Optical-Gamma-ray correlation in the blazar S5 1803+784

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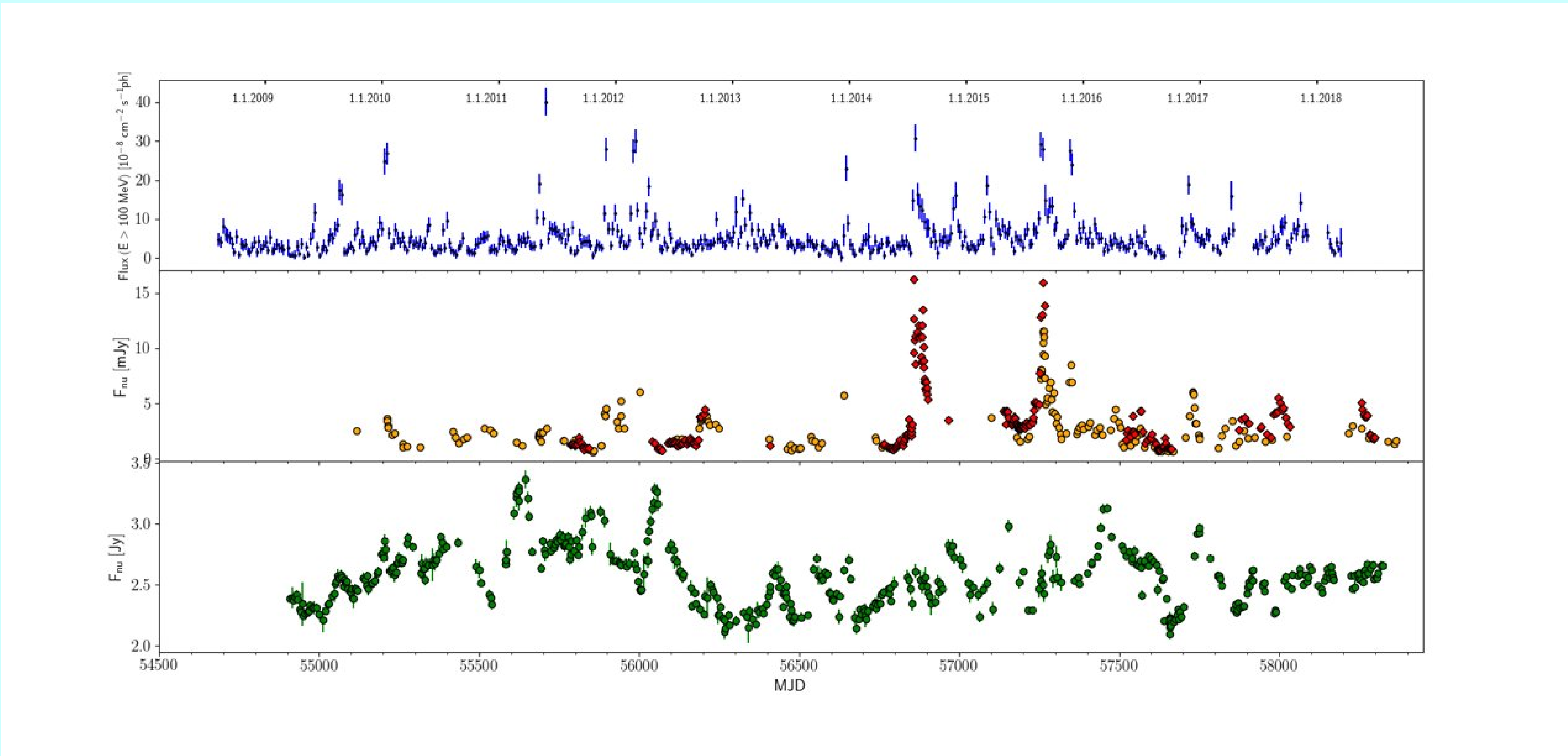

Fig. 1. Light curve of S5 1803+784 from 2008 to 2018.
Green= Radio OVRO 15 GHz
Orange= our optical data
Red= KAIT public optical data
Blue= Fermi-LAT, E>100 MeV, averaged on 7 days

Gamma-ray and optical data show a very good correlation, with no appreciable time lag.

