The low-frequency radio emission in blazar PKS2155-304

M-Pandey-Pommier (1), S. Sirothia (2), P. Chadwick (3), J. M. Martin(4), P. Colom (4), F. Combes (5), W. van Driel (4), P-J. Crespeau (1), P. Kharb (6), J. Richard (1), B. Guiderdoni (1)

1-CRAL-l'Observatoire de Lyon, France, 2-National Centre for Rdaio Astrophysics, India, 3-University of Durham, UK, 4-GEPI-l'Observatoire de Paris, France, 5-LERMA-l'Observatire de Paris, France, 6-Indian Institute of Astrophysics, Bangalore, India

Blazars (BL Lacs) are active galactic nuclei (AGN) powered by accretion onto supermassive blackholes. The relativistic jets emerging from the vicinity of the black hole are directed to the observer and emit from radio (100 MHz) up to very high-energy gamma rays (tens of TeV). These jets are further characterized as compact in morphology with flat radio spectra cores that over shines the entire spectrum. The radio lobes from the blazar jets exhibit apparent superluminal motion and has high degree of linear polarization. BL Lacs in addition have a very variable (less than an hour to several days) emission from the core region due to relativistic beaming effects of the jet
==> ***justification for radio monitoring campaigns***

Object of the poster: AGN PKS 2155-304 is one of the most distant (Luminosity disatnce = 540 Mpc) well- established source of TeV gamma rays at z =*0.117* (Chadwick et al. 1999). This high frequency peaked blazar is known to be one of the brightest (synchrotron peak luminosity = 10^{46} ergs /s) extragalactic X ray sources in the sky and known to exhibit significant variability, both on long-term (months) and short-term (days to hours) times scales from radio upto gamma-ray wavelength (Aharonian et al. 2005).

The firstever deep images of the PKS 2155-304 at very low frequencies acquired with the *GMRT* are presented in this work. Thanks to our high sensitivity and high resolution observations, we have resolved for the first time 620 kpc-scale jet structure along with the core in PKS 2155-304, which was earlier known to show a compact morphology. The jet structure is clearly visible in 0.61 GHz map (resolution= 5", rms = 0.005 mJy /beam), and less resolved at 0.235 GHz (resolution= 13", 0.13 mJy/beam).

