



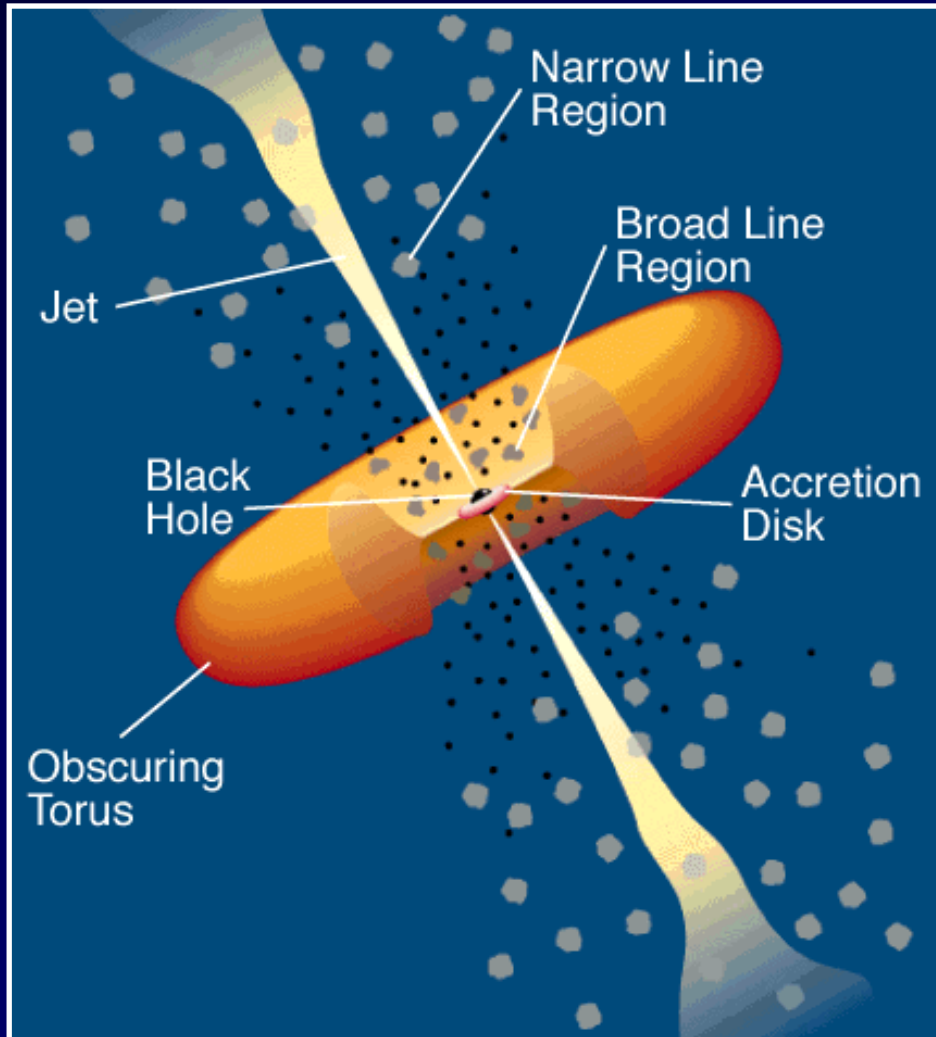
Multiwavelength observations of the gamma-ray blazar PKS 1510-089

Filippo D'Ammando

INAF - Istituto di Astrofisica Spaziale e Fisica Cosmica Roma
Università degli Studi di Roma "Tor Vergata"

