Image credit: IPAC-Caltech

BL Lac object 1ES 0647+250, a decade of MWL observations

J. Otero-Santos, D. Dorner, D. Morcuende, D. Paneque, V. Fallah Ramazani, E. Prandini, G. Bonnoli
on behalf of the MAGIC and *Fermi*-LAT Collaborations and MWL partners

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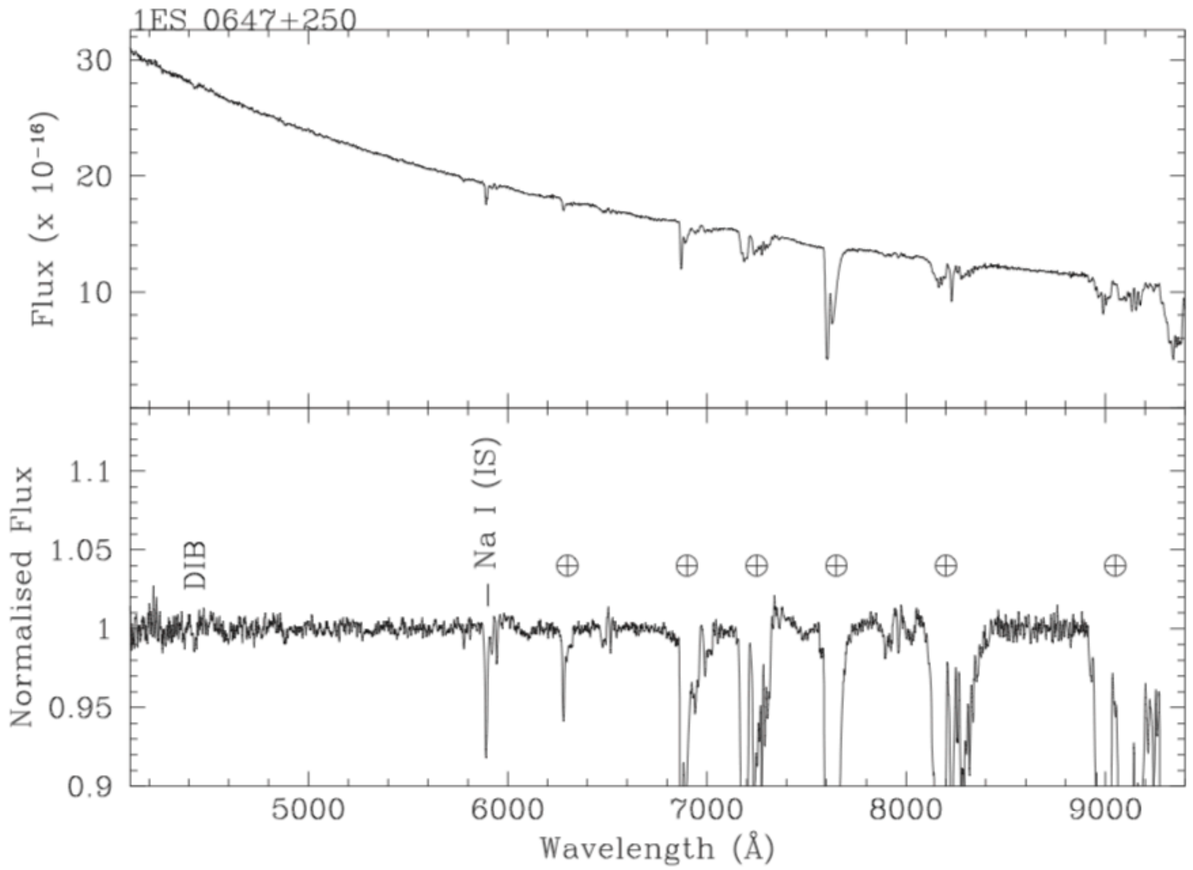
1ES 0647+250

- High synchrotron peak (HBL) BL Lac object
- Unknown redshift
  - Lower limit of z > 0.29
  - Tentative value of z = 0.41
- Detected by MAGIC in 2009-2011 in non-flaring state
- Detected in VHE γ-rays in several enhanced states (2014 after optical high state, 2019 and 2020 after X-ray high states)
- 11 years of MWL data collected

