Modeling the flaring activity of the high z, hard X-ray selected blazar IGR J22517+2217

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Abstract

We investigated the physical properties of one of the most luminous, high-redshift, hard-X-ray selected blazar IGR J22517+2217, through the modeling of its broad band spectral energy distribution (SED) in different activity states. Using new Suzaku and archival data we build two different SEDs, one for the flare occurred in 2005 and one for the following quiescent period. Both SEDs are strongly dominated by the high energy hump peaked at 10^{20} -10^{22} Hz, that is at least two orders of magnitude higher than the low energy (synchrotron) one at 10^{11} -10^{14} Hz, and varies by a factor of 10 between the two states. In both states the high energy hump is modeled as inverse Compton emission between relativistic electrons and seed photons produced externally to the jet, while the synchrotron self-Compton component is found to be negligible. The observed variability can be accounted for by a variation of the total number of emitting electrons, and by a dissipation region radius changing from within to outside the broad line region as the luminosity increases. In its flaring activity, IGR J22517+2217 shows one of the most powerful jet among the population of extreme, hard X-ray selected, high redshift blazar observed so far.

THE SOURCE

- IGR J22517+2217 unidentified object detected by *Integral*-IBIS [1]
- *Swift* follow-up observations were used to associate the source with MG3 J225155+2217 [2]
- The **highest redshift** (z = 3.668) blazar detected in the fourth *Integral*-IBIS hard X-rays catalog [3]
- Non simultaneous SED of the source, shows an extremely bright X-ray emission with respect to optical (**α_{ox} < 0.75**)

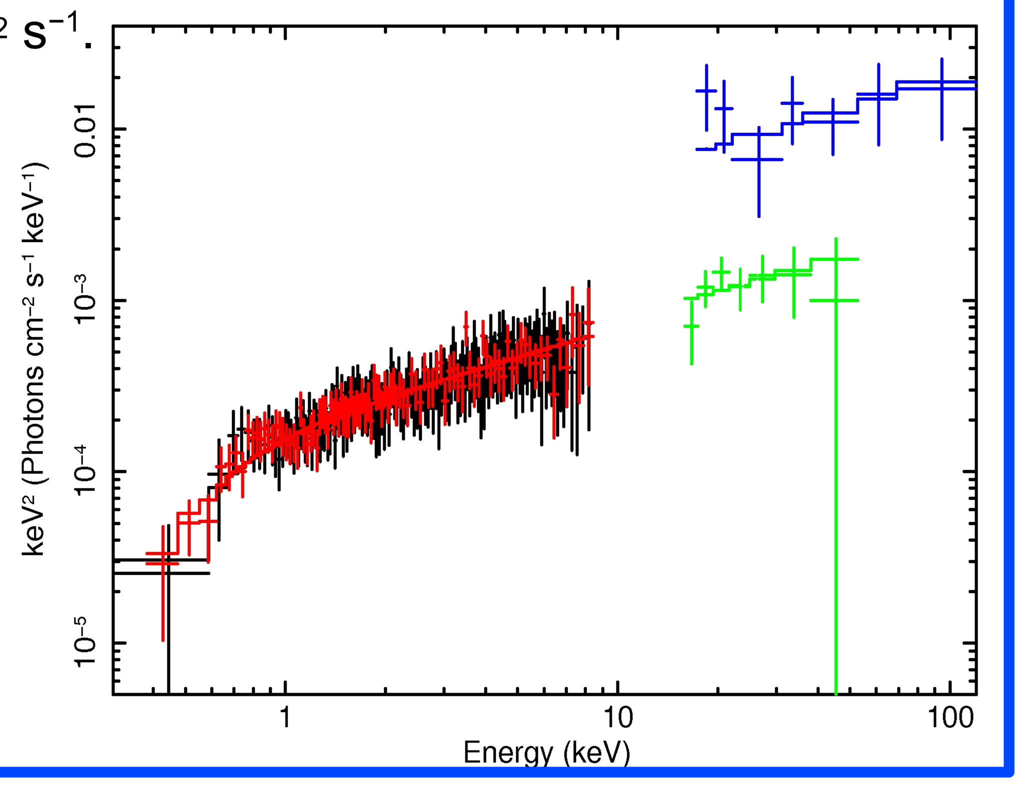
→ rare FSRQ with synchrotron peak at X-ray frequencies, OR

→ a "canonical" FSRQ with synchrotron peak at radio-mm frequencies but with an exceptionally strong **Compton dominance** [4].

