured in the same individual profile, which mean at the same location and time, as different spectral components. For the first time, we measure on the solar disk C IV 1548 Å 1550 Å profiles with an intensity lines ratio 1548/1550>2 which indicate that photons are produced due to resonance scattering. We also measured, for the first time on the solar disk, self reversed Si II profiles which are caused by the large opacity of the dense flaring plasma at chromospheric levels.

SUMER is the spectrograph with the best spectral resolution from the today space missions, and has rarely observed microflares on the solar disk which is why these results are important.

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References

[1] Berghmans, D., Clette, F., 1999, Sol. Phys., 186, 207

[2] Nicolas, K.R., Brueckner, G.E., Tousey, R., Tripp, D.A., White, O.R., Athay, R.G., 1977, Sol. Phys., 55, 305