H.E.S.S. DISCOVERY OF VHE EMISSION FROM PKS 0736+017:

on the location of the $\gamma$-ray emitting region in FSRQs

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67 known VHE (E > 100 GeV) blazars
only 6 are FSRQs

due to: -lower peak frequency compared to HBLs
   -higher (average) redshift compared to HBLs

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Well known radio quasar

- $z = 0.1894$ (Ho & Kim 2009)
- typical FSRQ optical spectrum
- presence of big-blue bump
- SMBH mass = $10^{8.47} M_\odot$ (McLure & Dunlop 2001)
- Host galaxy is a standard giant elliptical (Wright 1998, Kotilainen 1998, ++)

Milkan & Moore, 1986
PKS 0736+017

Well known radio quasar

- Core-jet radio morphology (from MOJAVE)

Lister & Homan, 2005
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Well known radio quasar

- Extreme optical flare in 2002, with 0.6 mag/hr (which classifies the source as Optically Violently Variable)

Clements et al., 2003
PKS 0736+017

The source is detected by Fermi, and known as 3FGLJ0739.4+0137

- Active in November 2014 (ATel 6731)
- and again in February 2015 (ATel 6975 from ASAS-SN)

From automatic aperture photometry analysis of Fermi-LAT data
PKS 0736+017 : LAT results

LAT likelihood data analysis – PASS8 – 12h bin
„Double“ flare in $\gamma$-rays

H.E.S.S. observations on 2015, Feb 18, 19, 21
H.E.S.S. II

Array of 4+1 Cherenkov telescopes located on Khomas Highland, Namibia
(23°16′ S, 16°30′ E)

Two different reconstructions:
- **Monoscopic** (CT5 only)
- **Stereoscopic** (any 2 out of 5 telescopes)
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PKS 0736+017 : H.E.S.S. results

Discovery of VHE emission on the night of 2015 Feb 19 (both in Mono & Stereo reconstruction)

PRELIMINARY

H.E.S.S. Mono 11σ detection

PRELIMINARY

H.E.S.S. Stereo 5.5σ detection
PKS 0736+017 : H.E.S.S. results

No detections during the other nights
Correlation with the second Fermi-LAT flare

Time selection for contemporaneous LAT analysis
PKS 0736+017: \(\gamma\)-ray SED

Fermi-LAT and H.E.S.S. spectra (mono & stereo)

\[ \Gamma = 2.15 \pm 0.10 \]

\[ \Gamma_{\text{mono}} = 3.1 \pm 0.3 \]

\[ \Gamma_{\text{stereo}} = 4.2 \pm 0.8 \]

Fermi-LAT spectrum extrapolated towards higher energies, including EBL absorption \(\rightarrow\) spectral break between LAT and H.E.S.S.
PKS 0736+017 : X-ray and optical

Swift ToO triggered by H.E.S.S., with three 4ks exposures on 2015, Feb 20, 22 and 23
→ No simultaneous observations during the H.E.S.S. detection (Feb 19)

ATOM long-term lightcurve:
PKS 0736+017: MWL picture

Day-by-day variability in H.E.S.S. data, but only Fermi-LAT simultaneous with H.E.S.S.
PKS 0736+017 : modeling

- No simultaneous SED during the HESS detection & nigh-by-night variability
  → No SED modelling / fitting

- On the location of the γ-ray emitting region using only γ-ray information
Hypotheses:
- MeV to TeV emission is produced in the same region
- Dominant radiative process in $\gamma$-rays is leptonic (External-Inverse-Compton)
- Variability time-scale $\sim 12$ hours (from Fermi-LAT)

Constraints:
- Opacity to $\gamma-\gamma$ pair production on BLR photons (Bottcher & Els, 2016)
- Collimation of the jet
- Cooling time-scale (by EIC) is smaller than variability time-scale (Nalewajko++ 2014)
PKS 0736+017: modeling

- **Cooling constraint**
- **Opacity constraint**
- **Collimation constraint**

Scattering on BLR photons, $\Gamma \sim 10$

Scattering on torus photons, $\Gamma \sim 50$

Not possible, due to opacity
PKS 0736+017: conclusions

Discovery of VHE emission from PKS 0736+017

- is the sixth VHE FSRQ
- the second one discovered with H.E.S.S.

Gamma-ray observations only can put constraints in the $\Gamma$-r plane.
PKS 0736+017: conclusions

Perspectives:

At $z=0.189$ it is the nearest FSRQ
The best one to study internal absorption

At $\text{dec} \sim 0$, easily visible by H.E.S.S. / MAGIC / VERITAS / FACT / HAWC

→ be ready for the next $\gamma$-ray flare