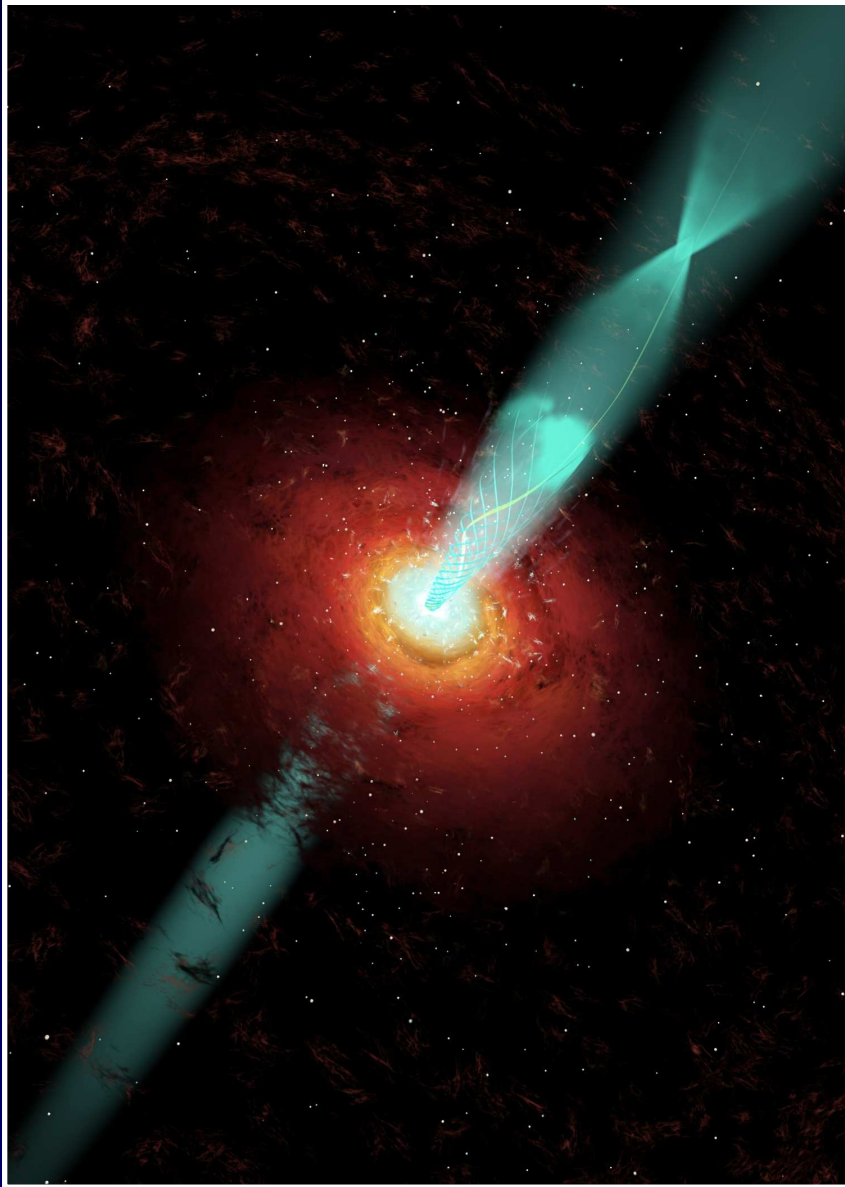
on behalf of the **AGILE WG-AGN** and
in collaboration with **C. M. Raiteri** and **M. Villata**

Active Galactic Nuclei - Unification Model



- **central Black Hole ($10^6 - 10^9 M_{\odot}$)**
- **accretion disc rotating around the SMBH**
- **clouds of gas gravitational attracted by the black hole and illuminated by the disk radiation**
- **optically thick torus of molecular gas and dust**
- **two collimated relativistic jets**

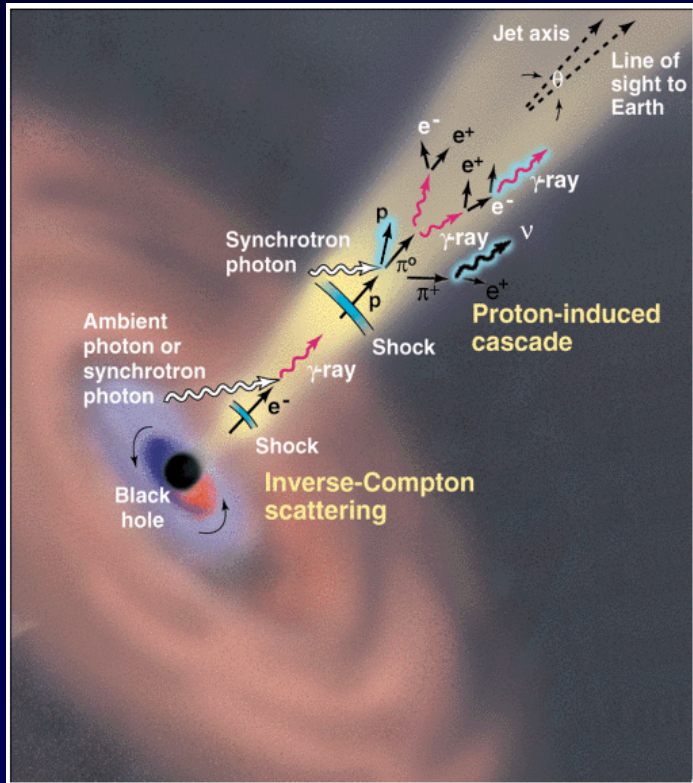
Urry and Padovani 1995



Almost all galaxies contains a massive black hole but 99% of them are silent and 1% is active (mostly radio-quiet AGNs) and only 0.1% is radio-loud AGNs