Suzaku DATA

Suzaku observed the source in 2009-11-26 (PI: A. De Rosa) with a net exposure of ~40 ks. Both XIS and PIN data were fitted with an absorbed power-law. The XIS and PIN data show a flat spectrum, with Γ = 1.5 ± 0.1 and Γ = 1.5 ± 0.8 respectively. The XIS observed 2-10 keV flux is $F_{2\text{-}10\,keV}$=(1.2 ± 0.1)×10^{-12} erg cm^{-2} s^{-1}.

The XIS data show some curvature below 1 keV, that can be reproduced either by an intrinsic column density of N_H = (1.5 ± 1.1) × 10^{22} cm^{-2}, or with a broken power-law with break energy of 0.8±0.1 keV and ΔΓ = 0.8. Suzaku XIS (red, black), PIN (green) IBIS (blue) unfolded spectra and model are shown.

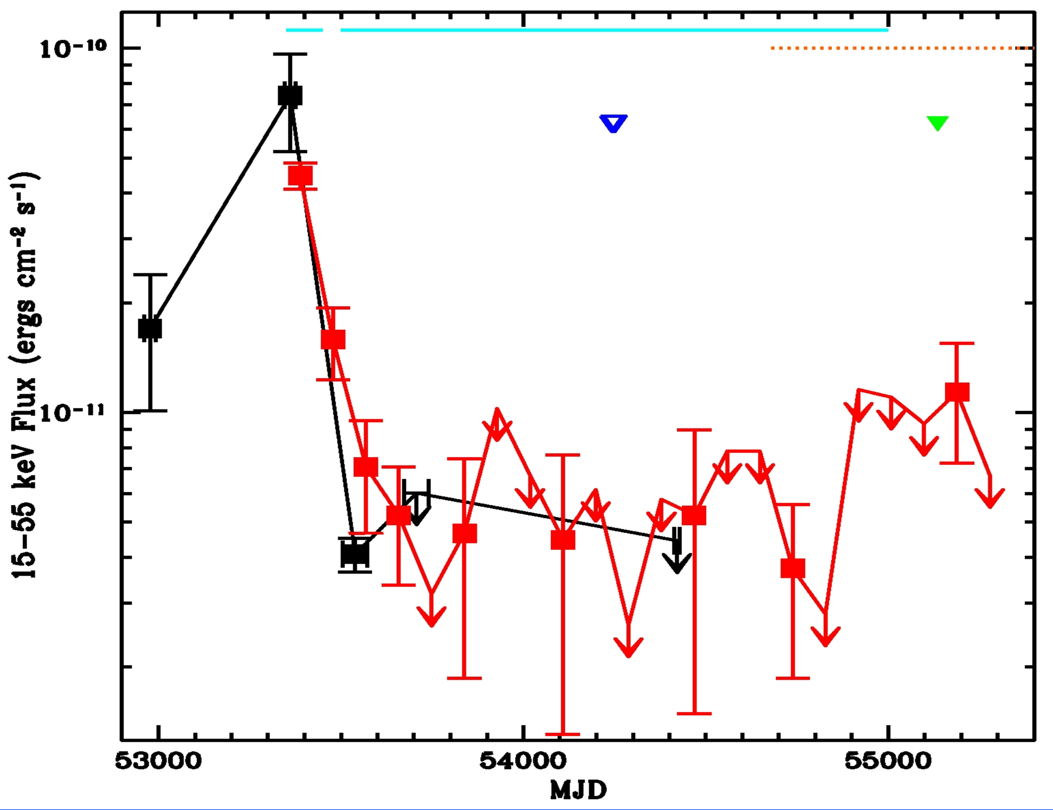


HARD X-RAY LIGHTCURVE

Both the *Integral*-IBIS and *Swift*-BAT spectra can be reproduced with a simple power law with Γ = 1.6±0.5. The 15–55 keV flux is $F_{15\text{-}55}$=(2.5±0.9)×10^{-11} and $F_{15\text{-}55}$=(2.1 ± 0.8)×10^{-11} erg cm^{-2} s^{-1}, respectively. We converted the observed IBIS (black) and BAT (red) count rates into 15-55 keV flux. The source shows a strong long term variability in hard X-rays: it experienced a strong flare around Jan-2005, reaching a 15-55 keV flux maximum of (8±2)×10^{-11} erg cm^{-2} s^{-1}, then fades into a quiescent state, reaching a flux that is at or below the detection limit of BAT and IBIS instruments.

