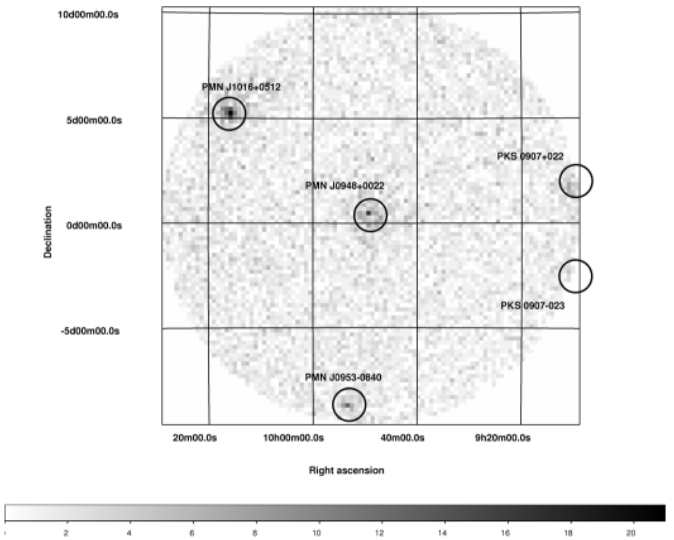
Study of NLSy1 galaxies as new class of gamma-ray emitting AGN

Lars Fuhrmann &
F-GAMMA program & team
Fermi-LAT collaboration
many multi-wavelength collaborators & programs!
L. Foschini (INAF) et al.

PMN J0948+0022 & Narrow-line Seyfert 1 galaxies

Fermi/LAT discovery of gamma-ray emission from a relativistic jet in the Narrow-Line Quasar PMN J0948+0022
Abdo et al. 2009, ApJ, 699, 976



- before *Fermi*/LAT: γ-ray emitting AGN are blazars and radio galaxies
- *Fermi*/LAT: LBAS/1LAC confirmed extragalactic γ-ray sky dominated by those!

BUT:

first *Fermi*/LAT detection of a γ-ray emitting Narrow-line Seyfert 1 (NLS1) in 2008: PMN J0948+0022 (contact author: L. Foschini)

- NLS1:
  - Seyfert-like AGN, usually spiral host galaxies
  - e.g. permitted optical lines from BLR much narrower than in Seyfert 1 or blazars (FWHM(Hβ) < 2000 km s^{-1}); no intrinsic obscuring matter
  - large fraction radio-quiet (only ~ 7% radio-loud, Komossa et al. 2006)
  - radio jets in NLS1 ?

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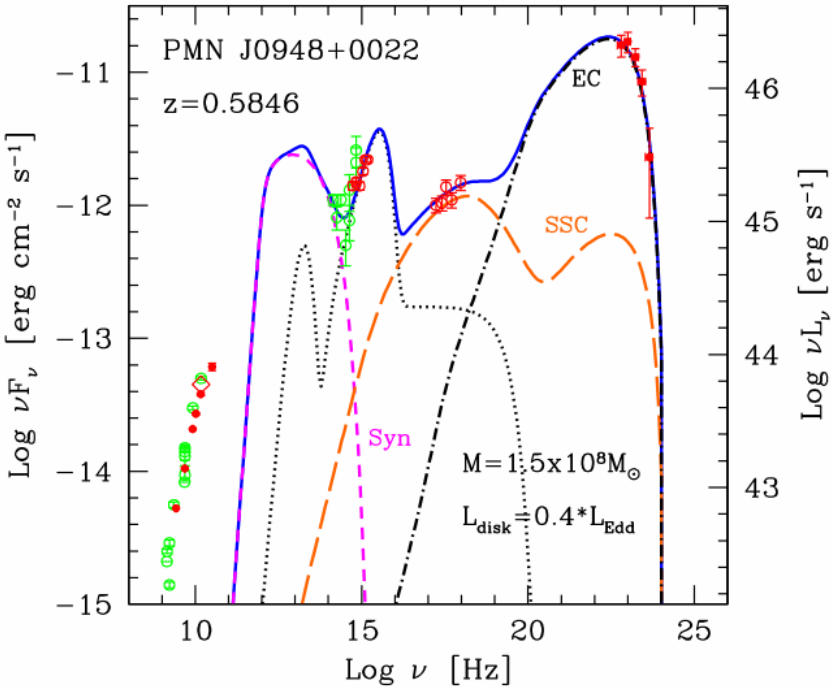
- answer promptly:
  early MW follow-up and a triggered MW campaign (Abdo et al. 2009a, 2009b, Foschini et al. 2009)
- many MW facilities involved
- first averaged SED similar to ordinary blazars