Near simultaneous, multiwavelength observations are a key to understand the physical mechanisms responsible for the emission of radiation in BL Lac objects. We present a comparison between the optical and Gamma-ray light curves of the Low Frequency Peaked BL Lac object S5 1803+784 since the beginning of the Fermi-LAT mission (August 2008) up to September 2018. Data from Fermi-LAT instrument have been analysed taking into account the presence of nearby sources. We integrated optical data from our own observations (MASTER robotic network (Lipunov et al. 2010), Foligno Observatory, Lajatico Observatory) with other data from the KAIT public archive (Cohen et al. 2014) to build an optical light curve as complete as possible.
In addition we considered X-ray data from SWIFT-XRT taken in several pointings between 2009 and 2015, two of them during the 2015 flare. Furthermore we compared a VLBA radio map obtained by us in 2016 with the last available MOJAVE map (November 2012) to look for possible morphology changes in the relativistic jet.

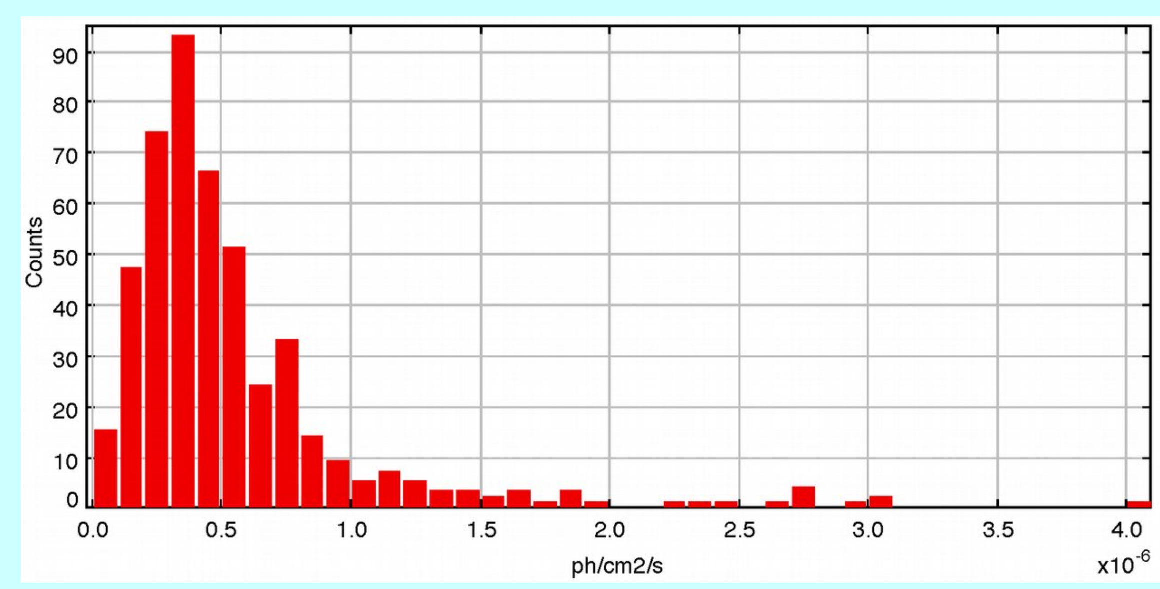

Fig. 2: The distribution of the Gamma-ray observations with TS>16. The median flux of the source is 3.7E-7 ph/cm2/s. High states may be defined as having flux > 3*sigma above the mean, i.e.1.0E-6 ph/cm2/s: this gives about 12 flaring episodes during the Fermi-LAT monitoring.
Only one flare (May 2011) had no optical counterpart (orphan flare, see Fig.1).