The IBIS light curve is completely dominated by the flare. BAT has a much more regular and extended coverage of the source, and we were able to extract one spectrum for the flare and one for the quiescent period indicated with cyan lines.

The epochs of *Suzaku* (green), XRT (blue) and *Fermi* (orange dotted line) observations are shown.



SED MODEL

The model adopted to fit the SED is a **leptonic, one-zone synchrotron and inverse Compton model** [5]. The emitting region is assumed to be spherical (with radius R) and at a distance R_{diss} from the central BH. The accretion disk is a standard "Shakura & Syunyaev" disk, emitting as a blackbody at each radius. Thus from the peak of the disk luminosity, and the total luminosity of the accretion disk (L_d) it is possible to derive M_{BH} and M_{dot}, once the efficiency is assumed (η = 0.08 for a Schwarzschild BH). As a rough estimate we derive **M_{BH} = 10^9 M_{Sun}** and **L_d = 6.8 × 10^{46}** erg s^{-1} corresponding to the **45% of Eddington level**.

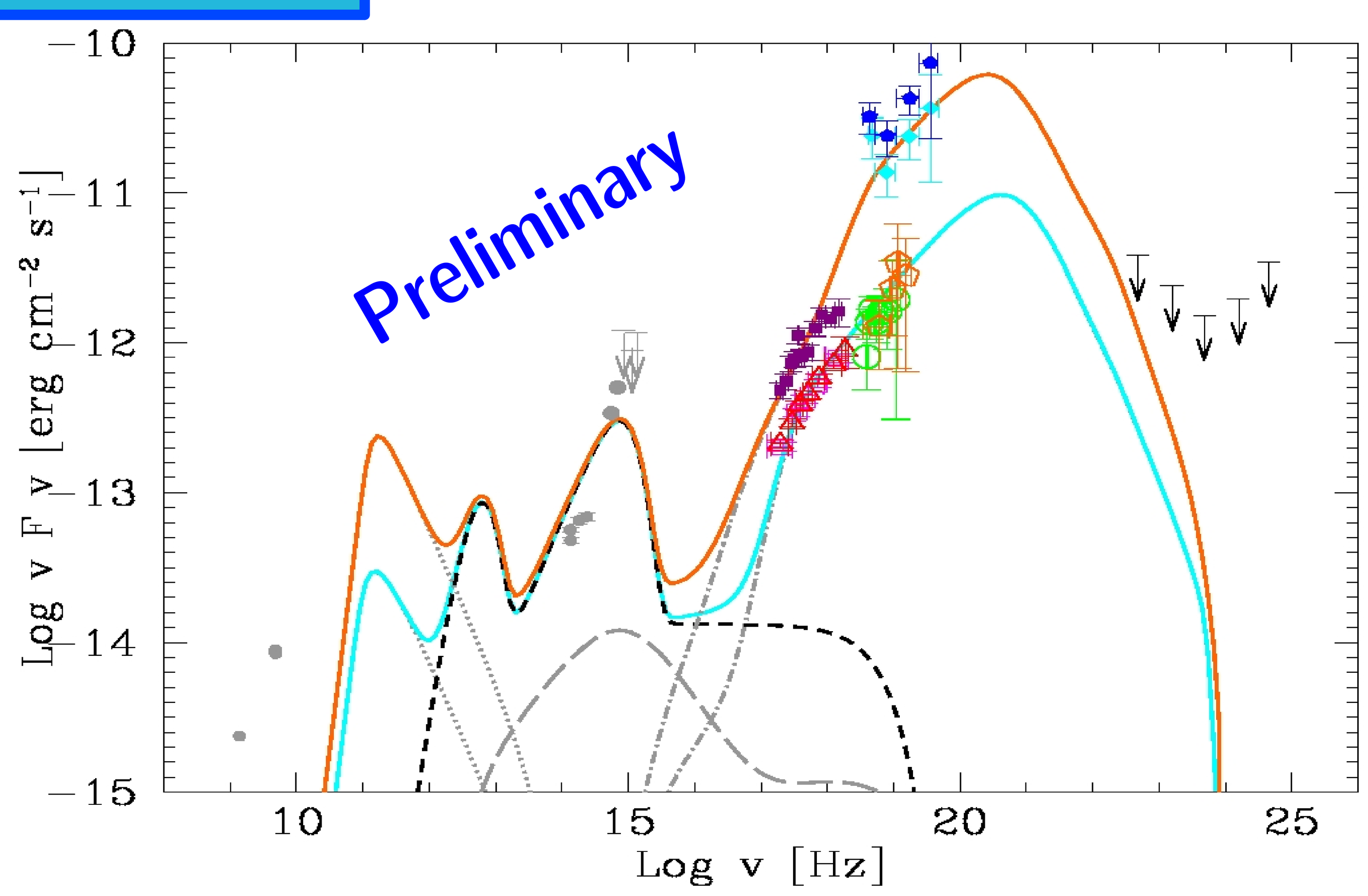
SPECTRAL ENERGY DISTRIBUTION

For the SED for the quiescent state, we used the X-ray data from *Suzaku*, the quiescent BAT spectrum, the *Fermi*/LAT 24-months upper limits and archival optical/UV data. For the flaring SED we used the *Integral*-IBIS spectrum and *Swift*–BAT spectrum extracted from the Jan-2005 flare. The black dashed line corresponds to the thermal emission of the disk, the IR torus and the X-ray corona, while the gray lines represent non-thermal emission: synchrotron (dotted), synchrotron self-Compton (SSC, long dashed) and External Compton (EC, dot-dashed).

The hard X-ray spectrum and the *Fermi*/LAT upper limits, constrain the peak of the **high energy hump** to be located at ~ **10^{20}-10^{22} Hz**; the corresponding **synchrotron** peak falls between **10^{11} and 10^{14} Hz**, where no data are available.

The main difference between the two SEDs is the power P_{inj} injected in the source in the form of relativistic electrons, that changes by a **factor ~7**. The increase of P_{inj} accounts for the enhanced X-ray flux in the high state. The other difference is the location of the emitting region **R_{diss} , becoming larger** for the high state. The main seed photons source for the EC is the **BLR**.