Domain	Energy band/Filter /Frequency	Facility
Gamma-rays	0.1-10 GeV	Fermi/LAT
Hard X-rays	20-100 keV	Swift/BAT
X-rays	0.2-10 keV	Swift/XRT
Optical/UV	V,B,U,UVW1,UVM2,UVW2	Swift/UVOT
Optical	B, R	ATOM
Optical/NIR	B, R, J	SMARTS/Yale
NIR	J, H, Ks	INAOEP
NIR	J, K	WIRO
Radio	15 GHz	OVRO
Radio	cm/mm, Polarization	Effelsberg
Radio	1-22 GHz	RATAN-600
Radio	15 GHz, Polarization	MOJAVE
Radio	1.66, 22.2 GHz	e-VLBI
Radio	37 GHz	Metsahovi



- double-humped SED with disk component in UV band
- m_{BH} upper limit: 1.5 x 10^8 $M_\odot$

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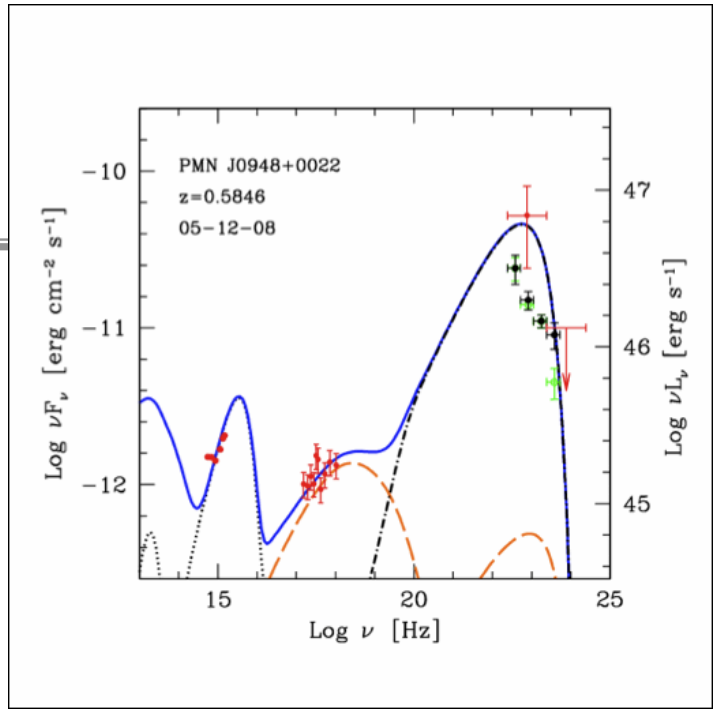
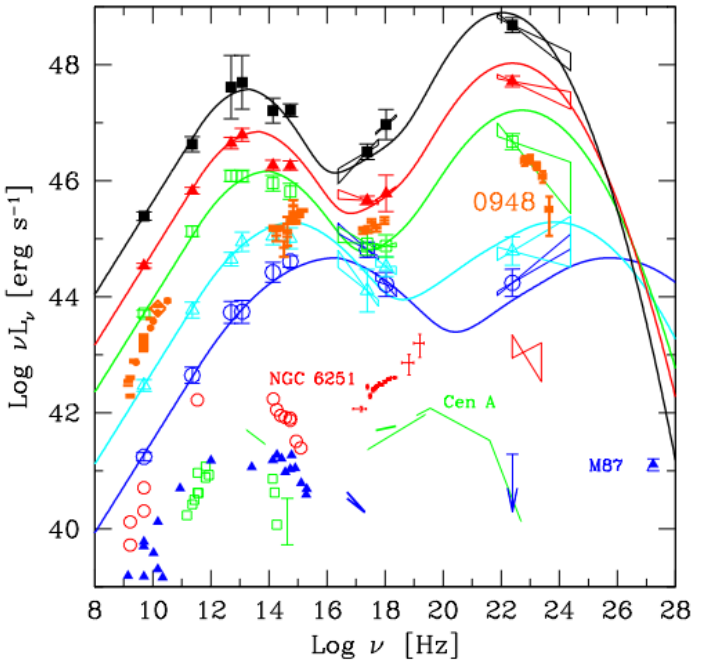
- variability & SED modeling (averaged plus time-resolved) using Ghisellini & Tavecchio (2009)
- Synchro/SSC component plus EC component
- physical parameters: typically blazar-like
- jet power similar to those of blazars (intermediate between FSRQs and BL Lacs)





