A comprehensive study of an Active Region filament using simultaneous GREGOR and IRIS data

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Abstract

Solar filaments are cool, dense plasma structures suspended in the extremely hot solar corona. They always lie above photospheric magnetic polarity inversion lines (PILs) on the photosphere and are supported by the local magnetic fields against gravity. According to their locations on the solar disk, filaments can be classified as active region, intermediate, and quiescent filaments. Observationally, active region filaments are lower, smaller, and shorter-lived than quiescent or intermediate filaments. We present the observation of an active region filament from the photosphere up to the corona using the observations acquired with the 1.5-meter ground-based GREGOR telescope and the IRIS satellite. The filament lies above an orphan penumbra. The high-resolution ground-based spectropolarimetric observations (in the 1.0 μ range) were carried out on 2020 November 9 and 10 and IRIS also observed the same portion of the AR with three very large rasters. During this time interval, the filament appears to be quite stable while at the photospheric layer the orphan penumbra disappears. We report preliminary results of the observation of the filament from the photosphere to the chromosphere using spectropolarimetric data (along Si I 10827 Å and He I 10830 Å), fast imaging in Halpha and UV IRIS imaging and spectra.

OBSERVATIONS

- GREGOR/GRIS data: 10830 Å band on 2020 November 9 and 10
- co-temporal GREGOR/HiFI G-band and GFPI-MLITE Hα (continuum and line core) data
- SDO/HMI data: 2020 November 9 to 11
- IRIS scans:
  - 20:26-21:15 UT, 49 min, 32(
  - 22:03-23:08 UT, 55 min, 32”
  - 11:03-11:52 UT, 50 min, 320

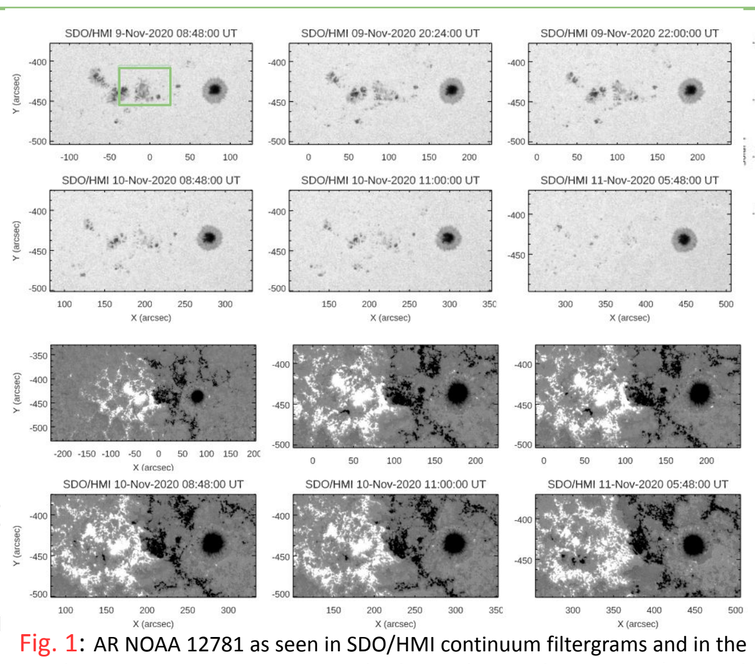

Fig. 1: AR NOAA 12781 as seen in SDO/HMI continuum filtergrams and in the simultaneous LOS magnetograms. The box indicates the GREGOR/HiFI and MLITE FOV. The polarity inversion line is nicely seen in the magnetograms.

