Multi-wavelength follow-up of a large flare of PKS0346-27

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ABSTRACT: A large Gamma-ray flare of the FSRQ PKS0346-27 was detected by Fermi-LAT in February 2018. This enhanced activity signaled the first awakening of the blazar since the satellite is operational. Follow-up observations with REM and Swift reported the source at very high flux level also in the optical and X-rays bands. We investigate the object's properties thanks to the gamma-ray and NIR data collected, together with additional available radio, optical and mm-band data. The time variability patterns and the overall SED are briefly discussed.

PKS0346-27 is a Flat Spectrum Radio Quasar at z=0.991 (White et al. 1988). It is associated with the X-ray source 3FGL J0348-2748 from the third Fermi-LAT source catalog (Acero et al. 2015).
A NIR flare was first reported based on data taken on 14 November 2017 (Carrasco et al 2017). A first, strong Gamma-ray flare was reported on 2 February 2018 based on Fermi-LAT data (Angioni et al. 2018), with a daily flux more than 100 times larger than the average one reported in the 3FGL, and a significantly harder photon index. This prompted multiwavelength follow-up which revealed ongoing activity in the optical-NIR (Nesci 2018a), UV and X-ray (Nesci 2018b). The high-energy flare continued over the following months, showing a second, brighter peak on 13 May 2018 (Ciprini 2018), with a daily flux 150 times the catalog level. X-ray and UV follow-up by Swift continued over the following days (16 to 24 May).

Data analysis.
Fermi-LAT data. The first pronounced peak is seen in December 2017, lasting only one week. A more extended flaring period is seen between April and June 2018, with a peak flux of (1.4+-0.2) E-6 photons cm^-2 s^-1 and a photon index 1.99+-0.12 in the week centered on 2018-05-10. The highest luminosity is found in the following week, despite the slightly lower flux of (1.2+- 0.05) E10-6 photons cm^-2 s^-1, due to the harder photon index of 1.87+-0.03, and corresponds to (9.1+-0.4) E48 erg s^-1.
REM data. NIR J and H band magnitudes were measured with aperture photometry using as comparison 10 nearby stars from the 2MASS catalog. Sloan r' and i' magnitudes were measured using comparison stars from the UCAC4 catalog.
Swift XRT and UVOT images were analysed using the standard tools provided by the SSDC data center.

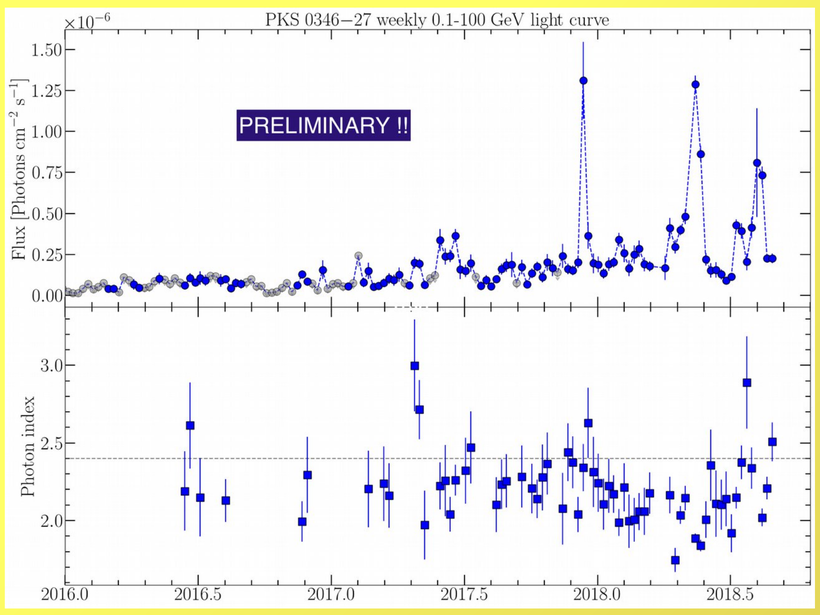

Fig. 1. The weekly binned Gamma-ray light curve (upper panel) and the corresponding photon index. The flare on 2017.9 corresponds to the NIR brightening reported by Carrasco et al. (2017). Between 2018.0 and 2018.5 the source is characterized by a "lower-than-average" photon index value, which we call "hard state".