Blazar characteristics:

- compact radio core, flat or inverted spectrum
- apparent superluminal motion
- irregular, rapid and often very large variability at all frequencies
- high and variable polarization at optical and radio frequencies

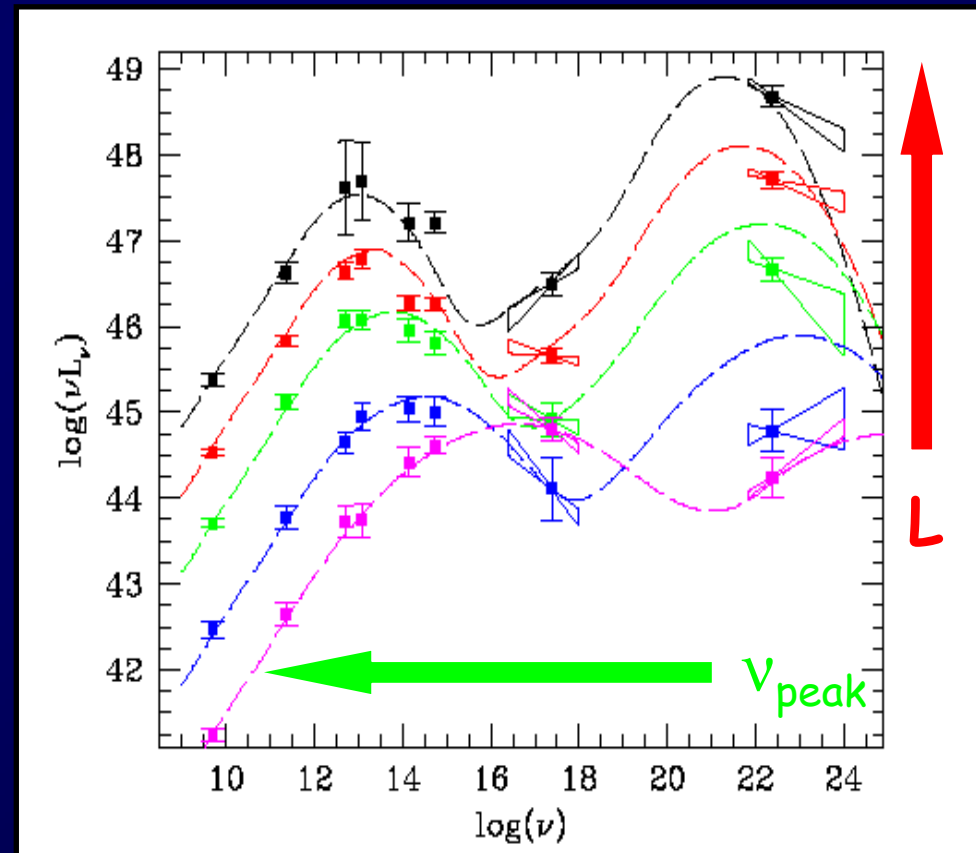


Leptonic processes:

- synchrotron emission
- inverse Compton where seed photons came from the internal synchrotron radiation
- inverse Compton where seed photons came from external radiation (accretion disc, BLR and/or torus)