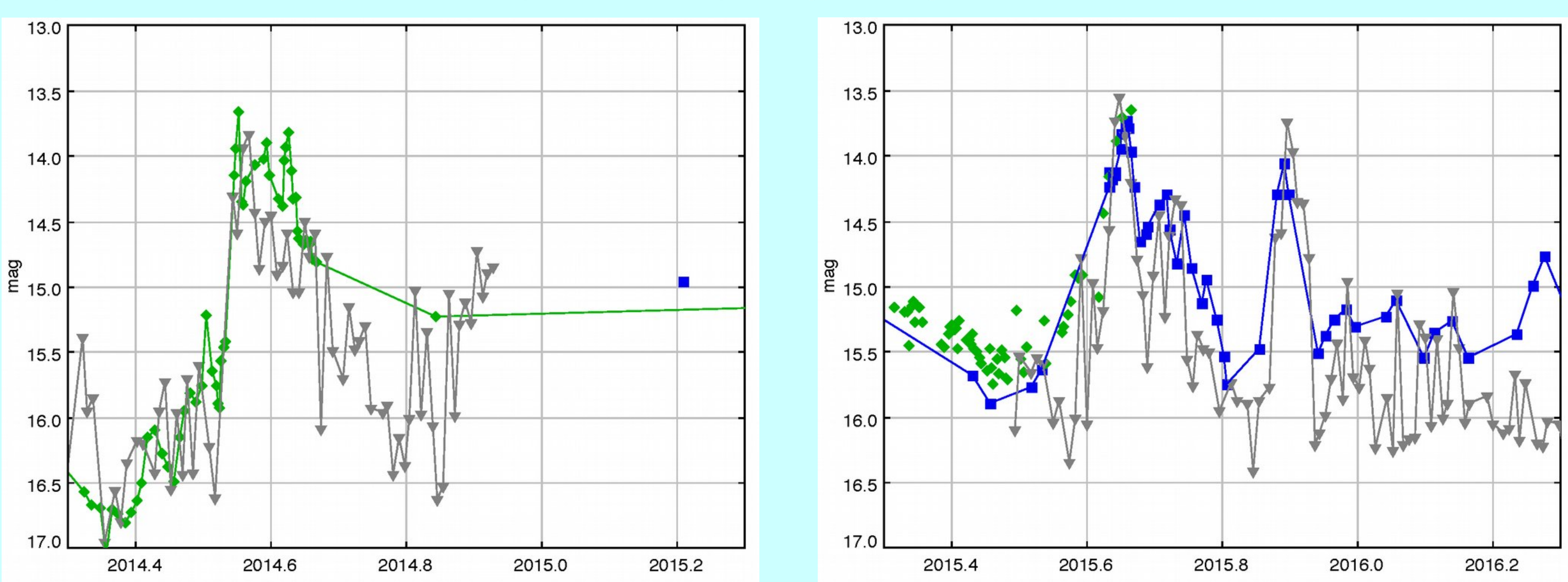

Fig. 3: A closer view of the two major flares in 2014 and 2015.
Grey: 3-days averaged LAT data transformed in arbitrary magnitudes. Green: KAIT (mag1) public data; Blue: our data.
The overall structure of the flares is very similar in optical and Gamma-ray.

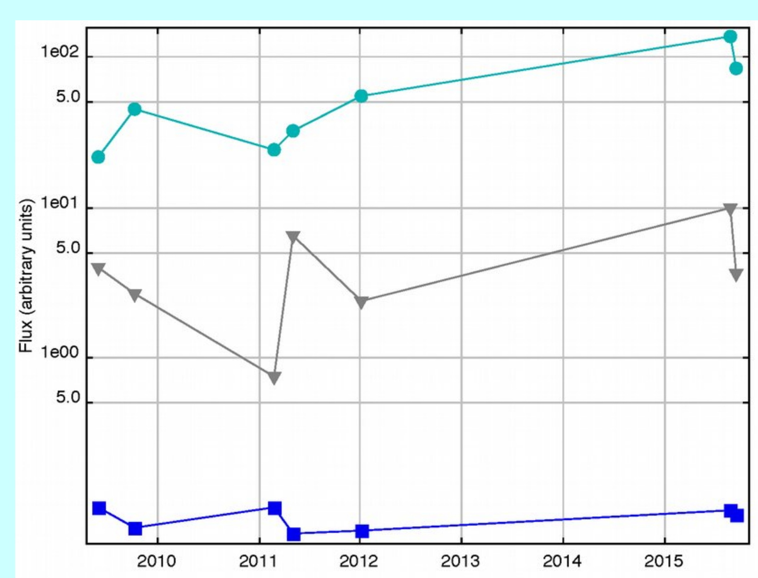

Fig. 4: UVOT M2 (green circles), LAT (grey triangles), and XRT (blue squares) fluxes in arbitrary units at epochs with simultaneous data. The last two points were taken during the 2015 flare.