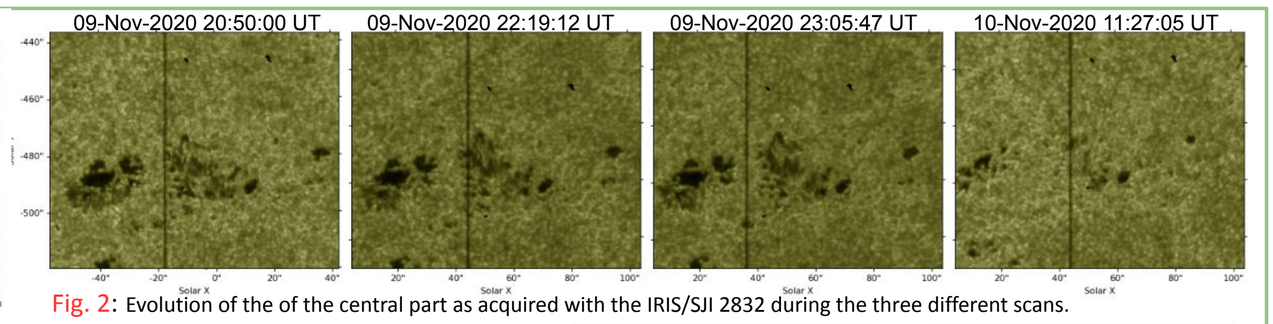

Fig. 2: Evolution of the of the central part as acquired with the IRIS/SJI 2832 during the three different scans.

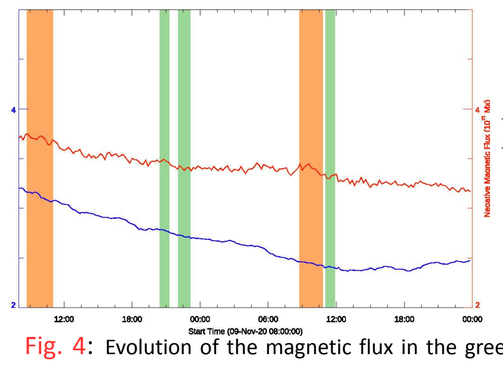

Fig. 4: Evolution of the magnetic flux in the green box of the AR NOAA 12781. The orange stripes indicate the two time intervals of the GREGOR observations, while the green stripes indicate the time of the three IRIS scans.

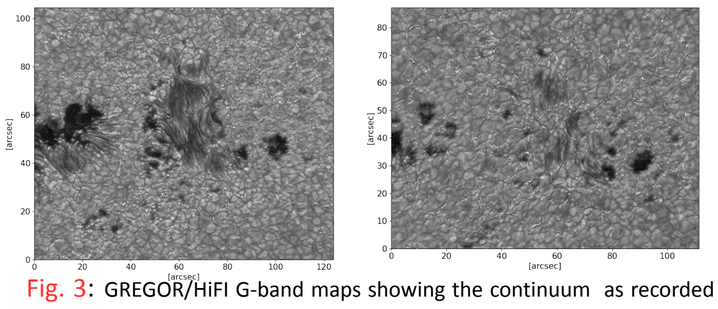

Fig. 3: GREGOR/HiFI G-band maps showing the continuum as recorded on 9 and 10 November at higher spatial resolution.

