Observations of AGNs with the MAGIC Telescope

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Outline:

- Active Galactic Nuclei (AGN) and blazars
- Extragalactic Background Light (EBL)
- MAGIC
  - Markarian 421, $z=0.030$
  - Markarian 501, $z=0.034$
  - 1ES2344+514, $z=0.044$
  - Markarian 180, $z=0.045$
  - 1ES1218+304, $z=0.182$
  - PG1553+113, $z>0.09$
- Conclusions, outlook
TeV blazars

- TeV blazars: non-thermal emission, highly variable
- All but one are HBL (high peaked BL Lacs)
- Models: leptonic vs. hadronic origin


Synchrotron Self Compton (SSC)

• TeV blazars: non-thermal emission, highly variable
• All but one are HBL (high peaked BL Lacs)
• Models: leptonic vs. hadronic origin
Where are the sources?

- In the Galactic plane, it starts to be crowded above 100 GeV. Expectations fulfilled.
- 16 extragalactic sources: 15 blazars and radio galaxy M87. The number is growing but slow.
- Expect many more if extrapolate from EGRET sources.
- Possible reasons:
  - Intrinsic cut-off
  - Extragalactic absorption
- GLAST will clarify
Attenuation of GeV-TeV photons

\[ \gamma(\text{TeV}) + \gamma(\text{eV}) \rightarrow e^+e^- \]

Red shifted stellar light
Red shifted dust light

Effect of Extragalactic Background Light

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The largest imaging atmospheric Cherenkov Telescope with 17m mirror diameter

- 3.5° FoV Camera with 576 enhanced QE PMT’s
- Trigger threshold: 50-60GeV
- Sensitivity: 2% Crab Nebula in 50 hours
- $\gamma$-PSF is about 0.1°
- Energy resolution: 30% at 150 GeV, 20% at 300 GeV

Canarian Island La Palma, 2200 m asl
Observations of AGNs with the MAGIC Telescope

**Mkn 421 (z=0.030)**

- Dec 2004 – Apr 2005
- 25.6 h, over 7000 excess events
- Energy threshold: 150 GeV

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**Clear TeV-X-ray correlation**

**Unclear TeV-optical correlation**

**Historical TeV spectra**

In case of 1-day variability scale, the model provides the same parameters as from the 1997 flare (Whipple): different flux states only matter of electron population?

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**Mkn 501 (z=0.034)**

- June – July 2005
- 32.2 h, around 16 kevents above 100 GeV
- Energy threshold: 150 GeV
- Details: D. Paneque on Wednesday (P1.4)

**IC peak detected: measured and de-absorbed!**


**Flux doubling times ~2 min**

**SED**

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1ES2344+514 (z=0.044)

- Whipple: Flare (20-12-95), F(>350GeV) = 63% Crab, (Catanese, 97)
- Whipple later upper limits only, F(>350GeV) < 8% Crab in 96/97 (Schroedter, 05)
- HEGRA 1997-2002: 4.4 \( \sigma \) F_{int}(>970GeV) = 3.3% Crab (Tluczykont et al. 03)
- MAGIC. Aug 05 – Jan 06, 27.4 h: Clear detection! 8.1 \( \sigma \); F(>350GeV) = 6% Crab, no variability; index: -2.96±0.12

Mkn 180 (z=0.045)

- Whipple: $F_{>300\text{GeV}} < 10.5\%$ Crab units
- HEGRA: $F_{>1.5\text{TeV}} < 12\%$ Crab units
- MAGIC: DISCOVERY!
  - March 2006, 11.1 h
  - Triggered by optical flare
  - $5.5\,\sigma$, $F_{>200\text{GeV}} = 11\%$ Crab units
  - Index: $-3.3 \pm 0.7$

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1ES1218+304 (z=0.182)

- **Whipple**: $F_{(>350\text{GeV})} < 8\%$ Crab units.
- **HEGRA**: $F_{(>750\text{GeV})} < 12\%$ Crab units
- **MAGIC**: **DISCOVERY!**
  - Jan 2005, 8.2 h
  - $6.4 \sigma$, $F_{(>120\text{GeV})} = 13\%$ Crab units
  - Index: $-3.0 \pm 0.4$

From PhD of T. Bretz

**Observed with the MAGIC Telescope**

**Sky Map**

**Spectrum**

**SED**

**Counts**

**θ² plot**

**SED** from PhD of T. Bretz

**Daniel Mazin, MPI, Munich**
PG1553+113 (z>0.09)

- Observed 18.8h in 2005-06
- 8.8σ, firm detection.

Alpha plot

SED: assuming $z=0.3$

Observations of AGNs with the MAGIC Telescope

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• Used H.E.S.S+MAGIC spectrum
• Assumed there is no break in the intrinsic spectrum of PG1553+113
• Assumed minimum evolving EBL (Kneiske et al. 2004)

⇒ $z < 0.42$
Conclusions / Outlook

• There are **15 blazars** above 100 GeV established (discovered by Whipple, Durham, TA, CANGAROO, H.E.S.S., and MAGIC)

• MAGIC detected **7** of them; **2** of them discovered by MAGIC, **1** co-discovered with H.E.S.S.

• GeV-TeV sources up to redshift $z=0.2$. Possible detections up to $z=1$ with HESS, MAGIC, CANGAROO, and VERITAS

• Simple leptonic emission models usually work

• Hard constraint on the redshift for **PG1553+113** of $z<0.42$ in case there is one peak above 100 GeV. If $z>0.42$, first detection of multipeak structure of a blazar above 100 GeV.

• TeV blazars constrain EBL: see Mazin on Wednesday (P5.2)

**More new MAGIC sources in the pipeline! Stay tuned!**