**The blazar (spectral) sequence:
 E_{pk} of synchrotron and inverse Compton components inversely correlated with L**

Fossati et al. 1998
 Donato et al. 2001



PKS 1510-089: a rapid gamma-ray flare in March 2008

AGILE detection of a gamma-ray source coincident with Blazar PKS 1510-08

ATel #1436; [F. D'Ammando \(INAF/IASF Roma\)](#), [A. Bulgarelli \(INAF/IASF Bologna\)](#), [S. Vercellone](#), [A. Giuliani](#), [A. Chen](#), [S. Mereghetti](#), [A. Pellizzoni](#), [F. Perotti](#), [F. Fornari](#), [M. Fiorini](#), [P. Caraveo](#), [A. Zambra \(INAF/IASF Milano\)](#), [F. Gianotti](#), [M. Trifoglio](#), [G. Di Cocco](#), [C. Labanti](#), [F. Fuschino](#), [M. Marisaldi](#), [M. Galli \(INAF/IASF Bologna\)](#), [M. Tavani](#), [G. Pucella](#), [V. Vittorini](#), [E. Costa](#), [M. Feroci](#), [I. Donnarumma](#), [L. Pacciani](#), [E. Del Monte](#), [F. Lazzarotto](#), [P. Soffitta](#), [Y. Evangelista](#), [I. Lapshov](#), [M. Rapisarda](#), [A. Argan](#), [A. Trois](#), [G. De Paris \(INAF/IASF Roma\)](#), [G. Barbiellini](#), [F. Longo](#), [E. Vallazza \(INFN Trieste\)](#), [P. Picozza](#), [A. Morselli \(INFN Roma-2\)](#), [M. Prest \(Universita' dell'Insubria\)](#), [P. Lipari](#), [D. Zanello \(INFN Roma-1\)](#), [F. Mauri \(INFN Pavia\)](#) and [P. Giommi](#), [C. Pittori](#), [D. Gasparrini](#), [S. Cutini](#), [B. Preger](#), [P. Santolamazza](#), [F. Verrecchia \(ASDC\)](#) and [L. Salotti \(ASI\)](#)
on 20 Mar 2008; 15:08 UT
Password Certification: Stefano Vercellone
(stefano@iasf-milano.inaf.it)

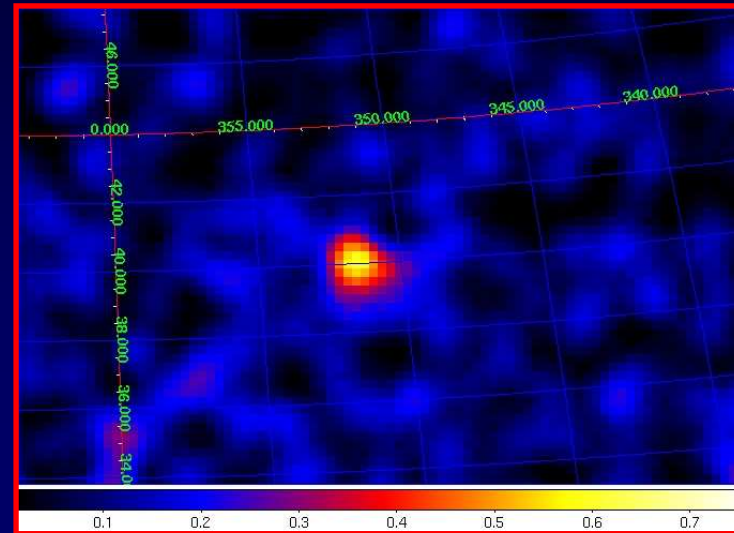
Subjects: Gamma Ray, AGN, Quasars

The AGILE satellite, currently in a Cycle-1 pointing centered on the Galactic Center region, during the observing period that started on 2008-03-16 12:00 UT, detected significant gamma-ray emission from a source at approximately 40 degrees off the AGILE pointing direction. The AGILE Quicklook Analysis provides the source positional error box that is centered at Galactic coordinates $l = 351.61$ deg, $b = 40.09$ deg, and has a radius of about 0.5 degrees.

We note that this position is consistent with the radio position of the blazar PKS 1510-08 that has been associated with the gamma-ray source 3EG J1512-0849. This source was already detected by the AGILE-GRID (Gamma-Ray Imaging Detector) between 2007-08-27 14:48 UT and 2007-08-30 10:50 UT (see ATEL #1199 and ATEL #1204).

A preliminary maximum likelihood analysis of the AGILE-GRID data obtained between 2008-03-18 03:00 UT and 2008-03-20 03:00 UT for photon energies above 100 MeV results in a detection significance of about 7 sigma. During the same period, the source was outside the Super-AGILE field of view.

We strongly encourage multi-frequency observations of PKS 1510-08 detected by AGILE in an active gamma-ray flaring state.



