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Dynamics and Evolution of a Giant Solar Filament as Observed by the Solar Dynamics Observatory

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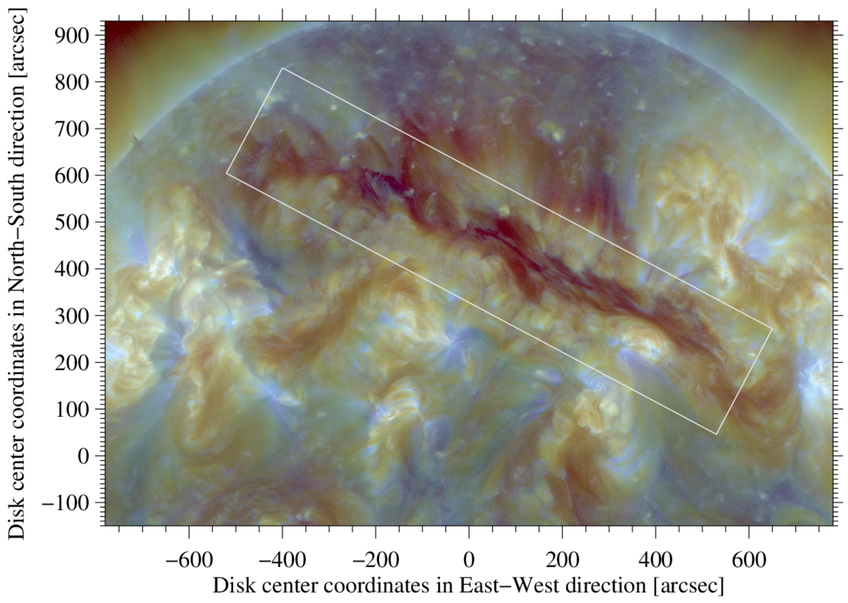
Abstract. *Giant solar filaments are scarce objects found in the solar atmosphere. We studied such a filament focusing on dynamical and evolutionary aspects. The filament was visible on the Sun from 8 – 22 November 2011. To analyze the filament, we used data of the Atmospheric Imaging Assembly (AIA) on board the Solar Dynamics Observatory (SDO) in the wavelength bands 171 Å, 193 Å, 211 Å, and 304 Å. With contrast enhancing techniques, it was possible to detect counter-streaming flows along the spine of the filament in all four wavelengths. The magnitude of these flows were then inferred by applying local correlation tracking (LCT) to the 171 Å AIA data.*

Observations

On 2011 November 8 this filament appeared in the field-of-view (FOV) of the SDO satellite in the northern solar hemisphere. The eastern end of the filament erupted a few days later on 14 November 2011 as a coronal mass ejection (CME). Much of the filament erupted as a non-geoeffective CME on 2011 November 22, likely due to a nearby emerging flux region destabilizing the magnetic field topology. The filament vanished completely one day later.

Concerning our aim to investigate the spatial and temporal evolution of the giant filament, we use AIA data, which can be subdivided into two groups: (1) long-duration data, which contain images of the two weeks when the filament was visible on the solar surface with a time resolution of one hour and (2) high-cadence data with images of two hours on 16 November 2011 from 11:00 to 13:00 UT with a time resolution of 12 s.