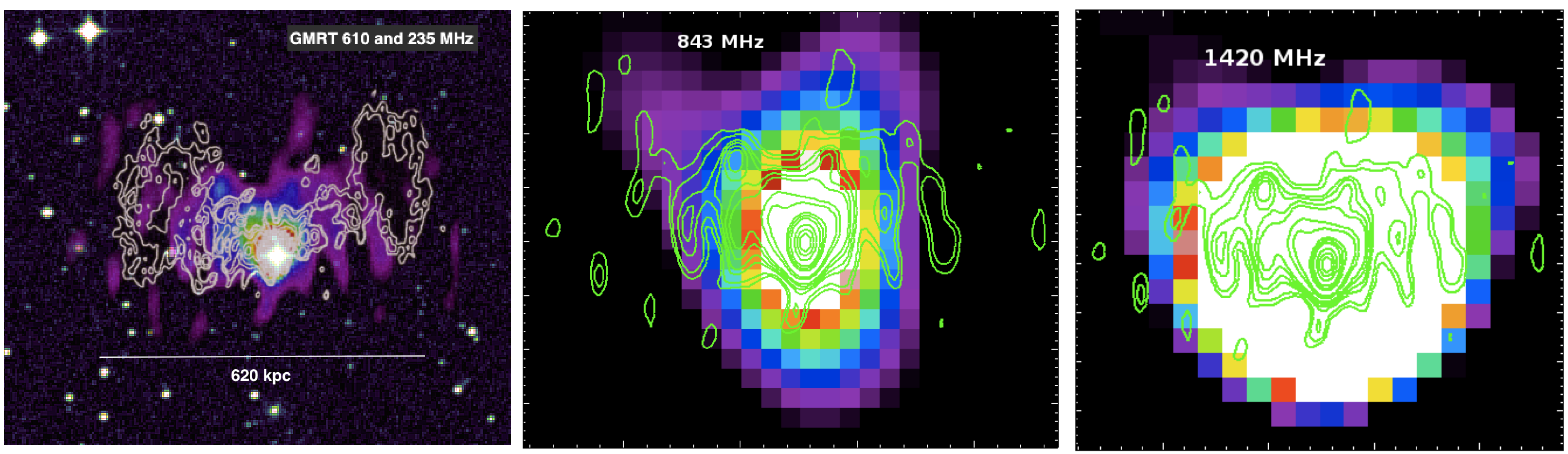

Figure 1. ***Deep GMRT*** **observations at 235 and 610 MHz (in colour and contours, left) of PKS 2155-304 an erstwhile core-dominated BL Lac object, SUMSS 0.843 GHz (middle) and VLA NVSS survey (right)**

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Spectral properties of PKS 2155-304:

The spectral index measurement for PKS2155-304 suggests that the emission in the radio lobe is steepest near the outer edge (α = -1.5) and less steep near the centre (-1<α <0). The core region shows flatter spectral index (α = -0.2) in agreement with the earlier VLA observations (Liuzzo et al. 2013). Further the left lobe is steeper (α = -0.55) as compared to the right lobe (α = -0.43) *(Pandey-Pommier et al. 2016 in prep.)*

Variability monitoring of PKS 2155-304 during the 2008 flare

The data at 610 MHz shows highest flux density as compared to 1.4 and 2.7 GHz, suggesting that at low frequencies the emission is dominated by diffuse radio lobes. The core emission shows day-to-day variability between MJD 53200-54800 down to 610 MHz. A shift/delay in the peak of the radio light curve between MJD 54705-54710 is also measured at 610 MHz as compared to 2.7 GHz.

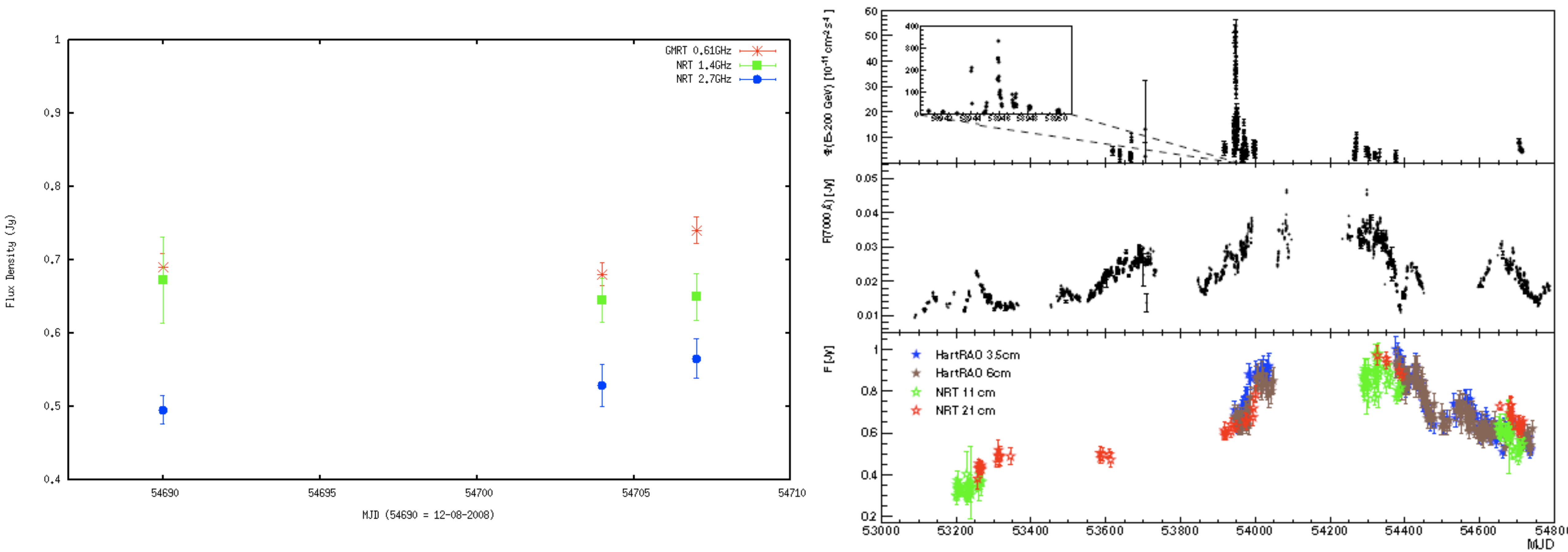

Fig. 8. Long-term light curves from VHE γ-ray measurements (*upper panel*: H.E.S.S.), optical data (*middle panel*: ROTSE) and radio data (*lower panel*: NRT and HartRAO). Please note that the y-axis is truncated for the long-term H.E.S.S. light curve due to the large dynamic range caused by the flares. A zoom on the period covering the two VHE flares is shown in an inset in *the upper panel*.

