Blazar studies with H.E.S.S.

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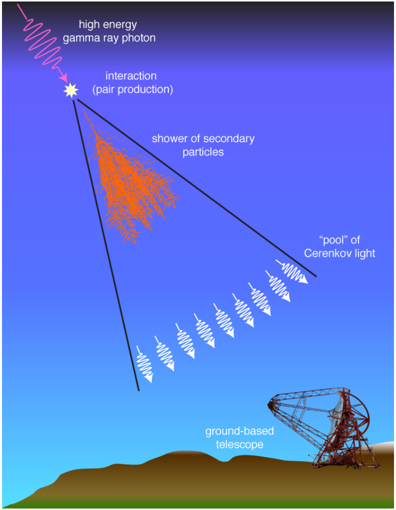
Imaging Atmospheric Cherenkov Telescopes

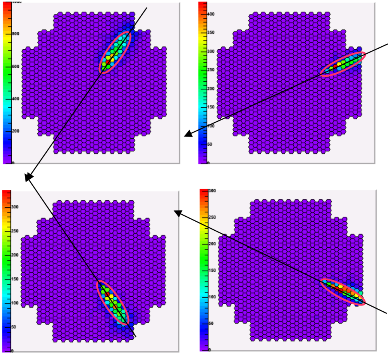
- High energy gamma rays hit the upper atmosphere and create air-showers
- The shower particles are relativistic and induce Cherenkov light in a narrow cone along the direction of the incoming photon
- Telescopes on the ground can take images of the air-showers using fast electronics



(Albert, doi:10.1088/978-1-6817-4269-4ch3)

Reconstructing photons from Cherenkov light

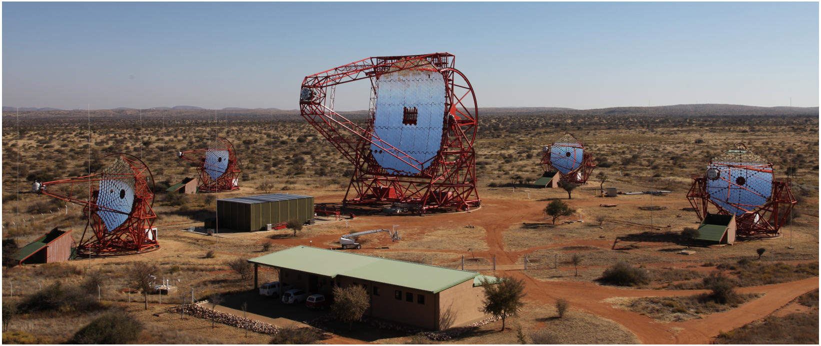
- The shape of the images can then be used to reconstruct energy and direction of the initial photon
- More views on the same shower gives better direction reconstruction
- More pixels in the camera gives better shape resolution: better energy reconstruction



(de Naurois, tel-00687872)

High Energy Stereoscopic System (HESS)

- Located in Namibia, Khomas Highlands, at 1800 m altitude
- Inaugurated in 2004, consisting of four 12m telescopes
- Much bigger, fifth, telescope with higher resolution camera added in 2012 to get better low energy sensitivity
- Sensitive to gamma rays between 80 GeV and $\sim$ 60 TeV



(HESS collaboration)

Extragalactic gamma ray sources: Blazars

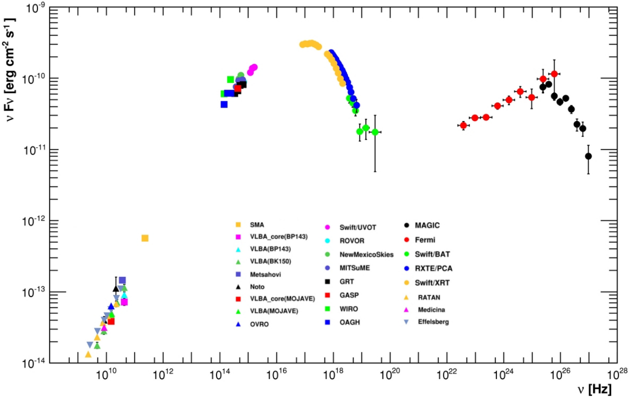
- Actively accreting supermassive black holes with relativistic jet pointing close to directly at us
- The bright jet is a strong source of non-thermal radiation spanning from the radio up to very high energy gamma rays
- Can be highly variable, implying very small emission regions

A BL Lac in the optical: Markarian 421

(Sloan Digital Sky Survey)

Blazar broad band spectrum

- Spectral energy distribution dominated by two non-thermal peaks
- Low energy peak from synchrotron radiation, high energy from Inverse Compton scattering

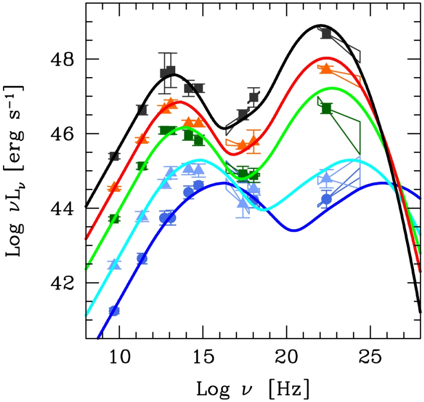


SED of nearby blazar Markarian 421

(Fermi, 2011ApJ...736..131A)

