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Peculiar emission from the new VHE gamma-ray source H1722+119

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The BL Lac object H1722+119 was observed in the very high energy band (VHE, $E >$ 100 GeV) by the MAGIC (Major Atmospheric Gamma-ray Imaging Cherenkov) telescopes (Aleksić *et al.* 2016a, b) between 2013 May 17 and 22, following a state of high activity in the optical band measured by the KVA (Kungliga Vetenskapsakademien†) telescope. Optical high states are often used to trigger MAGIC observations, which result in the VHE γ-ray signal detection (see e.g. Aleksić *et al.* 2015, Ahnen *et al.* 2016 and references therein).

Integrating 12.5 h of observation, the source was detected at VHE with a statistical significance of 5.9 sigma. The flux appears to be constant at the level of $f = (6.3 \pm 1.6) \times 10^{-12}\,\mathrm{ph\,cm^{-2}\,s^{-1}}$ above 150 GeV with $\chi^2/N_{\mathrm{d.o.f.}} = 3.5/5$ (fig. 1 right top). This corresponds to $(2.0 \pm 0.5)\,\%$ of the Crab Nebula flux in the same energy range. Contemporaneous observations were performed by the *Fermi*-LAT (Large Area Telescope, Atwood *et al.* 2009, Ackermann *et al.* 2012) in the high energy range (HE, 100 MeV$< E <$ 100 GeV); by the *Swift*-XRT: 200 eV$< E <$ 10 keV (Burrows *et al.* 2005) and the *Swift*-UVOT: 170 nm $< \lambda <$ 600 nm (Roming *et al.* 2005); by the KVA and the Abastumani telescope‡ in the R-band, and by the OVRO (Owens Valley Radio Observatory) telescope in the 15 GHz radio band (Richards *et al.* 2011).

The multiwavelength light curve (fig. 1 left) shows no significant temporal variability in the HE band either. The flux was $f = (3.4 \pm 0.6) \times 10^{-8}\,\mathrm{ph\,cm^{-2}\,s^{-1}}$, with $\chi^2/N_{\mathrm{d.o.f.}} = 3.9/5$, while the spectrum appears to be constant as well, with the spectral index of 1.96 ± 0.07, with $\chi^2/N_{\mathrm{d.o.f.}} = 1.7/5$. The optical flux varied with no apparent regularity, and the radio data show a linear trend ($F[\mathrm{Jy}] = p_0 + p_1 \times (t - 56300)[\mathrm{MJD}]$) of increasing flux on a time-scale of one year, with the fit parameters $p_0 = (5.2 \pm 0.2) \times 10^{-2}$ Jy, $p_1 = (1.07 \pm 0.10) \times 10^{-4}$ Jy/day and $\chi^2/N_{\mathrm{d.o.f.}} = 39.68/36$.

Using the HE and VHE gamma-ray observations, and the expected imprint of the extragalactic background light (EBL, Franceschini *et al.* (2008)) absorption, we estimated the redshift of the source to be $z = 0.34 \pm 0.15_{\mathrm{stat}} \pm 0.05_{\mathrm{meth}}$ with upper limit (UL) of $z < 1.06$ (95% C.L.), using the method from Prandini *et al.* (2010). Using the method of Mazin & Goebel (2007) we obtain an UL of $z < 0.95$. Our reconstructed redshift value is in agreement with the latest Landoni *et al.* (2014) and Farina *et al.* (2013, priv. comm.) results. A quasi simultaneous multi-wavelength SED (spectral energy distribution, fig. 1 right bottom) shows an unexpected feature in the $3 \times 10^{14} - 10^{18}$ Hz frequency range. A possible explanation using an inhomogeneous helical jet synchrotron self-Compton model is suggested (Villata & Raiteri 1999, Ahnen *et al.* 2016).