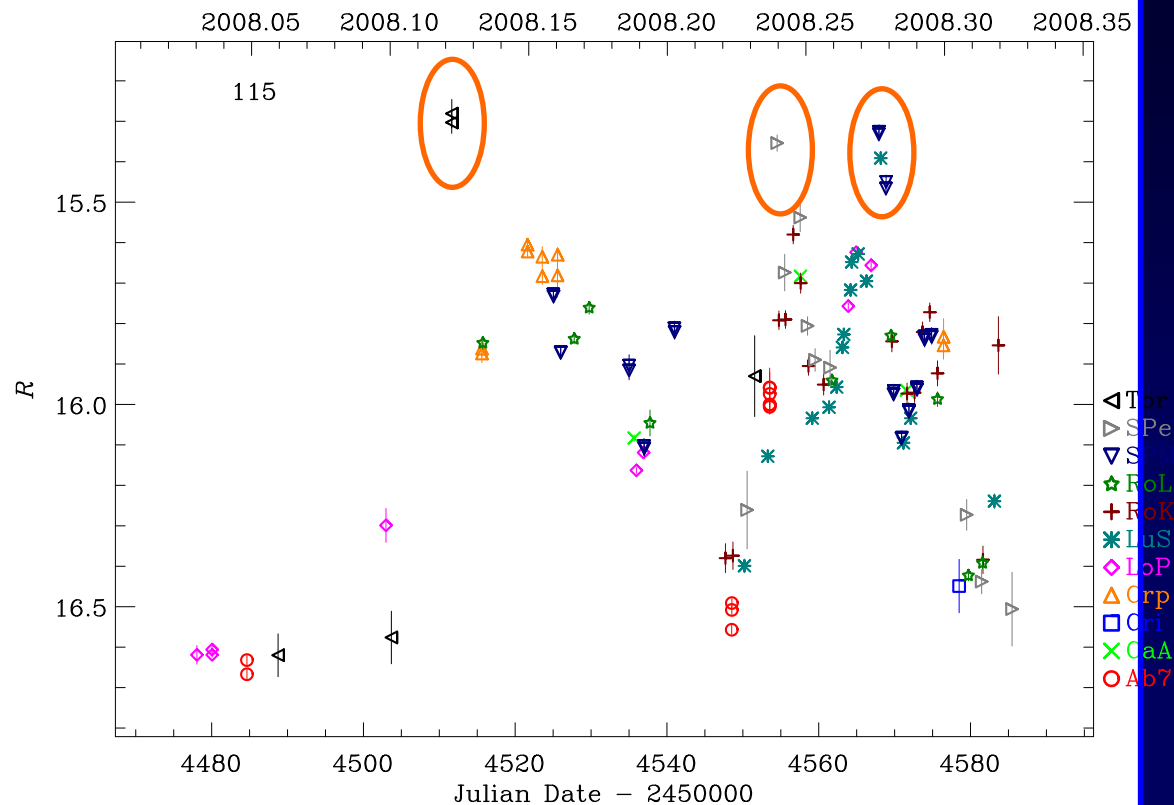
17 - 21 March 2008

**D'Ammando, Pucella, Raiteri et al.,
submitted to A&A**

**Serendipitous detection during an AGILE
pointing towards the Galactic Center**

**3 ToO by Swift/XRT: the spectrum becomes
harder when the source is brighter**

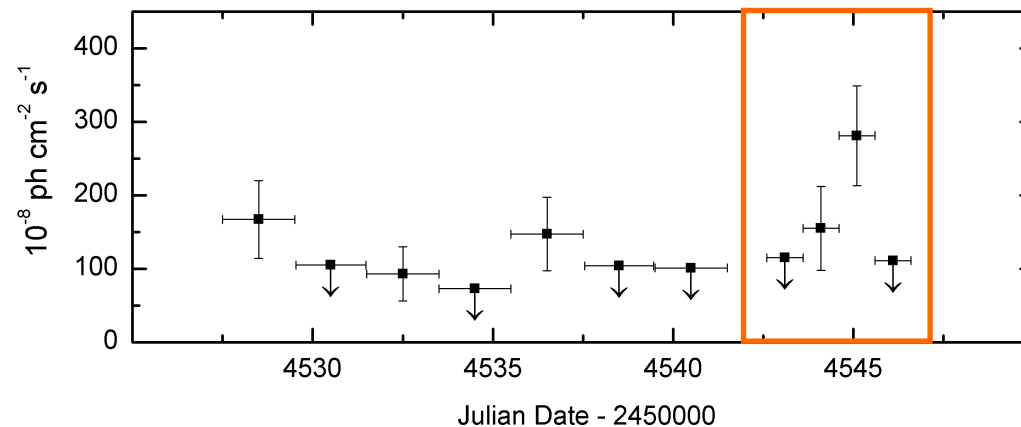
**GASP-WEBT observed intense optical activity
between January and April 2008**