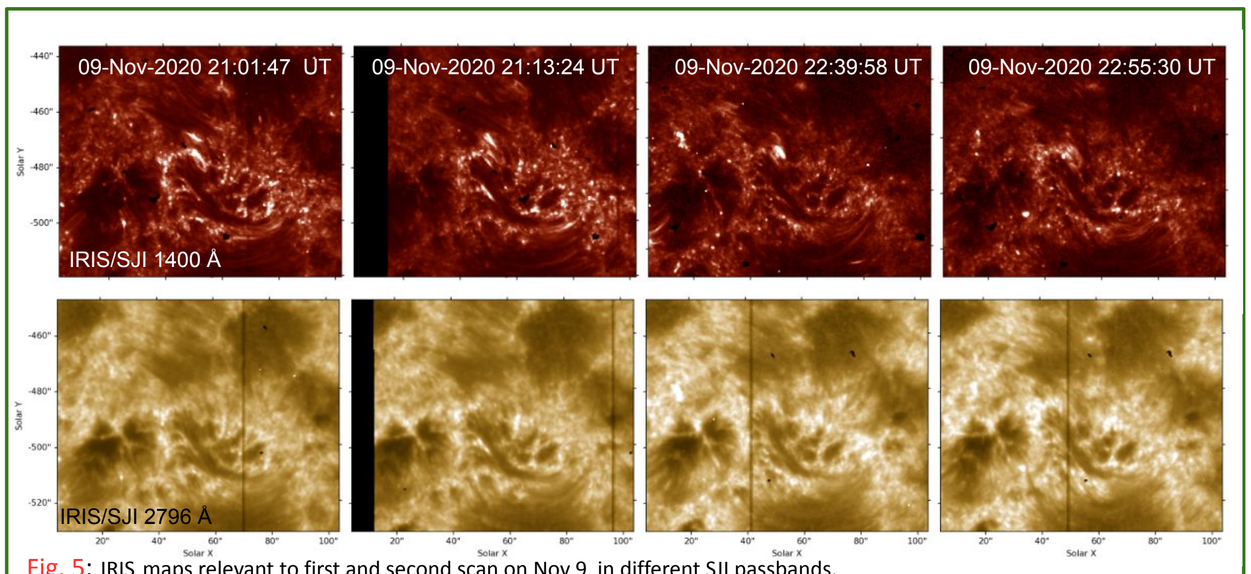

Fig. 5: IRIS maps relevant to first and second scan on Nov 9 in different SJI passbands.

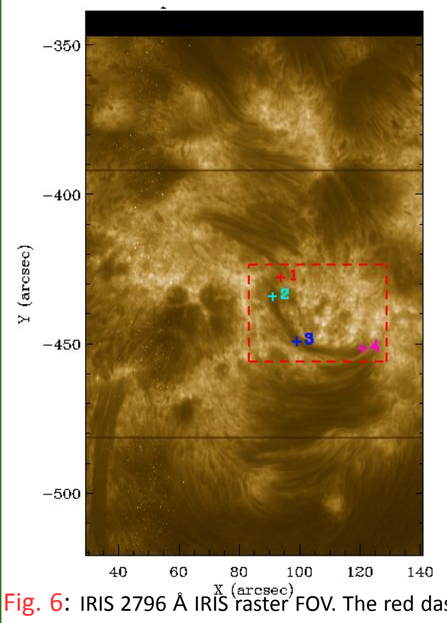

Fig. 6: IRIS 2796 Å IRIS raster FOV. The red dashed box indicates where the Si IV line ratio map is calculated (Fig. 7).

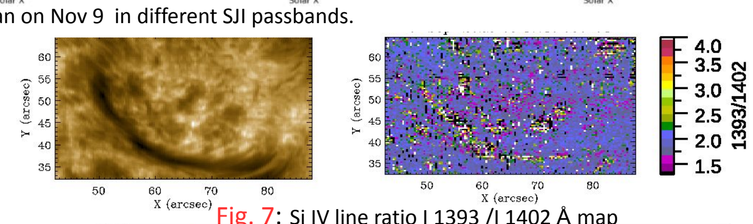

Fig. 7: Si IV line ratio I 1393 /I 1402 Å map

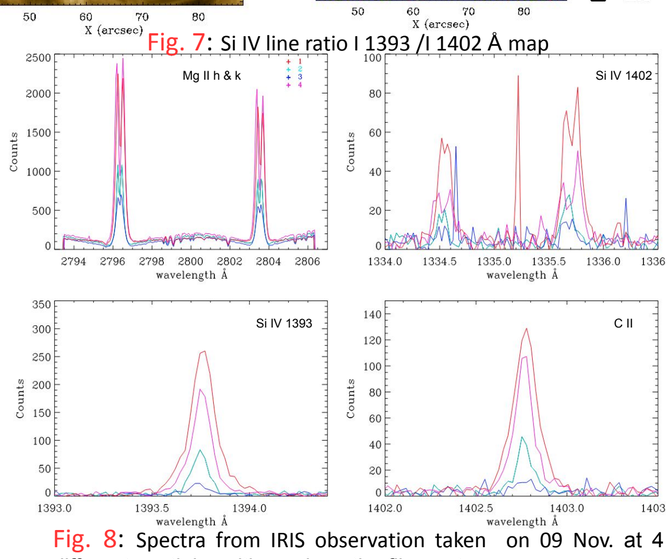

Fig. 8: Spectra from IRIS observation taken on 09 Nov. at 4 different spatial positions along the filament.