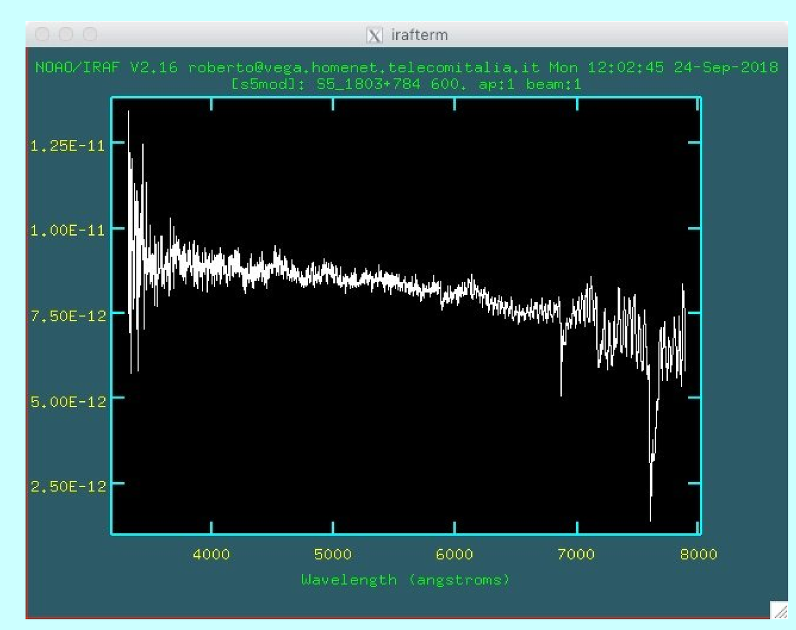

Fig. 5: Spectrum of S5 1803+784 taken on 27-08-2015 with the Asiago 122cm telescope while the source was around the optical maximum.
The MgII 2800 A line expected at 4700 A with a 6 A equivalent width (Lawrence et al., 1996), is not detected with a 1 A equivalent width limit, likely because swamped by the high continuum level.

Overall variability: during the 9 years of monitoring the Gamma-ray flux varied by a factor of 10, and the optical flux changed by a factor 8, while the X-ray one varied only by a factor 2. No clear correlation of the X-ray emission with the optical or the Gamma-ray emission was found.
Spectral slopes: the X-ray emission was always well fitted by a power law with photon index +1.5, independently of the flux level. The Gamma-ray spectral slope was well fitted by a power law with photon index +2.2, with very small variations despite the large changes in flux level. No significant optical (V-I) color changes were detected.