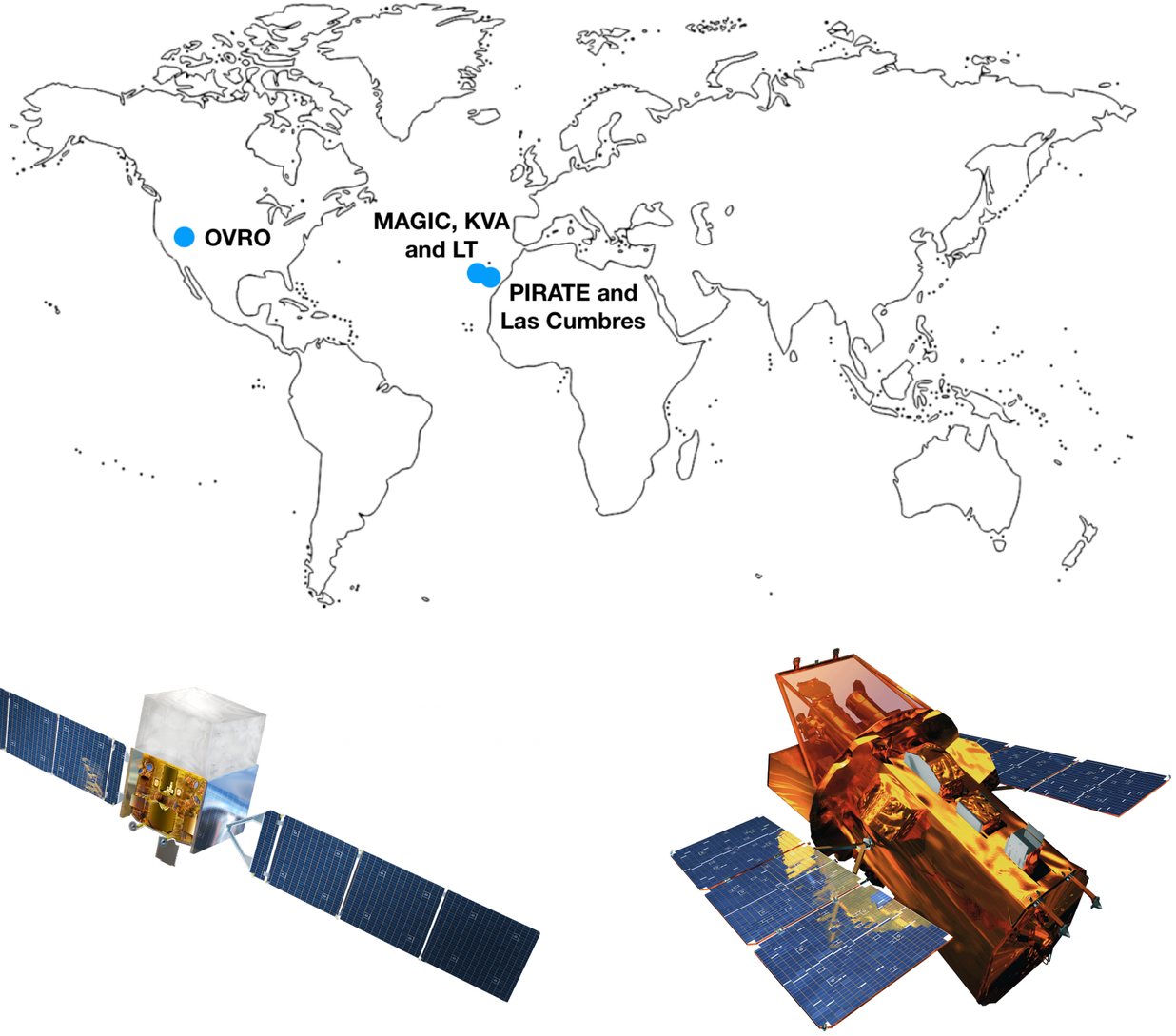


Optical spectrum of 1ES 0647+250 presented by Paiano et al. (2017) for constraining the redshift lower limit of the source.

MAGIC and MWL data set

- MAGIC data from 2009 to 2020
- MWL data from several facilities form HE γ-rays to radio

MAGIC Telescopes at the Roque de los Muchachos Observatory, La Palma, Spain. (*Credit: Daniel López/IAC*).

