# Challenging Electron Populations and Magnetic Fields in SNRs Shocks through Single-Dish Radio Observations

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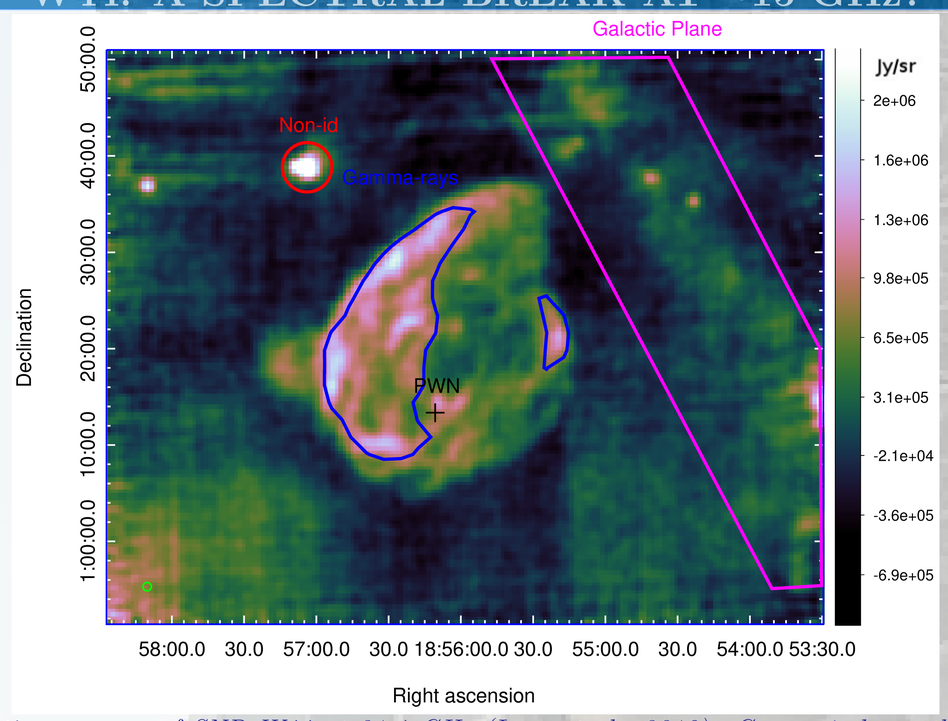
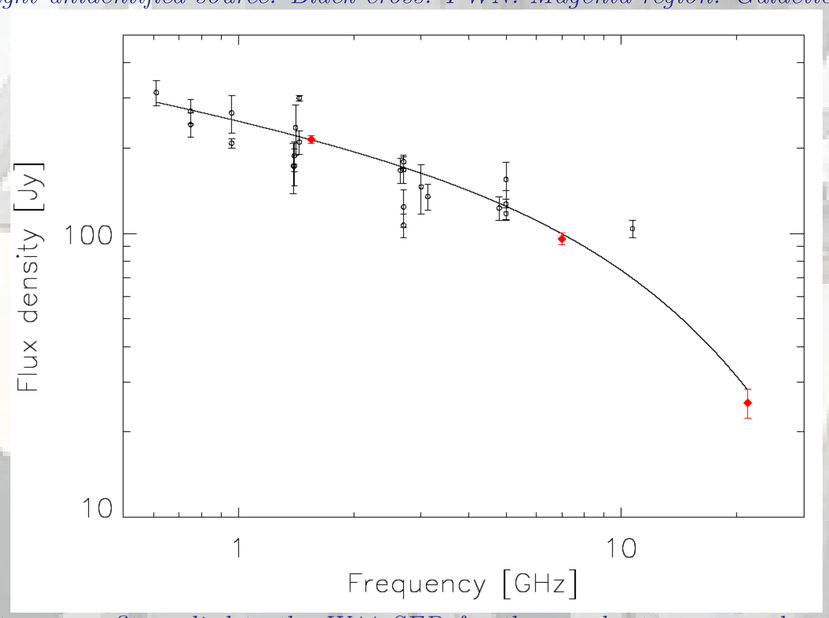
## SNRs RADIO SPECTRA IN THE 5-25 GHz RANGE