The large Compton dominance constrains the value of the magnetic field, and in turn the relevance of the **SSC** flux, found to be almost **negligible**. The total jet power [6] is **P_{jet} = 3.6×10^{47} and 2.6×10^{48}** erg s^{-1}, in the low and high state, respectively, i.e. the jet power is from **3 to 30 times** more powerful than the accretion luminosity.



State (1)	R_{diss} (2)	R_{BLR} (3)	P'_{inj} (4)	B (5)	Γ (6)	γ_b (7)	γ_{max} (8)	s_1 (9)	s_2 (10)	γ_c (11)
Low	570 (1900)	821	0.045	1.06	16	70	2e3	-1	4	1.7
High	990 (3300)	821	0.30	0.61	16	70	2e3	-1	4	5.8

(1) State (2) dissipation radius in units of 10^{15} cm and, in parenthesis, in units of Schwarzschild radii; (3) size of the BLR in units of 10^{15} cm (4) intrinsic injected power (10^{45} erg s^{-1}) in the form of relativistic electrons; (5) magnetic field intensity (Gauss); (6) bulk Lorentz factor at R_{Diss} ; (7) and (8) break and maximum random Lorentz factors of the injected electrons; (9) and (10) slopes of the injected electron distribution [Q(γ)] below and above γb ; (11) values of the minimum random Lorentz factor of those electrons cooling in one light crossing time.

CONCLUSIONS

Thanks to new high energy data, we were able to monitor a **strong flaring activity** of the high redshift, hard X-ray selected blazar IGR J22517+2217, which occurred in 2005. In both states a very **strong Compton dominance** is observed. The high energy hump (produced by EC from the BLR) is at least 2 orders of magnitudes higher than the synchrotron one. The high energy peak flux varies by a **factor 10**, while the frequency remain almost constant (10^{20}-10^{22}Hz). The total jet power in the flare is ~30 times more powerful than the accretion luminosity (2.6×10^{48} erg s^{-1}). Such extreme values have been derived only recently for a handful of extreme, high redshift, hard-X/soft-γ ray selected FSRQs, showing similar strong Compton dominance [7], and comparable with the value achieved by **3C 454.3** during the 2009 exceptional flare [8]. All the detail will be available in **G. Lanzuisi, A. De Rosa, G. Ghisellini et al. (2011) ApJ, submitted.**

[1] Krivonos et al. 2007, A&A, 475, 775

[2] Bassani et al. 2007, ApJ, 669, L1

[3] Bird et al. 2010, ApJS, 186, 1

[4] Maraschi et al. 2008, MNRAS, 391, 1981

[5] Ghisellini & Tavecchio 2009, MNRAS, 397, 98

[6] Celotti & Ghisellini 2008, MNRAS, 385, 283

[7] Ghisellini et al. 2011 MNRAS, 411, 901

[8] Ackermann et al. 2010ApJ, 721, 1383