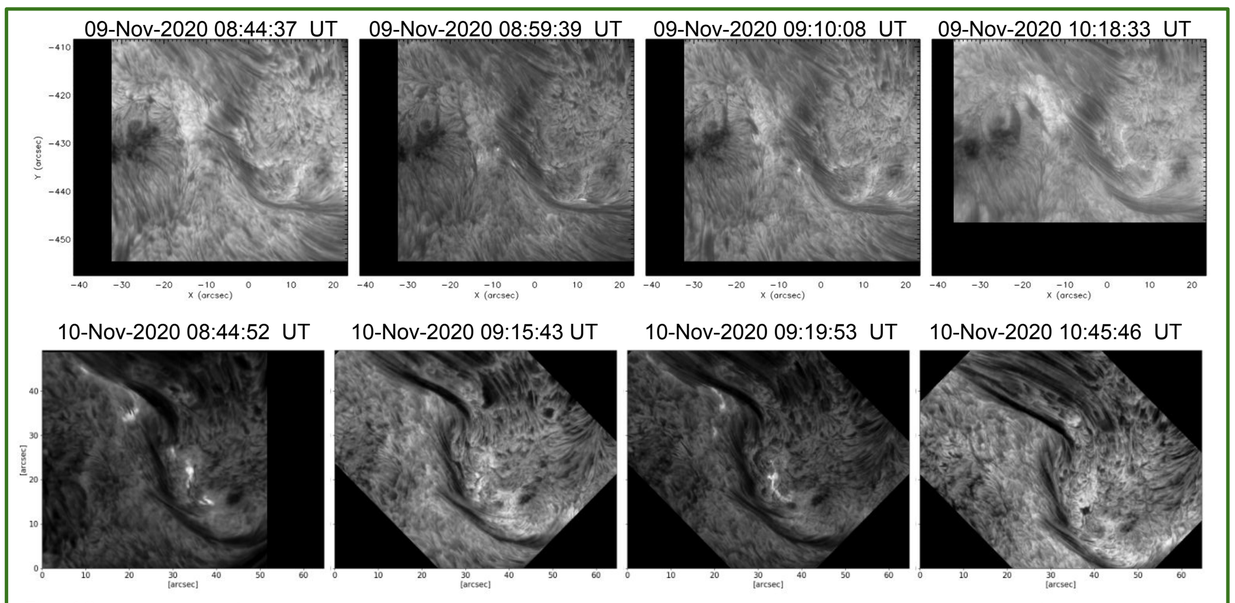

Fig. 10: Restored Hα filtergrams acquired by the GFPI-MLITE instrument at the GREGOR telescope showing fine structure of the chromospheric morphology of the central part of the AR NOAA 12781 at various times on 9th (top panels) and 10th (bottom panels) November 2020.