**High-resolution radio continuum SNRs images at frequencies above 5−10 GHz are surprisingly lacking. Our observations with the Sardina Radio Telescope (SRT) shed new light on spectral features and breaks up to 25 GHz.** Synchrotron cutoff differences between different SNR complexes could be related to still poorly understood different primary and secondary (from hadron interactions) electron energy distributions and/or magnetic fields, accordingly to local shock conditions arising from different interacting structures in the ISM. **We are providing spectro-polarimetric imaging in the frequency range 5-25 GHz of** a selected SNRs sample: **W44, IC443, Cygnus Loop, Kes 73, G85.4+0.7**. Our aim is to disentangle magnetic processes from spectral variation contributions due to different primary and secondary electron populations.

## W44: A SPECTRAL BREAK AT ∼15 GHz?

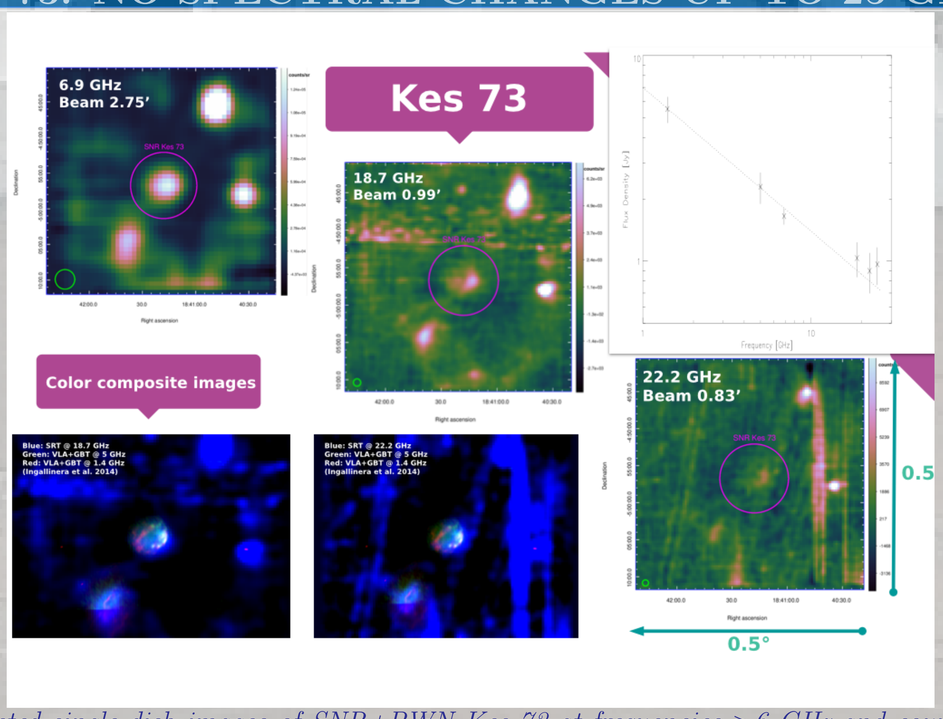



*SRT continuum map of SNR W44 at 21.4 GHz (Loru et al., 2019). Green circle on the bottom left: beam size (∼1′). Blue regions: MeV-GeV emission (Abdo et al., 2010; Giuliani et al., 2011). Red circle: bright unidentified source. Black cross: PWN. Magenta region: Galactic plane.*