† http://users.utu.fi/kani/1m
‡ http://www.oato.inaf.it/blazars/webt/aba_info.html

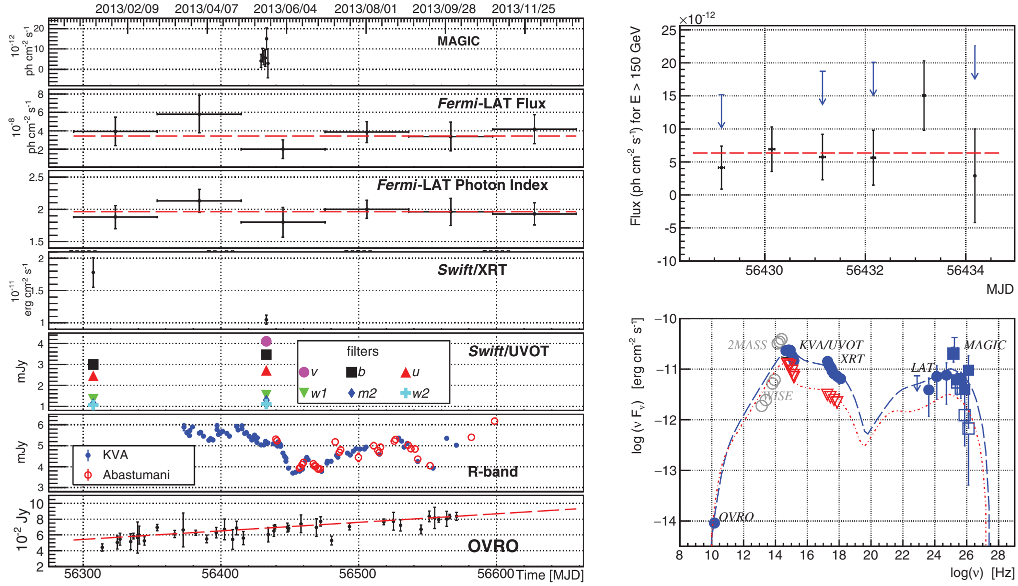

Figure 1. Light curve and the SED of H1722+119 for data collected during 2013. **Left**: Multi-wavelength light curve during 2013. The data were collected (from top to bottom) by MAGIC, *Fermi*-LAT, *Swift*/XRT, *Swift*/UVOT, KVA and Abastumani and OVRO. The HE γ-ray light curve and the evolution of the spectral index, as measured by *Fermi*-LAT, are shown in 2-month time bins, while daily observations time-scale is used in the light curves in the other energy bands. **Right top**: MAGIC nightly light curve for energies above 150 GeV. Horizontal error bars represent the duration of each observation. Vertical arrows represent ULs for points whose relative error of the excess is > 0.5. **Right bottom**: The H1722+119 SED. Full circles represent data contemporaneous to MAGIC observations. The MAGIC measured data are shown by empty squares, while full squares indicate the de-absorbed points. *Fermi*-LAT data are shown by full circles, while arrows represent *Fermi*-LAT ULs. The *Swift* data indicated by full circles were taken on 2013 May 20 (MJD 56432). The KVA *R*-band point represented by a full circle was taken on the same night. The OVRO measurement represented by a full circle was taken on 2013 May 22 (MJD 56434). Empty triangles show the *Swift* data from 2008 May 31 (MJD 54617). The solid line in the $10^{14} - 10^{15}$ Hz range indicating data from Landoni *et al.* (2014) was not considered for modelling, as well as archival data from 2MASS and WISE shown by empty circles. The long-dashed line indicates the fit of the helical jet model to the 2013 data, while the fit to the 2008 data is indicated by the dash-dot line. Both models represent the intrinsic VHE emission.

References

Ackermann, M., *et al.* 2012, *ApJS*, 203, 4
Ahnen M. L., *et al.* 2016, *MNRAS*, 459, 3271
Aleksić J., *et al.*, 2015, *MNRAS*, 451, 739
Aleksić J., *et al.* 2016a, *Astroparticle Physics*, 72, 61
Aleksić J., *et al.* 2016b, *Astroparticle Physics*, 72, 76
Atwood W. B., *et al.* 2009, *ApJ*, 697, 1071
Burrows D. N., *et al.* 2005, *Space Sci. Rev.*, 120, 165
Franceschini, A., Rodighiero, G., & Vaccari M. 2008, *A&A*, 487, 837
Landoni, M., *et al.* 2014, *A&A*, 570, A126
Mazin, D., Goebel F. 2007, *ApJ*, 655, L13
Prandini, E., *et al.* 2010, *MNRAS*, 405, L76
Richards J. L., *et al.* 2011, *ApJS*, 194, 29
Roming, P., *et al.* 2005, *Space Sci. Rev.*, 120, 95
Villata, M. & Raiteri, C. M. 1999, *A&A*, 347, 30