Blazar sequence

- Exists two main types of blazars, Flat Spectrum Radio Quasars (FSRQs) and BL Lac objects
- Fossati (1998) suggested how to classify the known blazars into a *Blazar sequence*
- FSRQs would be brighter sources with synchrotron peak at lower frequency, BL Lacs with lower luminosity but higher peak frequency

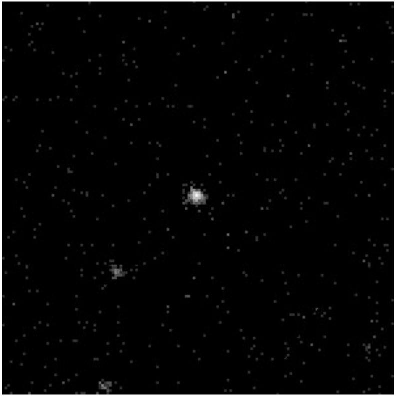


The original Blazar sequence

(G. Ghisellini et. al., 2017MNRAS.469..255G)

My source: KUV 00311-1938

- KUV 00311 is likely distant for a BL Lac, with redshift $0.5 \leq z \leq 1.5$
- Among the bright sources with hardest spectrum in the 2FLG
- If redshift at upper end of range, its luminosity would break the blazar sequence

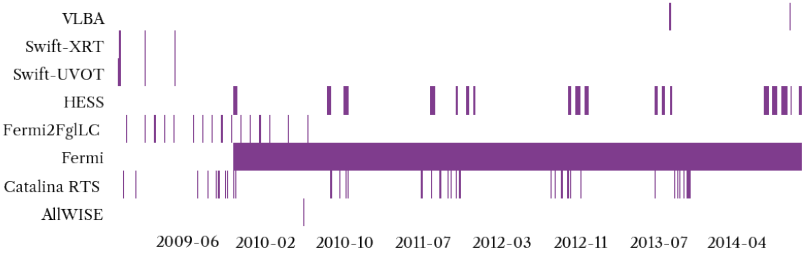


KUV 00311-1938 in X-ray

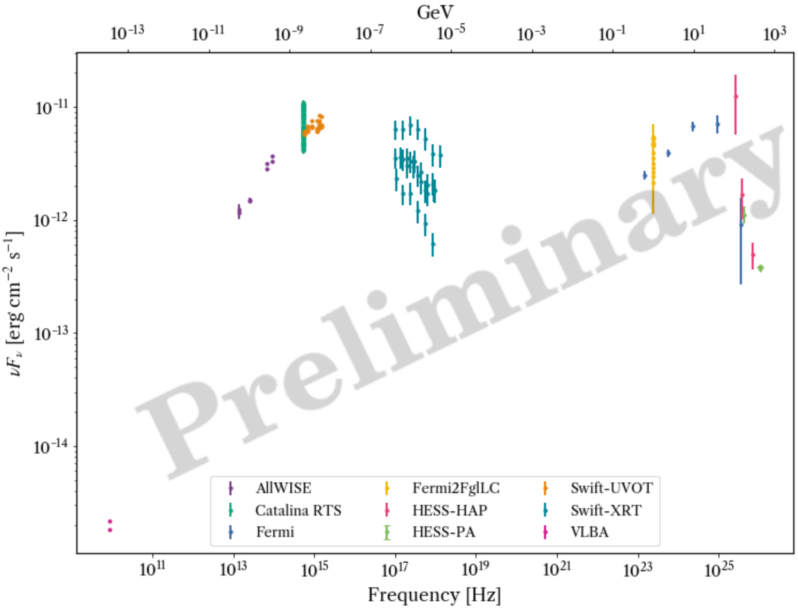
(ROSAT All-Sky X-ray Survey)

Observations of KUV 00311-1938 across all wavelengths

- HESS observations made between 2009-11-10 and 2014-10-24
- Fermi spectrum integrate full period between 2009-11-10 and 2014-10-24



KUV 00311-1938 across all wavelengths

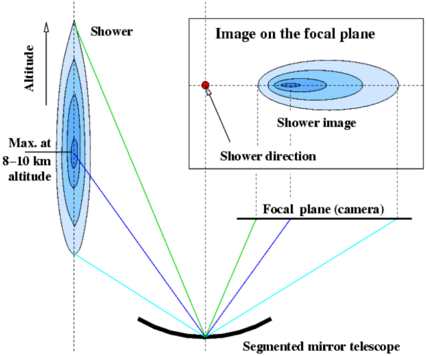


Understanding KUV 00311-1938 across all wavelengths

- Because the synchrotron peak and high energy peak are related to the same underlying electron population in the IC scenario, peaks should have similar shape
- Sharp break in high energy peak not seen in synchrotron is clear evidence of absorption from Extragalactic Background Light
- KUV 00311-1938 is likely a fairly distant BL Lac
- I am now working to further constrain redshift from estimates of observed EBL absorption

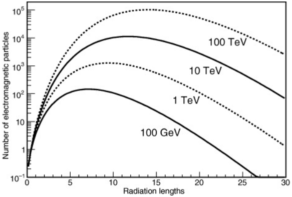
Thank you for your attention

Imaging atmospheric Cherenkov light



(K. Bernlöhr)

- The energy of the gamma photon influences the profile of the shower



(Sinnis, 2009NJPh...11e5007S)