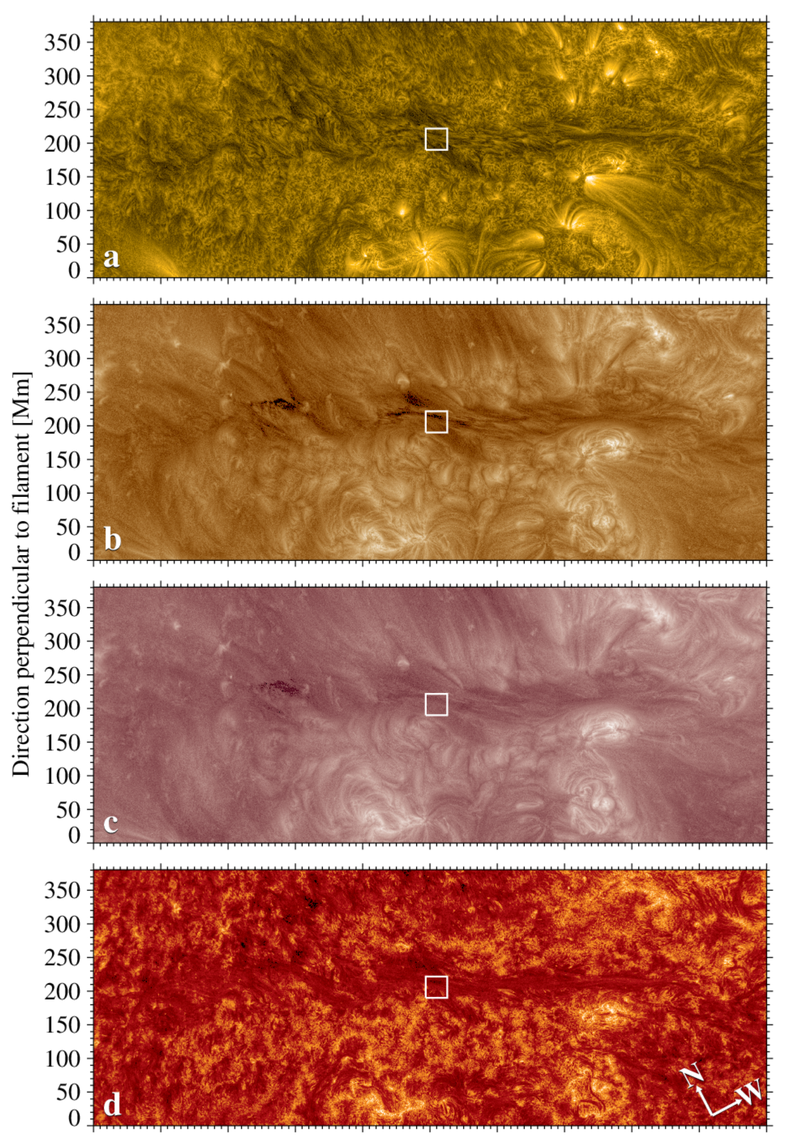


False-color image of the filament on 2011 November 16 at 12:00 UT composed of images at the AIA wavelengths 171 Å, 193 Å, and 211 Å.

Counter-Streaming Flows

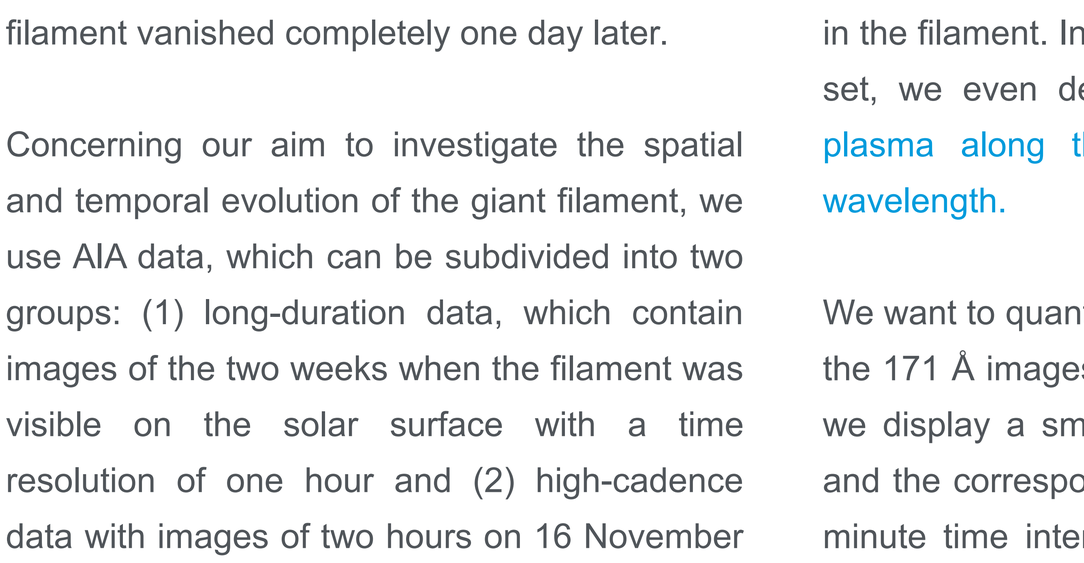
In the unprocessed images of the giant filament the counter-streaming flows are barely discernible. With the image processing tool NAFE (Druckmüller 2013, ApJSS., 207, 25) it is possible to enhance the contrast in the images and see very clearly the counter-streaming flows of plasma in the filament. In movies of the high-cadence data set, we even detect counter-streaming flows of plasma along the filament's spine in all four wavelength.

