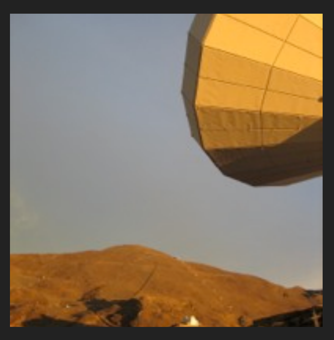
100-m Effelsberg
Located in Effelsberg it covers the band 2.64 - 43 GHz with a precision of a few percent for monthly sampling of 60 sources



30-m IRAM
Located in Granada, Spain it covers the band 86 - 250 GHz monthly also for roughly 60 sources

12-m APEX
It covers the 345 GHz band and it is located in Atacama desert in Chile at an altitude of 5100 m

Radio variability of Fermi gamma-ray loud AGNs and S_γ - S_{radio} correlations

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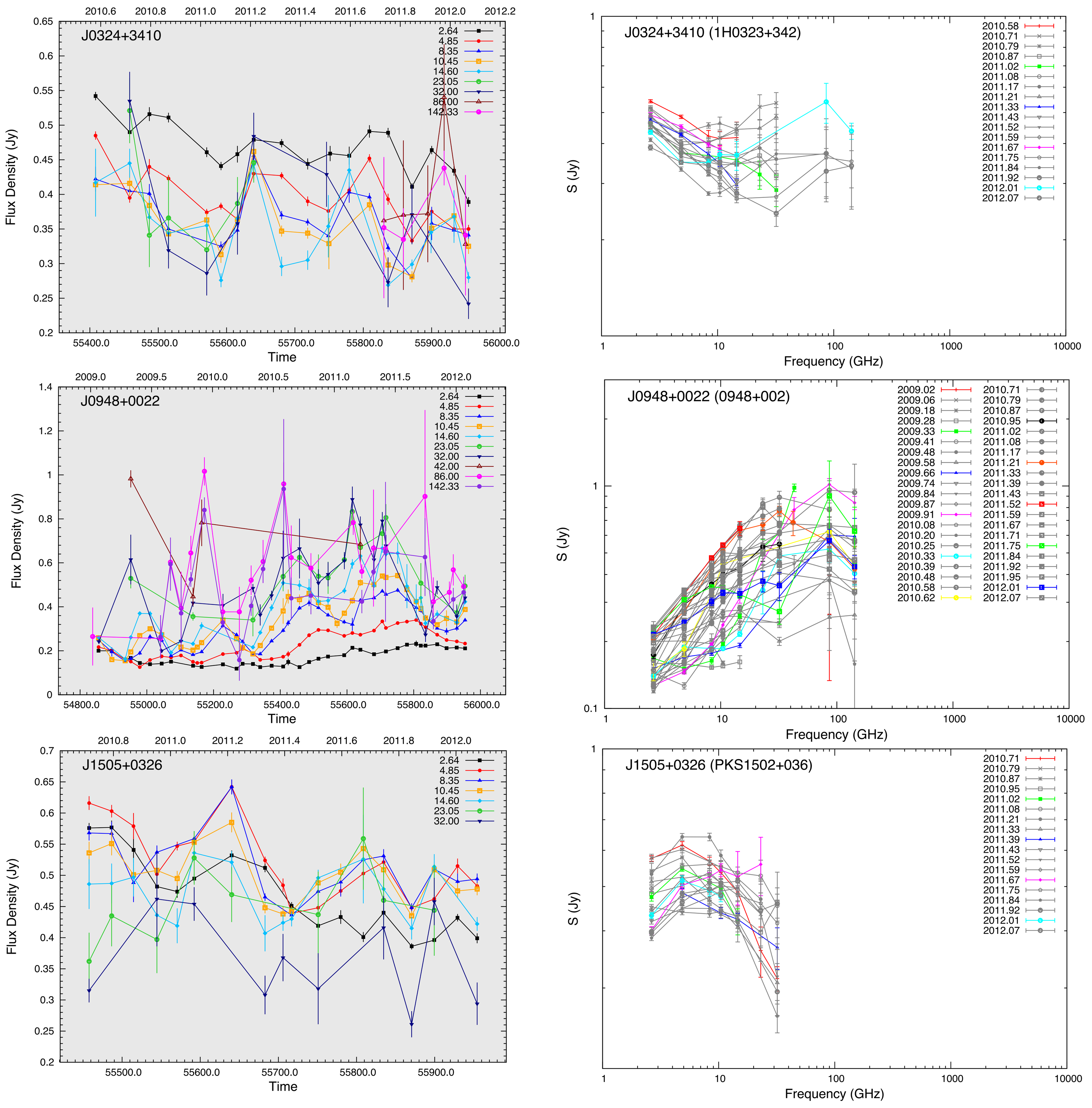
The *F-GAMMA* program

The F-GAMMA program aims at probing the AGN physics via multi-frequency monitoring. Roughly **65 *Fermi*-GST detectable blazars** are being **monitored monthly** since **January 2007** at cm to sub-mm bands. The core program includes the **100-m Effelsberg** telescope operating at 8 frequencies between 2.6 and 43 GHz, the **30-m IRAM** telescope observing at 86, 145 and 240 GHz and the **APEX 12-m** telescope at 345 GHz. Optical data are provided by the Abastomani 70-cm and 1.25-m telescopes.