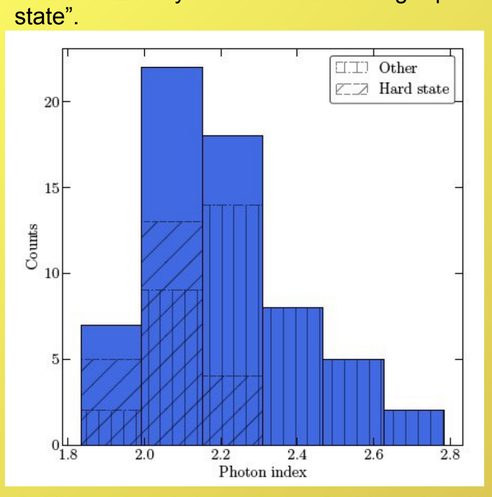

Fig.2. Histogram of photon index for bins when it was fitted as free parameter. The filled blue area represents the total distribution, while the hatched areas indicate the distributions for the "hard state" time interval (2018.0–2018.5) and for all the other bins.

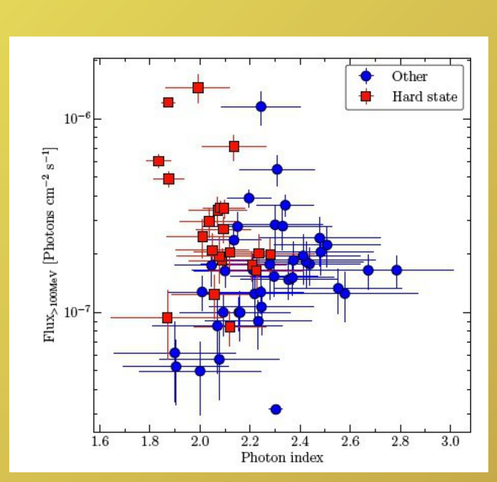

Fig. 3. Flux (0.1-100 GeV) as a function of photon index for bins where the index was fitted as a free parameter. Red squares correspond to times included in the "hard state", blue points indicate all other time bins.

Historic behavior:
A past flare in the I band is recorded in a SERC plate on 1992-11-03 at i=14.7. In another plate one year later (1993-10-06) the source was down at i=20.3. Optical monitoring in the years 2007-2010 is provided by the Catalina Sky Survey, showing a large variability between V=18 and V=20.
Data from ASASSN (Vallely et al. 2018) are available from 2013: the source was below the detection limit V~17 until 12 Feb 2018, reaching V=15.5 on Feb 21.

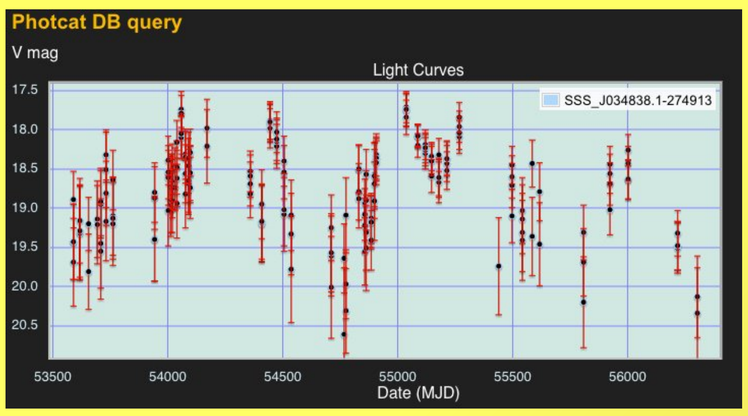

Fig. 4. The Catalina Sky Survey public data.

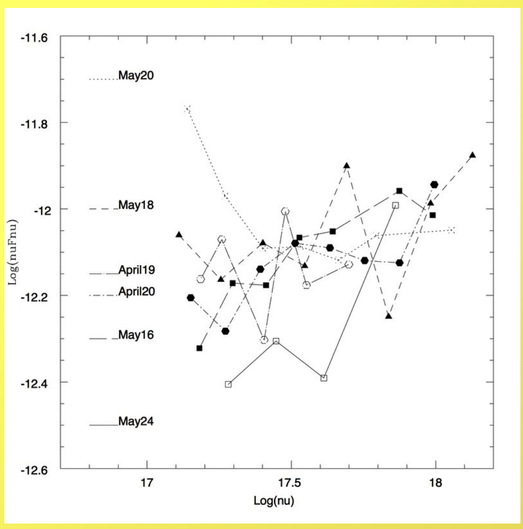

Fig. 6. The Swift-XRT spectra during the flares were well fitted by a power law: the date MM-DD marks each point. The N_H value was fixed at the galactic one (9.13E-19 cm^-2). The softening of the spectrum at the flare peak (May20) is likely due to the increased contribution in the soft-X range by the Synchrotron emission.
The data taken in quiescence in 2009 (count rate 0.02 cts/s) were too faint to allow a good spectral fit.