We want to quantify the counter-streaming flows in the 171 Å images with the help of LCT. Therefore, we display a smaller region of 32 Mm x 32 Mm and the corresponding velocity vectors for the 15-minute time interval. We see an north-streaming flow in the left part of the image and an south-streaming flow on the right side.

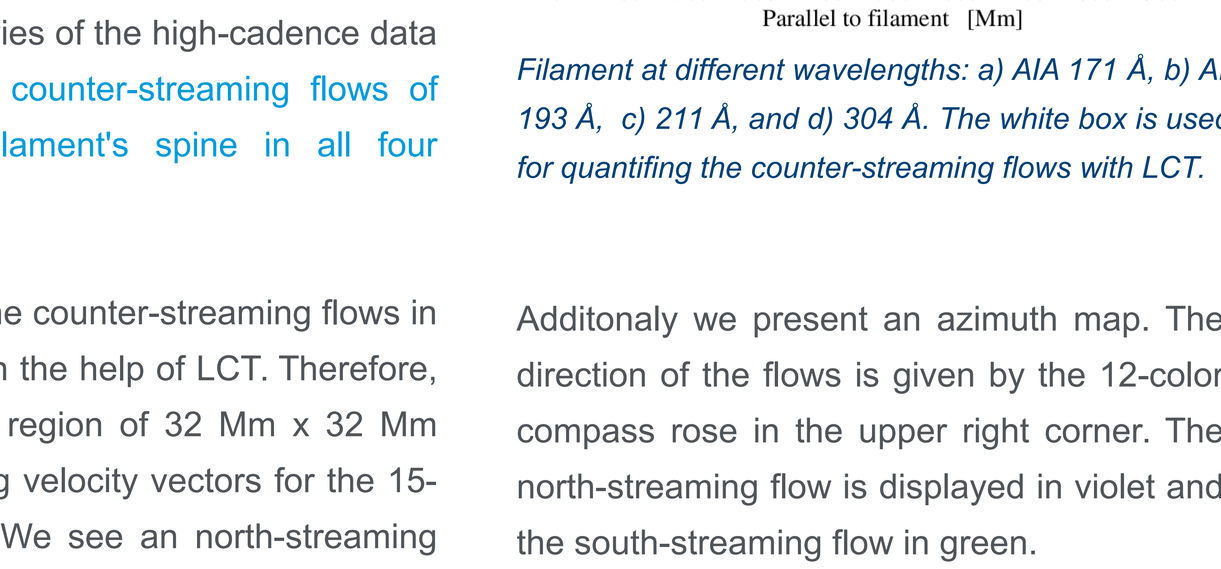


Filament at different wavelengths: a) AIA 171 Å, b) AIA 193 Å, c) 211 Å, and d) 304 Å. The white box is used for quantifing the counter-streaming flows with LCT.

Additonaly we present an azimuth map. The direction of the flows is given by the 12-color compass rose in the upper right corner. The north-streaming flow is displayed in violet and the south-streaming flow in green.



Two eruptions of the filament occurred during its life-time:
(a) on 2011 November 14 at 14:00 UT and
(b) on 2011 November 22 at 20:00 UT the filament lifted off.



a) Anti-parallel flows in a region of 32 Mm x 32 Mm along the spine region of the filament for the 15-minute time-series.
b) Azimuth map of the velocities.