Here we summarize the first results from the monitoring of three gamma-loud Narrow Line Seyfert 1 galaxies (NLSy1s) and a bias-free S_γ - S_{radio} correlation study between gamma and radio flux densities.

Jet emission from 3 gamma-ray loud Narrow Line Seyfert 1 galaxies

NLSy1s are AGNs that show low black hole masses and high accretion rates [e.g. 1-4]. Only some 7 % of them appears to be radio loud [5]. The *Fermi* discovery of γ-ray emission from a small number of NLSy1s [6,7]) came as surprise; until then the only γ-ray bright classes were thought to be blazars (i.e. FSRQs and BL Lac objects) and radio galaxies (for a review, see [8]). This discovery not only introduced a new class of γ ray emitting AGNs but also challenges the well spread belief that jets are associated with large ellipticals. The multi-wavelength campaign between March and July 2009 following the discovery of γ-ray emission from PMN 0948 + 0022 showed that the source was exhibiting a spectral behavior typical of a relativistic jet [9, 10]. Responding to the *Fermi* detection the *F-GAMMA* team initiated a dedicated program, to understand their cm to mm behavior [11]. The light curves and the dynamical spectra of the three sources that are monitored are shown below.



Radio Variability

1H0323+342: its radio spectrum displays a quiescent part reaching up to roughly 10 GHz beyond which a high frequency component (hereafter HFC) appears. Its mean spectral index is of the order of −0.23, not very different from a typical value of −0.5 ($S \propto \nu^\alpha$). The HFC shows intense spectral evolution which gradually shifts its peak towards the steep spectrum component. The pace of the evolution is remarkably fast. Its light curve, shows a collection of events more prominent at higher frequencies and with cross-band lags indicative of the spectral evolution superimposed on a long term decreasing trend. The *Structure Function* analysis revealed times scales of the order of 60 days which implies a variability brightness temperature of 10^{12} K at 4.85 GHz and 2×10^{11} K at 14.6 GHz. The corresponding equipartition Doppler factors are 2.4 and 1.5 respectively, placing the source in the lower part of the Doppler factor distribution of typical blazars. The Doppler factor calculated from fitting the Spectral Energy Distribution (SED) [9] is around 17.

PMNJ0948+0022: For PMNJ0948+0022 the spectral index below 10GHz ranges between marginally steep or flat (≈ −0.1) to highly inverted reaching values of +1.0. Its evolution is exceptionally dynamic. Its light curve shows at least 4 prominent events which emerge with time lags at different bands. At the lowest frequencies the events are barely seen. Yet, the modulation index shows a monotonic increase with frequency. The standard variability analysis reveals brightness temperatures of 8×10^{12} K at 4.85 GHz, 2×10^{12} K at 14.6 GHz and 1.5×10^{11} K at 32 GHz which would require Doppler factors of 6, 4 and 2 respectively corresponding to the rather higher part of the Doppler factor distribution. The SED modeling gives Doppler factors that vary between 10 and 20 with the latter being observed during the outburst of July 2010 [12].