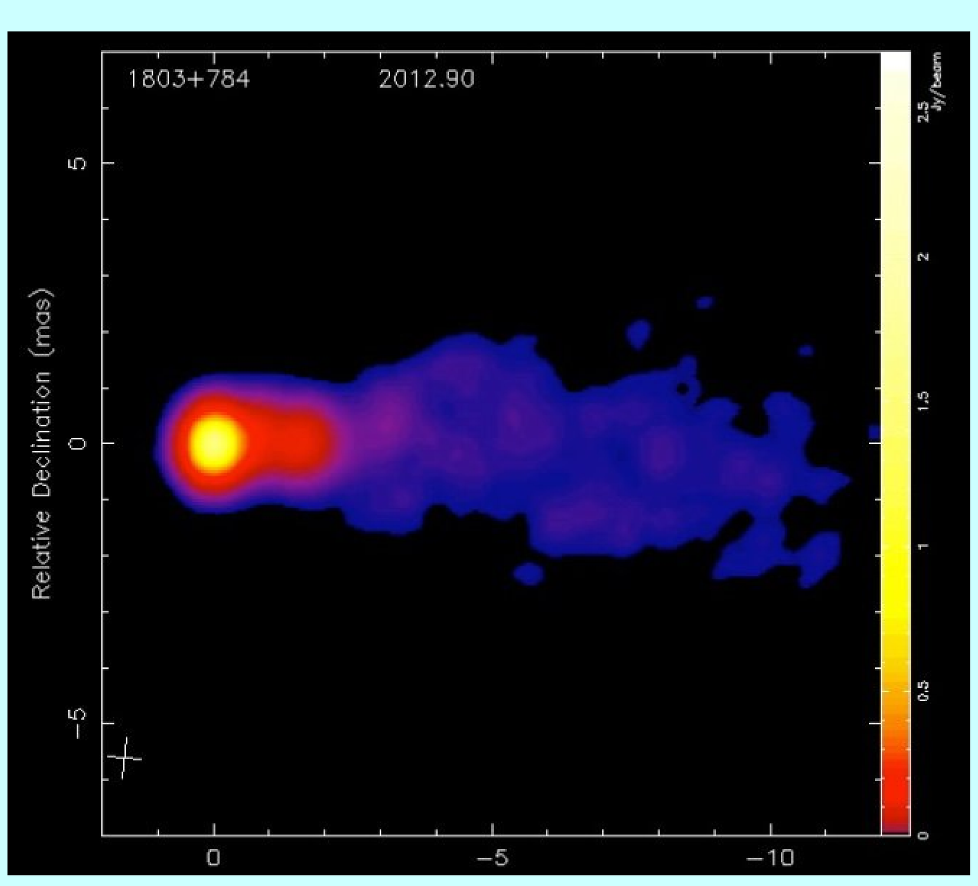

Fig. 6: The MOJAVE radio map at 15 GHz taken on November 2012 (Lister et al. 2016). The distance between main and secondary peak is 1.6 mas. Total flux is 2.1 Jy. The historic recorded MOJAVE maximum was 3.2 Jy in March 2011, after the Gamma-ray flare of January 2010.

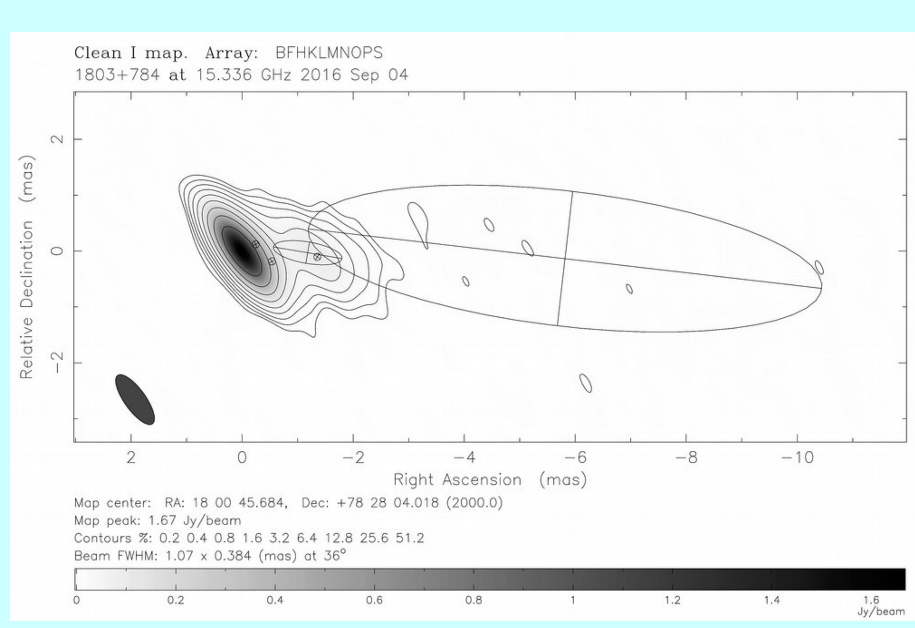

Fig. 7: Our VLBA map at 15 GHz taken on September 2016, four year after the MOJAVE one.The large ellipse corresponds to the MOJAVE "blue" tail, while the small ellipse is a fit to the secondary component to the right of the main source. The distance between the main and the secondary component is 1.1 mas. Fluxes of the two peaks are 1.8 and 0.4 Jy respectively, for a total flux of 2.2 Jy.
We interpret the apparent shift of the secondary peak towards the left as due to the actual birth of a new component moving from the main peak along the jet towards the right, filling the gap between the two peaks.

Conclusions

- The good temporal correlation between optical and Gamma-ray fluxes supports a common origin for the emitting processes in the two energy bands.
- The smaller variability of the X-ray flux is consistent with an SSC scenario, where it is due mainly to the low-energy tail of an Inverse Compton process, in agreement with previous findings (Nesci et al. 2012; 2002).
- The MgII 2800 A emission line is not detected (E.W.< 1 A) during the flare, indicating that the BLR was not involved.
- The VLBA map suggests that a radio-emitting blob has been formed after the Gamma-ray flare and is moving along the jet. The analysis of further radio VLBA and EVN maps is in progress.

References:
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