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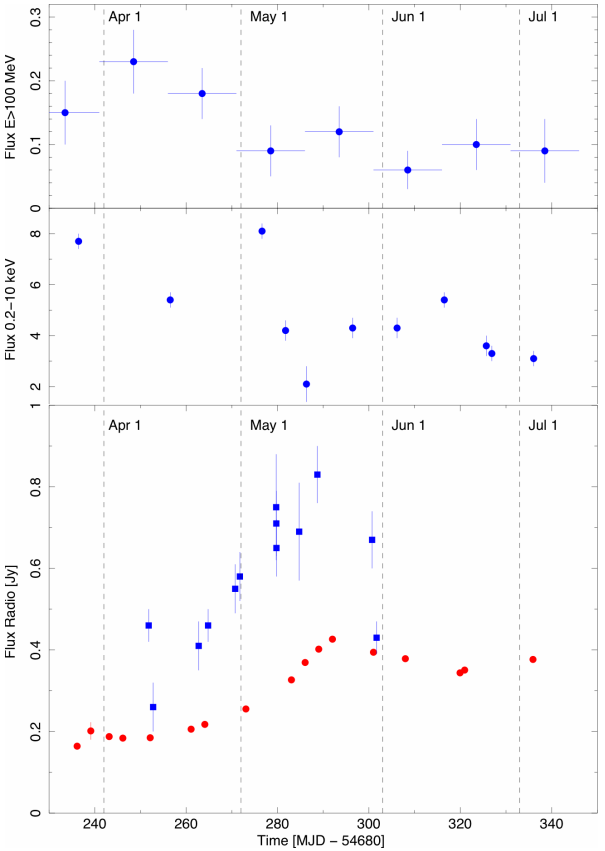
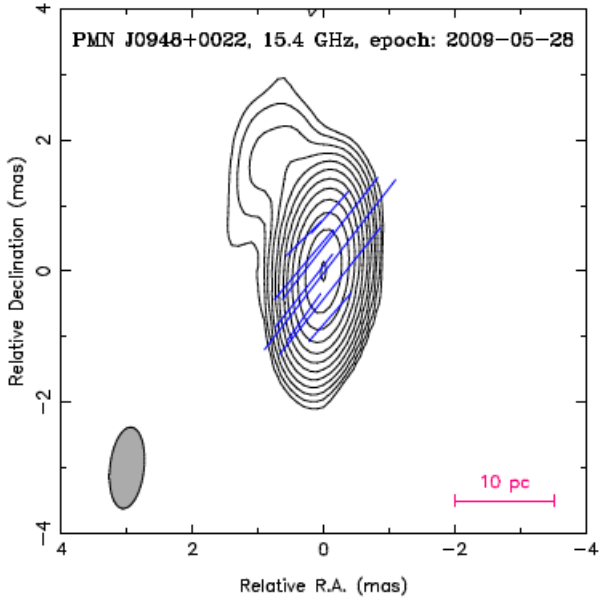
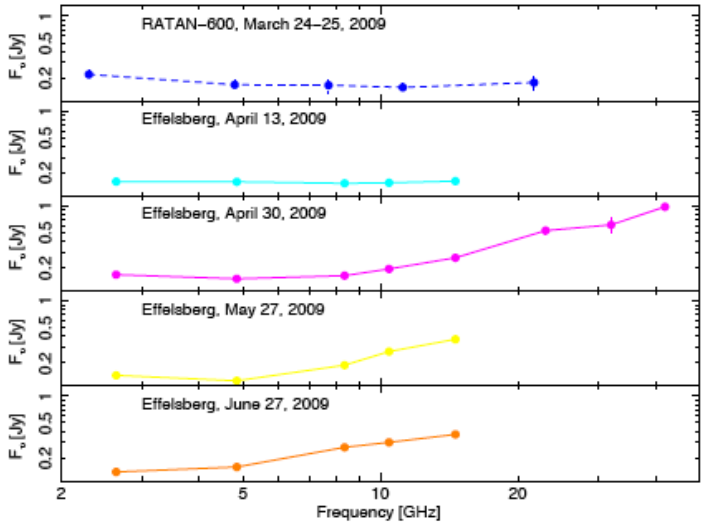
- presence of a relativistic jet from radio bands:
  - flux density & spectral variability/flare
  - equipartition Doppler factors of ~7
  - highly compact, unresolved 15 GHz core on pc-scales with size < 60 μas, $T_b = 1.0 \times 10^{12}$ K
  - VLBI core fractional linear polarization of 0.7%



→ Typical signature of a relativistic jet





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- In summary:
  - Fermi/LAT + MW observations: NLS1 new class of γ-ray AGN hosting a relativistic jet
  - four further detections : emerging population of RL-NLS1 (Abdo et al. 2009)

Highly interesting new class of SMBH objects:

  - SEDs similar to blazars/radio galaxies plus radio characteristics plus MW variability: NLSy1s host relativistic jets similar to blazars
  - But differences in
    radio morphology
    optical spectrum

  - optical: general different physical conditions

PMN J0948+0022 & Narrow-line Seyfert 1 galaxies

NLS1	blazars
High accretion (up to 90%)	Low accretion (~ 50%)
Small BH masses < 10^8 $M_\odot$	Large BH masses > 10^8 $M_\odot$
typically Spiral hosts	Elliptical hosts
Parent population: NLS1 + ?	Parent population: blazars & radio galaxies

Challenges:

- relativistic jets: typically hosted in elliptical galaxies - fully developed jets in Spirals with different environment!?!
- location of gamma-rays ? NLSy1: high accretion ➔ high radiation density! ➔ pair-production opacity high!
- parent population? NLS1s low mass set of systems “parallel“ to blazars & radio galaxies ?

- additional programs/proposals (e.g. Effelsberg, XMM) and MW campaigns (e.g. Foschini et al. submitted) for future detailed studies