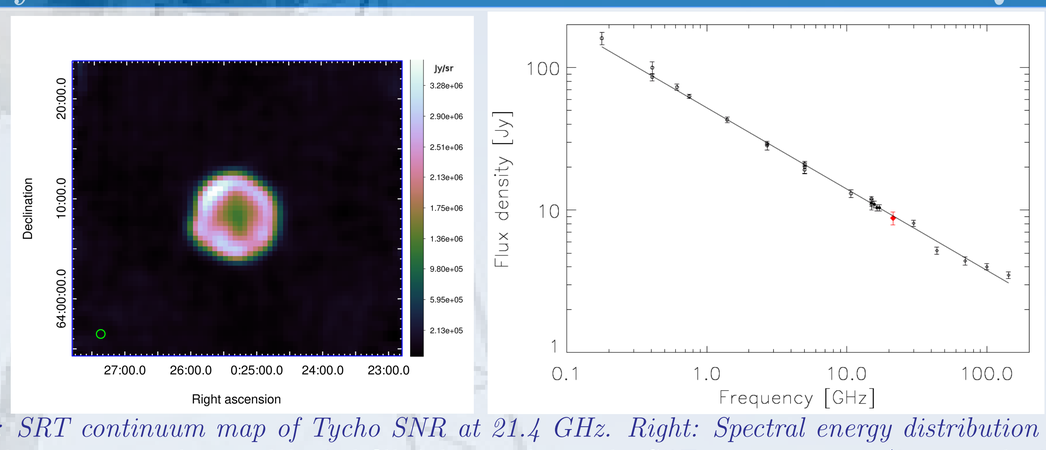

*Weighted least-squares fit applied to the W44 SED for the synchrotron power law with an exponential cut-off model providing a spectral break at 15 ± 2 GHz . Red diamonds: SRT flux density measurements at 1.55, 7.0 and 21.4 GHz (Egron et al., 2017; Loru et al., 2019).*

## Kes 73: NO SPECTRAL CHANGES UP TO 25 GHz?



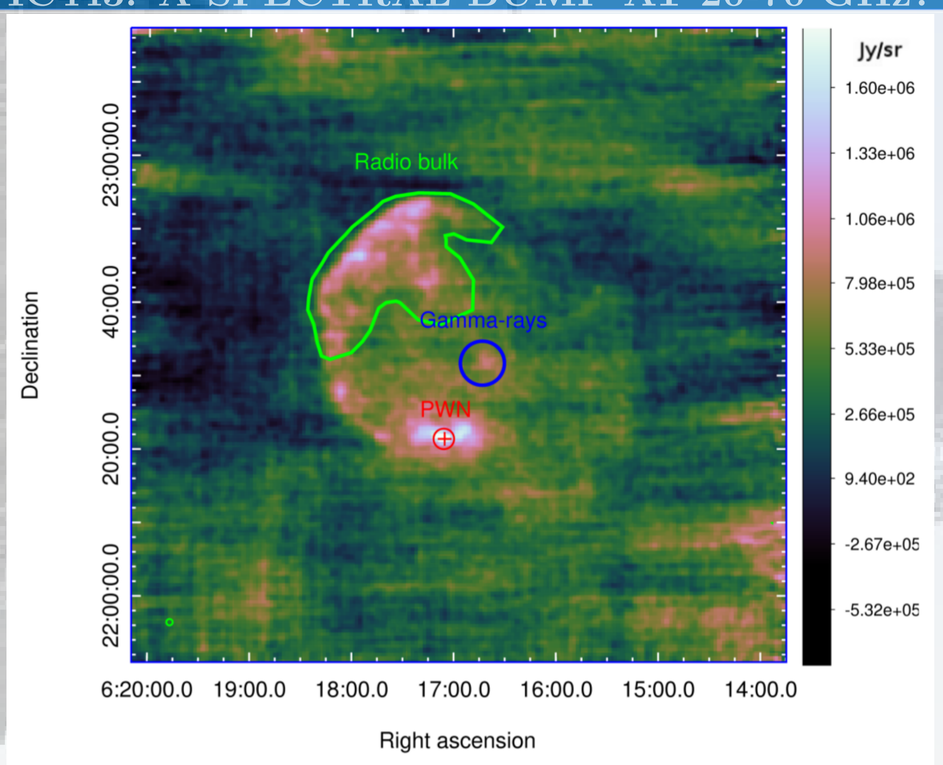

*We collected single-dish images of SNR+PWN Kes 73 at frequencies >6 GHz and coupled them with lower frequency interferometric images (Ingallinera et al., 2014). No spectral changes are evident in the total flux density, but strong region-dependent spectral variations are observed.*