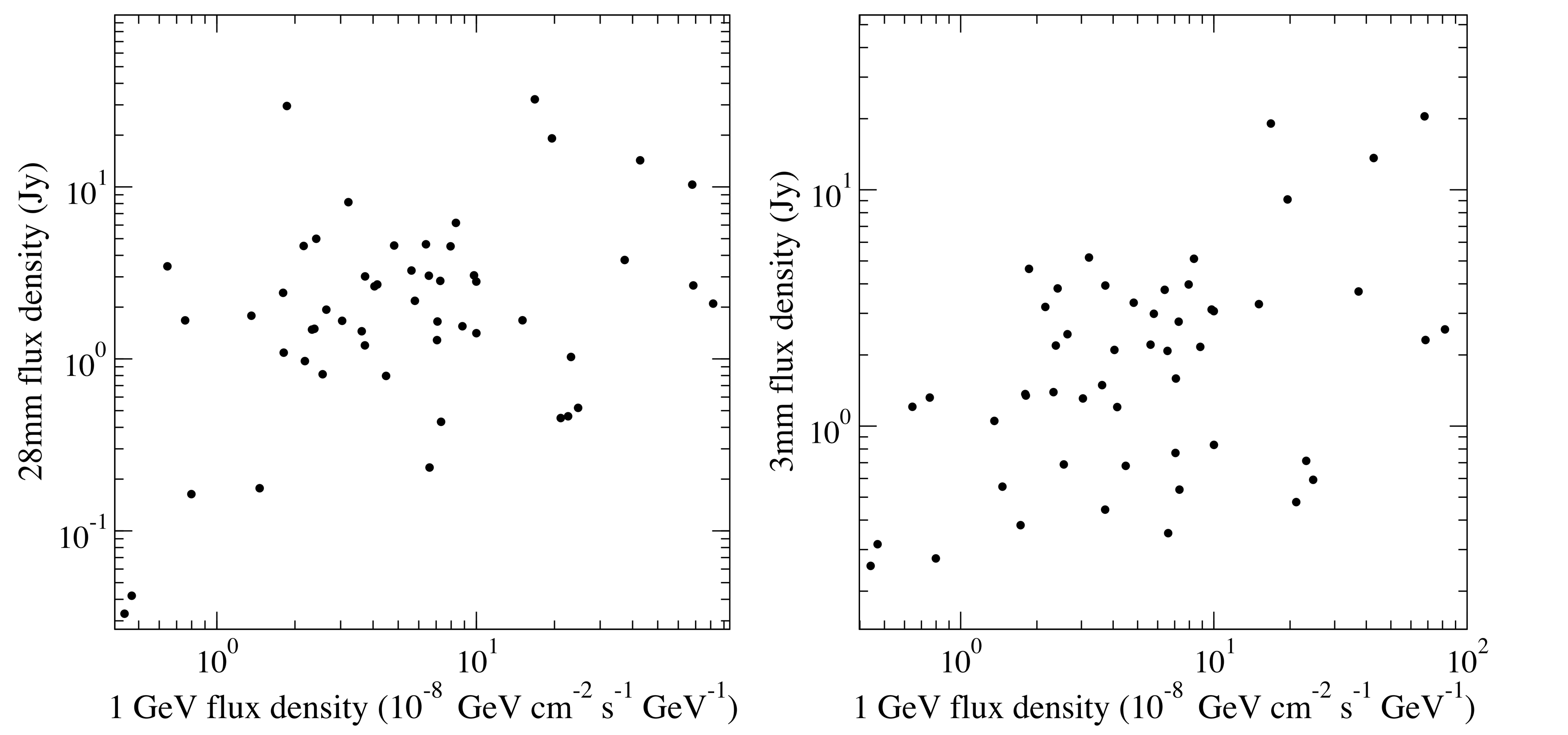
PKS 1502+036: The light curve shows at least 2 events better seen at higher frequencies. The high frequency cut-off of the spectrum prohibits IRAM monitoring. The typical time scales identified here are of the order of 60 - 80 days. At 4.85GHz the brightness temperature is 2×10^{13} K and at 14.6 GHz it is 3×10^{12} K implying Doppler factors of 7 and 4, respectively while the SED fitting gives a value of 18.

Conclusions

- The three monitored NLSy1s show a very typical blazar-like behavior: highly variable spectra caused by the presence of evolving high frequency spectral components.
- The variability happens fast with the mean number of events per unit time being clearly larger than that of the rest of the *F-GAMMA* targets.
- The variability brightness temperature is relatively high with respect to the distribution of the whole sample in the cases of PMNJ0948+0022 and PKS1502+036. The opposite is the case for 1H 0323+342. The derived Doppler factors are lower limits and are systematically lower than the values obtained from the SED modeling.

S_γ - S_{radio} correlations

The investigation of an intrinsic correlation between radio and the γ-ray luminosity of blazars is a long-standing problem. Such correlations however are subject to biases, like: (a) in small samples of limited luminosity dynamic range, artificial flux-flux correlations can be induced due to the effect of distance, (ii) in flux-limited samples artificial luminosity-luminosity correlations can arise: most objects are close to the survey sensitivity in each wavelength. Applying a common redshift to return to luminosity space, artificial correlations arise, (iii) not synchronous datasets. *F-GAMMA* and *Fermi* provide a unique opportunity for such studies. Here, we make use of the simultaneous cm- to short-mm wavelengths data obtained for the 29 Fermi-detected LBAS sources of the *F-GAMMA* sample. In the next we show the flux densities at 10.45 and 86 GHz plotted against *Fermi* γ-ray fluxes. A completely new method introduced and described by [13] and [14] has been developed to quantify the significance of such possible correlations.



Conclusions

- Correlations between *F-GAMMA* and *Fermi* 1 GeV flux densities at concurrent time intervals and for a large radio frequency range, have been investigated.
- Flux densities at wavelengths ≤ 7 mm correlate with 1 GeV fluxes at a significance always better than 2 sigma, while longer wavelengths do not show significant correlations.
- Hence γ-ray emission is probably happening close to the mm-band emission region.
- A physical connection between the radio and high-energy emission may be present.

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