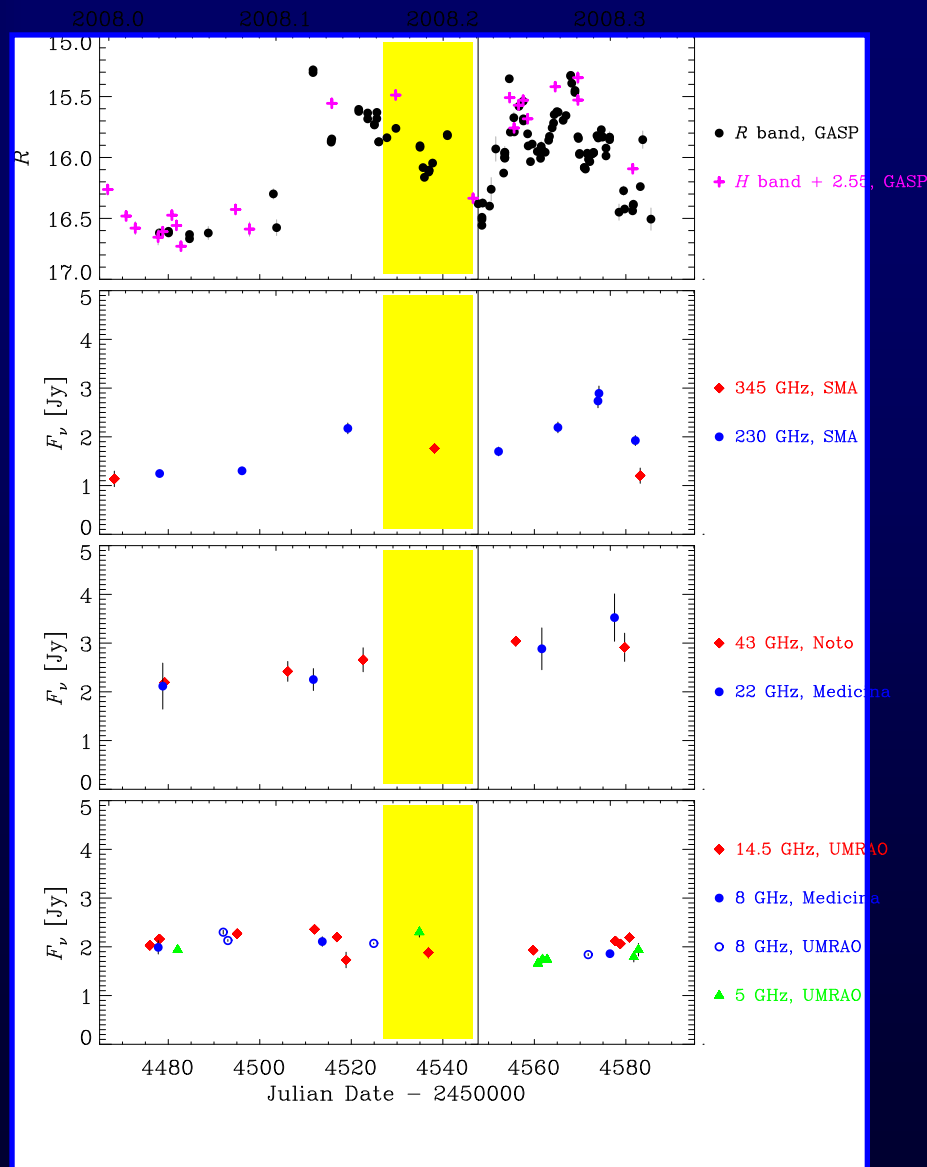
PKS 1510-089 showed intense optical activity during January - April 2008, with several episodes of fast variability detected by GASP -WEBT

Optical peaks was detected on February 15, March 29 and April 11

After two episodes of medium intensity the source was not detected for some days in gamma-ray band and suddenly a rapid flare was observed by AGILE on 18-19 March 2008