## Tycho: VALIDATING OUR IMAGING TECHNIQUE

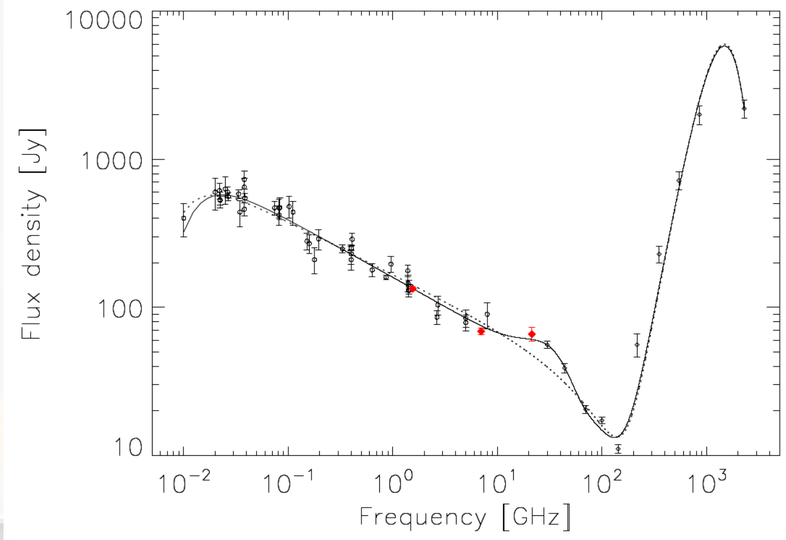



*Left: SRT continuum map of Tycho SNR at 21.4 GHz. Right: Spectral energy distribution for a synchrotron power-law model. Red filled diamonds are the SRT measurements (Loru et al., 2019). Our flux density measurements agrees with literature data and prove the accuracy of our single-dish imaging procedures. Any spectral curvature up to high radio frequencies is ruled out.*

## IC443: A SPECTRAL BUMP AT 20-70 GHz?




*Continuum map of SNR IC443 at 21.4 GHz (Loru et al., 2019). Red cross/circle: NS/PWN. Blue circle: TeV gamma-ray emission (Albert et al. 2007). Green region: bulk of the radio emission.*




*Spectral energy distribution from 0.408 to 857 GHz. Filled red diamonds: SRT measurements (Egron et al., 2017; Loru et al., 2019). The solid line model includes both synchrotron and spinning dust emission components (Onić et al., 2017).*

## HIGHLIGHTS AND CHALLENGES:

- Assuming a magnetic field in the range 18−90 $\mu$G, **our result on W44 provides a direct estimate for the maximum energy of accelerated cosmic ray electrons in the 6−13 GeV range**, which is consistent with evidence from gamma-ray observations (Ackermann et al., 2013). Assuming instead a locally enhanced magnetic field of ∼1 mG (Cardillo et al. 2016), the corresponding maximum electron energy would be <2 GeV (secondary electrons?).
- Our flux density measurement at 21.4 GHz independently supports the claimed spectral bump in IC443 (spinning dust process; Onić et al., 2017). A correlation between the TeV emission and radio bright/flat-spectrum regions could be related to an increase in hadron emission and a significant secondary electrons injection.
- High-frequency polarimetric images represent a major challenge in order to better constrain the magnetic field (regular or enhanced?)
- See Egron, Pellizzoni, Iacolina et al., MNRAS, 470, 1329, 2017 and Loru, Pellizzoni, Egron et al., MNRAS, 482, 3857, 2019

## Cygnus Loop HIGH-FREQUENCY SPECTRUM? ...SEE Sara Loru's TALK!

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