Figure 2. GMRT+NRT (left) and Multi wavelength (right) light curve of 2008 flare in PKS 2155-304 *(Abramowski et al. 2012)*

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Discussion:

Figure 3 shows that much lower sensitivity limits of SKA1-MID at GHz frequencies is likely to detect nearly twice as many new FRI/II sources, than previous studies carried out with the VLA (Kharb et al. 2016)

It is clear from the GMRT deep observations on PKS2155-304, that high sensitivity observations are needed to detect the faint jet structures in the already known compact BL Lac objects as well as newly discovered ones. SKA1 MID will also help us to find out whether this new class of sources have faint extended jet emission.

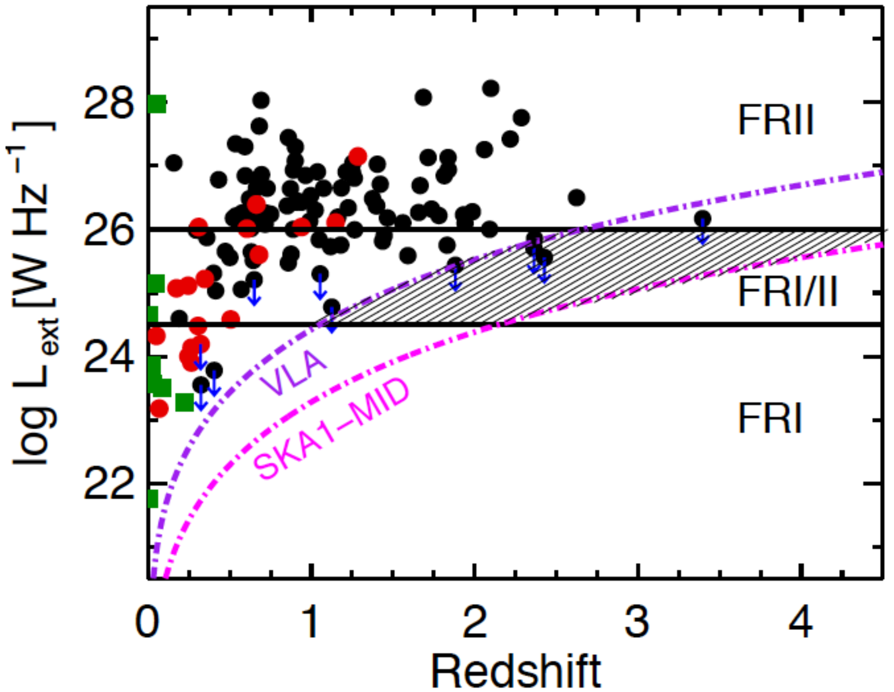

Figure 3. **1.4 GHz extended luminosity versus redshift for the MOJAVE Blazar sample. Black and red circles denote quasars and BL Lac objects, resp. while green squares denote radio galaxies. The purple line denote the sensitivity limit for the VLA MOJAVE survey, while the magenta line denotes the sensitivity limit for the upcoming SKA1 MID array** *(Kharb et al. 2016, Kharb et al. 2010)*

Results:

In this work we present a study of the non-thermal radio emission from the most brightest blazar PKS 2155-304 down to 0.235 GHz with the GMRT.

-We have confirmed the variability of the source down to 610 MHz during the 2008 flaring episode and detected a rare kpc scale jet structure.

-The compact core is highly variable over few hours to day in nature and has flat spectral index response.

-Low frequency radio emission at 235 MHz is dominated by emission from extended diffuse lobes.

-Further we show that SKA will play an important role in detecting new population of FRI/II sources as well as the faint blazar jets.

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