

A systematic study searching for the shortest time scales at gamma rays in FSRQ



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We performed a systematic search for shortest variability in the high-energy gamma-ray energy band (0.1-100 GeV) of the three flat-spectrum radio quasars (3C 454.3, 3C 273, PKS B1222+216), with the greatest flux in the MeV-GeV band ($>10^{-5}$ ph/cm²/s on daily basis). We set tight upper limits on the observed doubling time scale ($< 2-3$ hours), the smallest measured to date at MeV energies, which can constrain the size of the gamma-ray emitting region. The results obtained in the present work favor the hypothesis that gamma rays are generated inside the broad-line region.

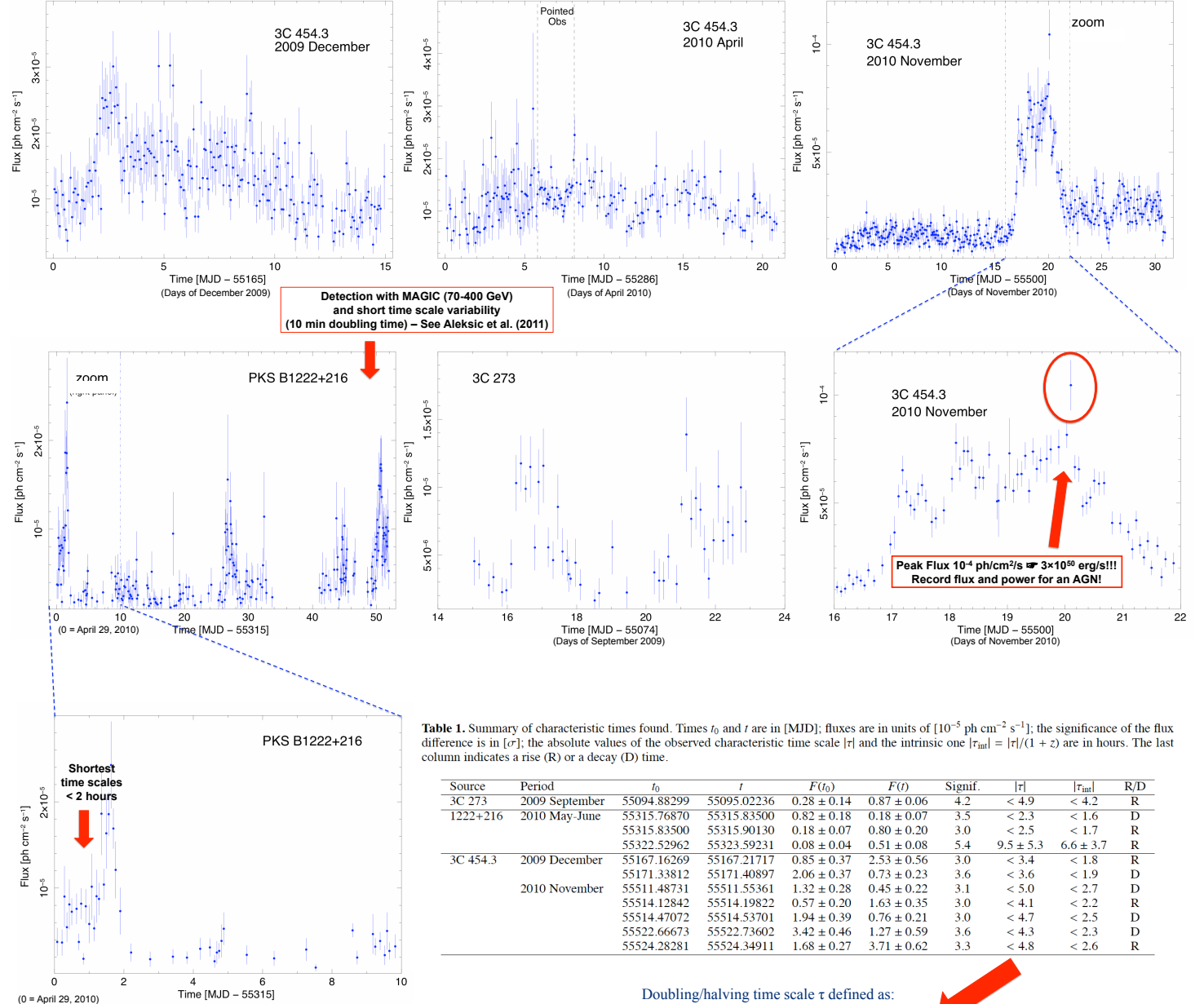


Table 1. Summary of characteristic times found. Times t_0 and t are in [MJD]; fluxes are in units of $[10^{-5} \text{ ph cm}^{-2} \text{ s}^{-1}]$; the significance of the flux difference is in $[\sigma]$; the absolute values of the observed characteristic time scale $|\tau|$ and the intrinsic one $|\tau_{\text{int}}| = |\tau|/(1+z)$ are in hours. The last column indicates a rise (R) or a decay (D) time.

Source	Period	t_0	t	$F(t_0)$	$F(t)$	Signif.	$ \tau $	$ \tau_{\text{int}} $	R/D
3C 273	2009 September	55094.88299	55095.02236	0.28 ± 0.14	0.87 ± 0.06	4.2	< 4.9	< 4.2	R
1222+216	2010 May-June	55315.76870	55315.83500	0.82 ± 0.18	0.18 ± 0.07	3.5	< 2.3	< 1.6	D
		55315.83500	55315.90130	0.18 ± 0.07	0.80 ± 0.20	3.0	< 2.5	< 1.7	R
		55322.52962	55323.59231	0.08 ± 0.04	0.51 ± 0.08	5.4	9.5 ± 5.3	6.6 ± 3.7	R
		55322.52962	55323.59231	0.08 ± 0.04	0.51 ± 0.08	5.4	9.5 ± 5.3	6.6 ± 3.7	R
3C 454.3	2009 December	55167.16269	55167.21717	0.85 ± 0.37	2.53 ± 0.56	3.0	< 3.4	< 1.8	R
		55171.33812	55171.40897	2.06 ± 0.37	0.73 ± 0.23	3.6	< 3.6	< 1.9	D
		55511.48731	55511.55361	1.32 ± 0.28	0.45 ± 0.22	3.1	< 5.0	< 2.7	D
		55514.12842	55514.19822	0.57 ± 0.20	1.63 ± 0.35	3.0	< 4.1	< 2.2	R
	2010 November	55514.47072	55514.53701	1.94 ± 0.39	0.76 ± 0.21	3.0	< 4.7	< 2.5	D
		55522.66673	55522.73602	3.42 ± 0.46	1.27 ± 0.59	3.6	< 4.3	< 2.3	D
		55524.28281	55524.34911	1.68 ± 0.27	3.71 ± 0.62	3.3	< 4.8	< 2.6	R
		55524.28281	55524.34911	1.68 ± 0.27	3.71 ± 0.62	3.3	< 4.8	< 2.6	D

Doubling/halving time scale τ defined as:

$$\frac{F(t)}{F(t_0)} = 2^{\frac{(t-t_0)}{\tau}}$$

Analysis of *Fermi*/LAT data in the 0.1-100 GeV energy band
LAT Science Tools 9.18.6 and IRF_P6_V3_DIFFUSE
Orbital time bins (a few thousands of seconds each)

More details in:
Foschini, Ghisellini, Tavecchio, Bonnoli, Stamerra:
2011, *A&A*, accepted for publication
[arXiv:1101.1085]