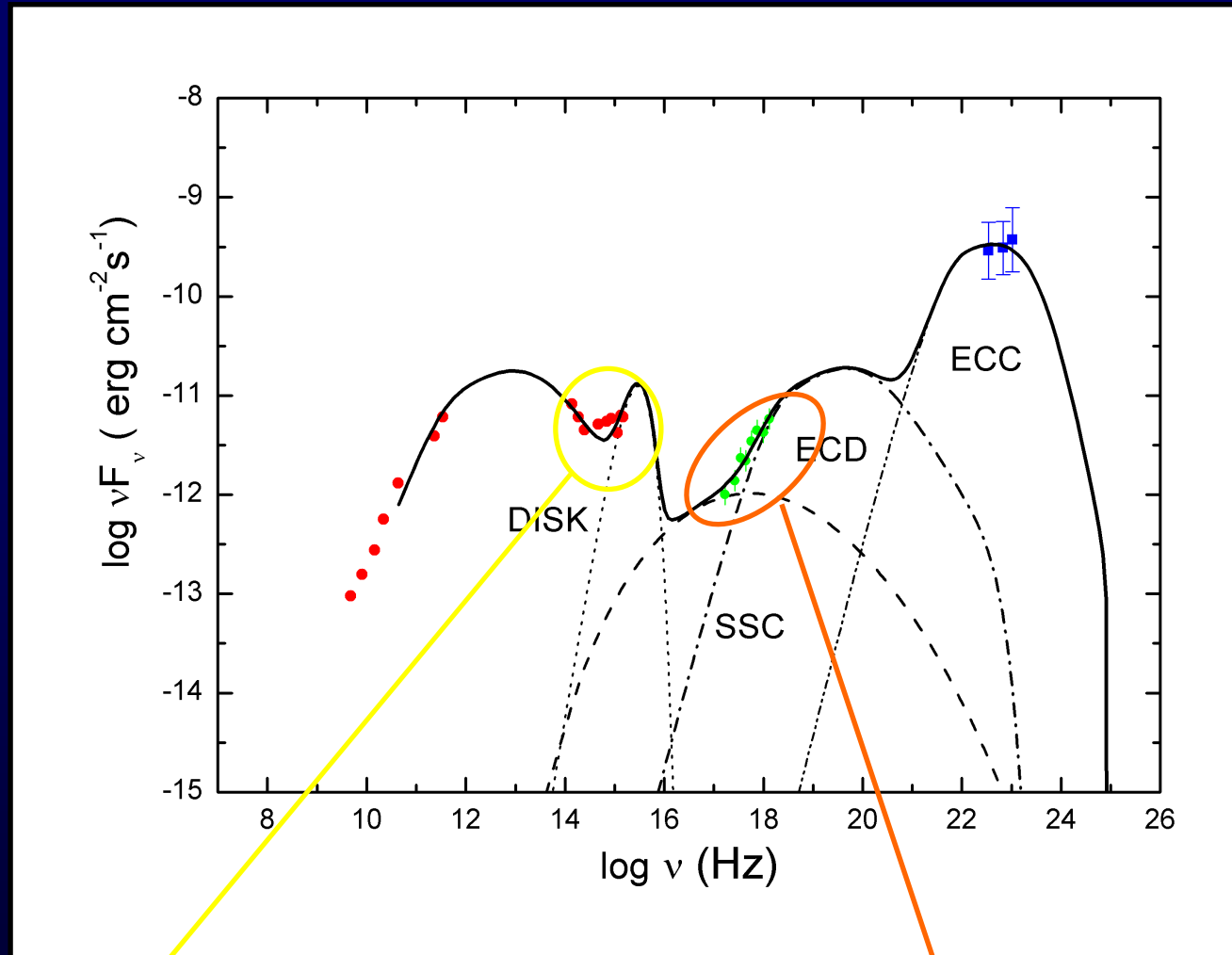
Radio-to-optical behaviour



The light curve at 230-345 GHz suggest that the mechanism producing the flaring event observed in optical in the second half of February and in late March-April 2008 also interested the millimetric emitting region, with some delay

At 22-43 GHz a hint of flux increase is visible in the second part of the light curve, while the radio flux at 5-15 GHz shows no trend