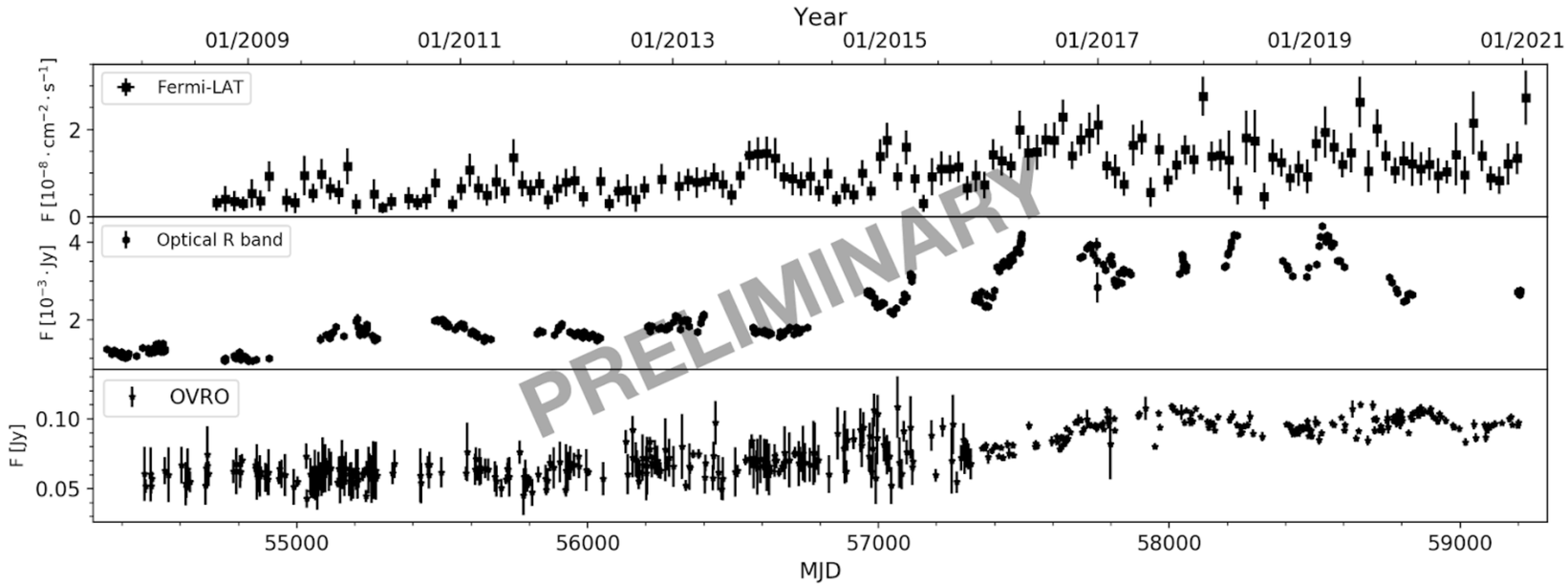


Ground- and space-based facilities and instruments used for this work. *Top:* optical telescopes (Tuorla-KVA, Las Cumbres, PIRATE and Liverpool Telescope) and radio telescope (OVRO) used. *Bottom left: Fermi* satellite. *Bottom right: Swift* satellite (Credit: NASA).

Results

MWL light curves

11-year LCs for long-term analysis



HE γ-rays (*Fermi*-LAT), optical R-band (KVA, Las Cumbres, PIRATE and LT) and 15 GHz radio (OVRO) light curves.

Spectral characterization

	$F(E > 100$ GeV) [% Crab Units]	Spectral parameters	
		E_0 [GeV]	Spec. index
2009-2011	2.0 ± 0.5	190	α = -3.1 ± 0.4
2014	3.4 ± 1.6	100	α = -3.3 ± 0.7
2019	8.0 ± 1.8	100	α = -3.7 ± 0.6
2020	15.0 ± 1.0	100	α = -3.2 ± 0.2 β = -1.9 ± 0.7

Integral flux above 100 GeV and spectral parameters of 1ES 0647+250 for the different detected periods.

Redshift estimation:

Prandini et al. (2010) empirical method + upper limit with joint MAGIC + *Fermi*-LAT spectrum

Estimated redshift, z_{est}	z_{UL} [95% C.L.]
0.45 ± 0.05	0.81

Results of the redshift estimation. z_{est} is the estimated value through the empirical relation from Prandini et al. (2010) and z_{UL} the 95% C.L. upper limit with the joint HE and VHE spectra.

MAGIC Major Atmospheric Gamma Imaging Cerenkov Telescopes