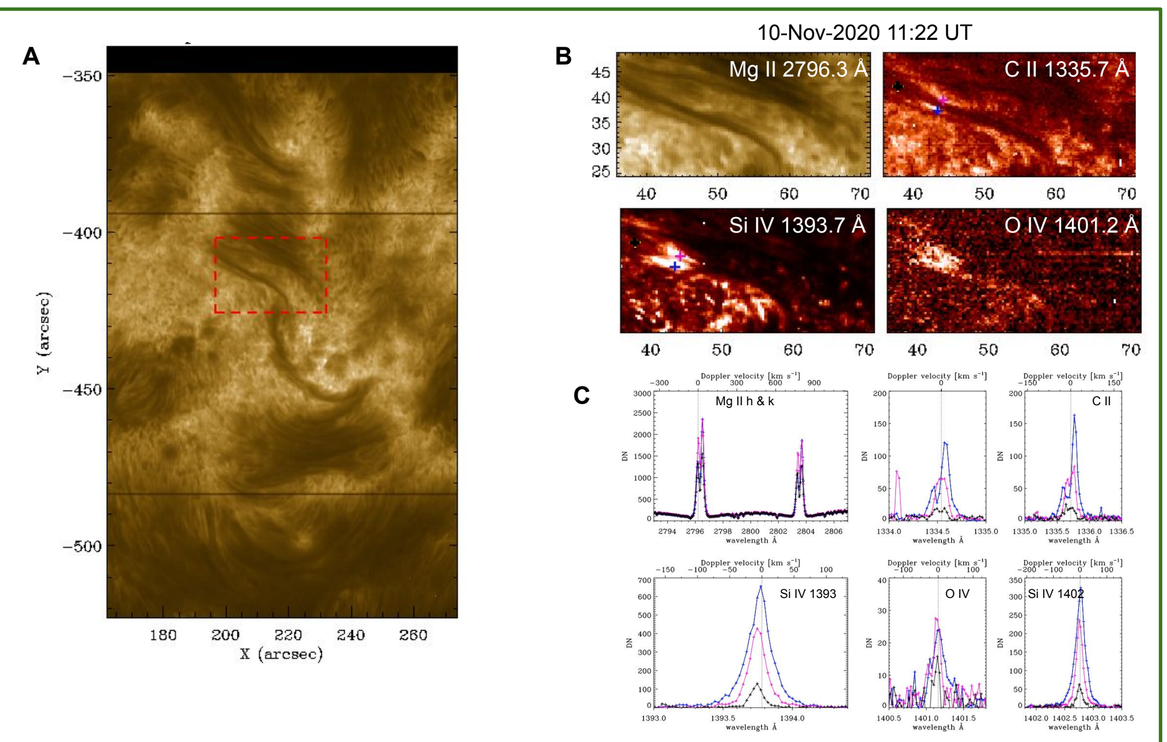

Fig. 10: **A:** IRIS 2796 Å raster ofgf the region on 10 Nov. at 11:00 UT. **B - C:** Zoom of the region inside the red dashed box showed in **A** panel and relative set of spectra from IRIS observation of the Mg II h & K, C II, Si IV 1393 and SiV 1402 Å lines at the 2 different spatial positions in the brigthening (blue and magenta crosses) and one outside (yellow cross).

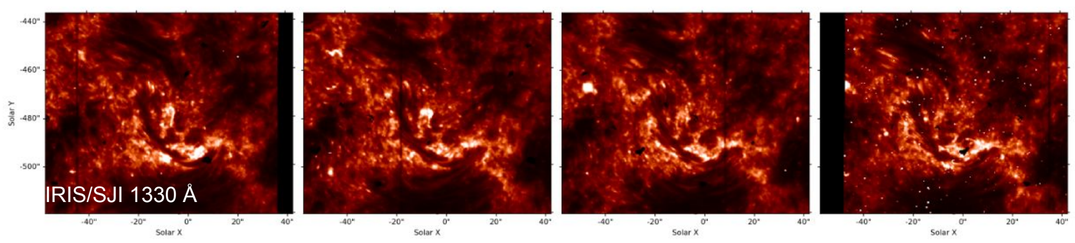

Fig. 11: IRIS/SJI 1330 Å event evolution from 11:15 to 11:50 UT on Nov. 10 (cadence 12 minutes). These maps show several brightening events all along the edge of the filament mostly in the following side where the orphan penumbra is disappearing.

HIGHLIGHTS

- Orphan penumbra in photosphere and Active region filament above it
- Homologous Hα brightening events across the GREGOR observations and changing filament’s shape
- Several small brightenings at the footpoints and along the edge of the filament in the IRIS/SJI 1330 Å - 1400 Å as well as during the disappeararing of the orphan penumbra (it takes ~45 hours)
- Si IV line ratio > 2 along the filament, i.e. along the PIL, as reported by Gontikakis et al. 2018.
- Variation and broadening of the Si IV and C II profiles from the center to the tails of the filament. Appearance of double-peak in C II at the footpoint of the filament
- SI IV, C II and OIV localized emission during a compact elongated brightening at the filament lateral edge.

Acknowledgements

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