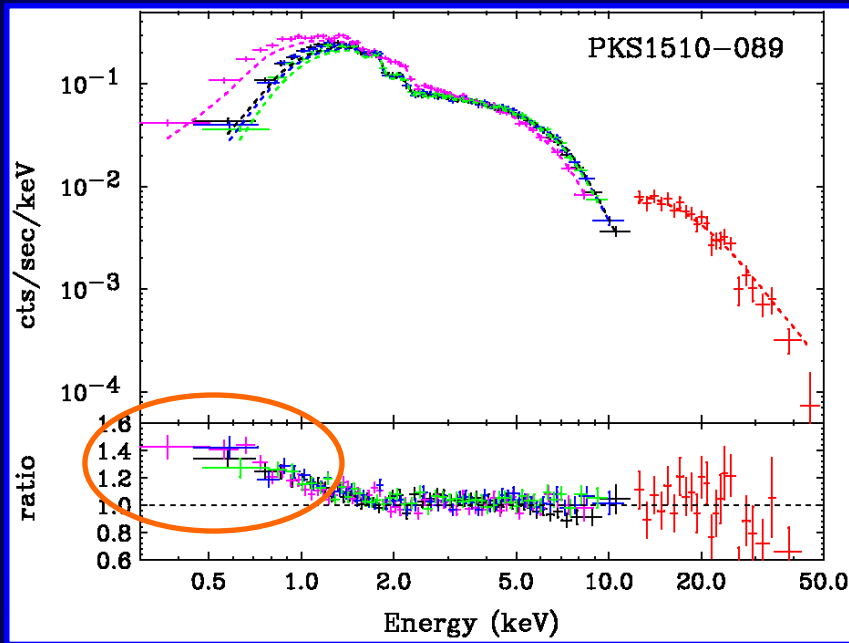
Spectral Energy Distribution



Likely signatures of the little and big blue bumps

Possible presence of the soft X-ray excess

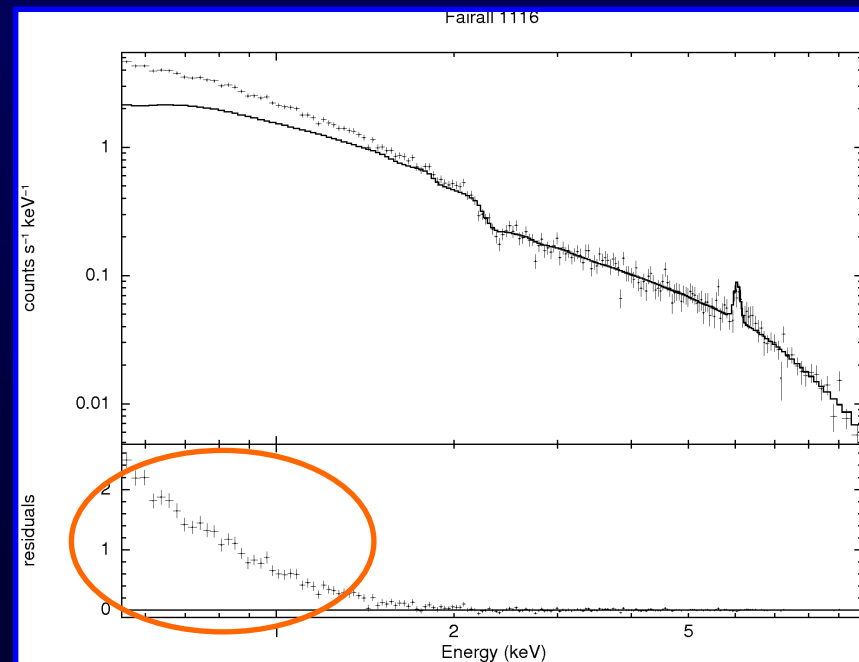
Soft X-ray excess



Kataoka et al. 2008

However, the nature and origin of the soft X-ray excess in radio quiet AGN is still an open issue and the interpretation in terms of thermal disc has been emission has been challenged by the discovery of the constancy of the effective temperature despite the wide range of BH masses

The soft X-ray excess observed in PKS 1510-089 could be a bulk Comptonization feature, the thermal emission of the accretion disc, the high energy tail of the synchrotron component or can be identified with the feature observed also in non-blazar AGNs



D'Ammando et al. 2008

Conclusions

- PKS 1510-089 showed strong activity between January and April 2008, with episodes of rapid variability from radio to gamma-rays and in particular a rapid gamma-ray flare detected by AGILE
- SED is modelled with a SSC + EC from both the accretion disc and the broad line region
- Some features in the optical-UV spectrum seems to indicate the presence of Seyfert-like components such as little blue bump and big blue bump
- X-ray observations seems to indicate an harder-when-brighter behaviour of the source spectrum, with a hard X-ray photon index observed on March 2008 ($\Gamma \sim 1.2$)
- This photon index could be due to the contamination of the soft X-ray excess or to the combination of SSC and EC emission and therefore to the mismatch of the spectral slopes of these two components

References

- D'Ammando F., Pucella G. , Raiteri C. M., et al. submitted to A&A (2009)
- D'Ammando F., Bulgarelli A., Vercellone S., et al., ATel #1436 (2008)
- D'Ammando F., Bianchi S., Jimenez-Bailon E., Matt G., A&A, 482, 499 (2008)
- Urry C. M., and Padovani P., PASP, 107, 803 (1995)
- Fossati G., Maraschi L., Celotti A., et al., MNRAS, 299, 433 (1998)
- Donato D., Ghisellini G., Tagliaferri G., et al., A&A, 375, 739 (2001)
- Kataoka J., Madjeski G., Sikora M., et al., ApJ, 672, 787 (2008)

Thanks to the LOC for financial support!!!

and

Thank you for your attention!!!