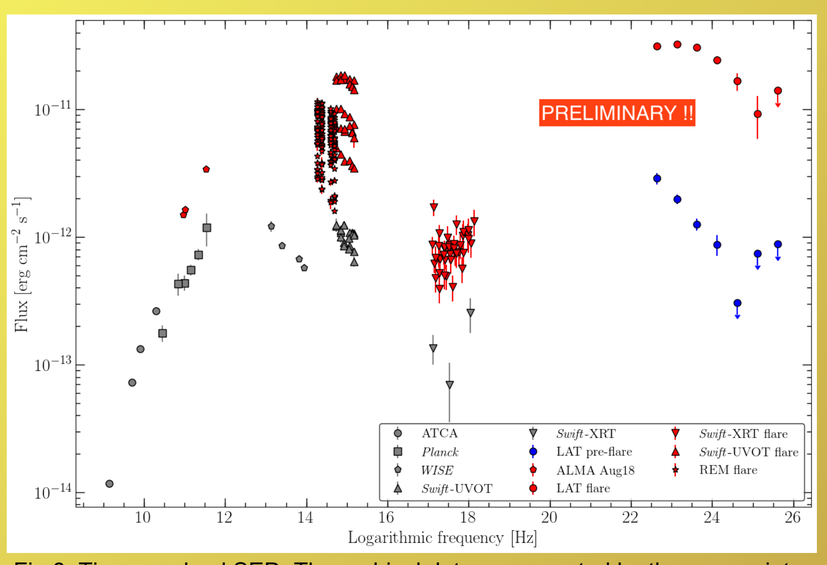

Fig.8. Time-resolved SED. The archival data, represented by the grey points, includes data from ATCA (Murphy et al. 2010), Planck (Planck Collaboration et al. 2016), WISE (Wright et al. 2010) and Swift (Evans et al. 2014). ALMA data is taken from the ALMA Calibrator Catalogue.

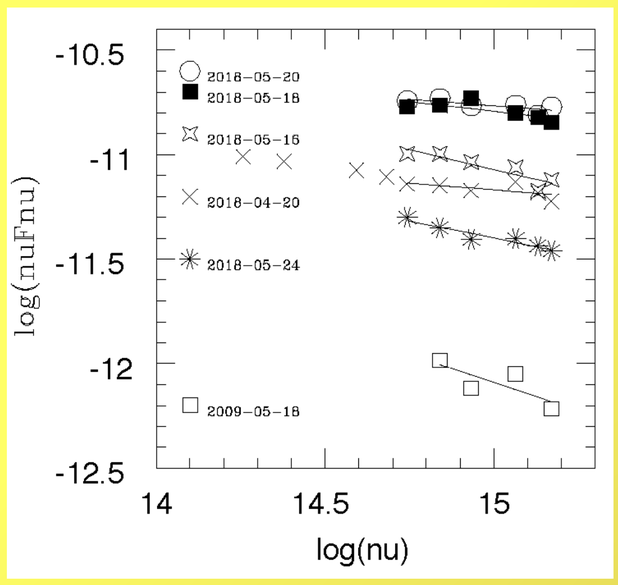

Fig. 5. UVOT SED at different flux levels during the April and May flares: the slope is flatter at the maxima, steeper during rise and fall. The slope was steeper in the 2009 pointing, when the source was at its average flux level (V~19). For the April pointing the simultaneous REM data are also plotted, showing a fair continuity of the SED.

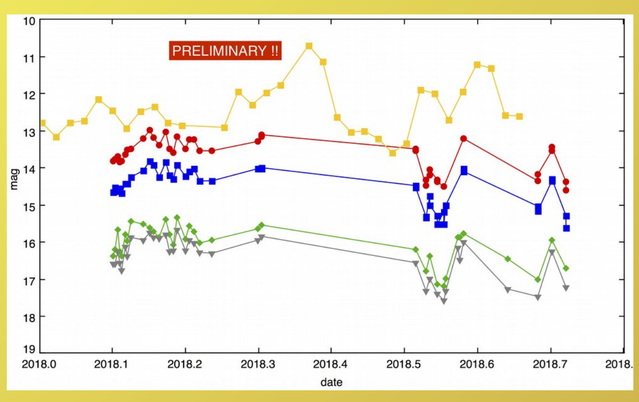

Fig.7. The LAT light curve (upper line) in a magnitude scale compared with the REM light curve in the r,i,J,H bands(from bottom to top). The strong flare at 2018.4 is covered by UVOT with U=14.6, corresponding to H~12.1

Results

PKS0346-27 is a FSRQ and its SED has a Synchrotron Peak around 1.0E13 Hz, typical for this kind of AGNs.

The Gamma-ray bright state is characterized by a hardening of the Gamma-ray spectrum.

Both the X-ray and the optical-NIR emissions look correlated to the Gamma-ray one during the flares.

The optical emission during the flares varies on a daily time scale.

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