X-ray synchrotron filaments in Cas A: the radio connection

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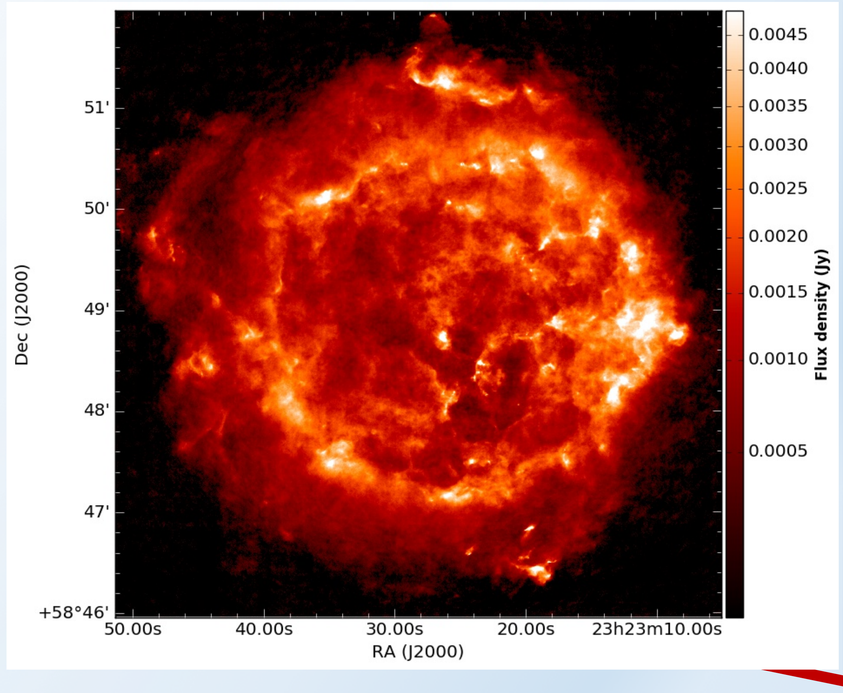
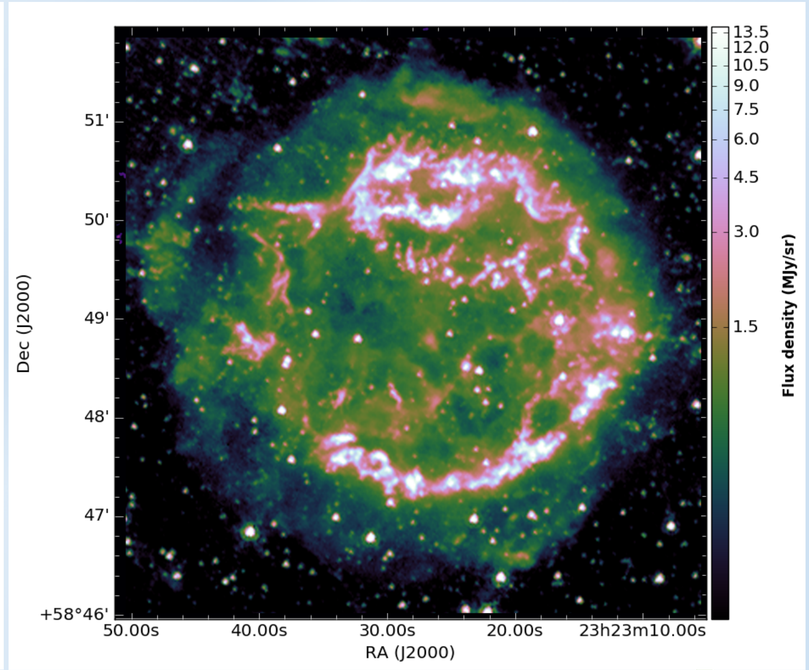
Supernova remnants (SNRs) are thought to be the dominant sources of Galactic cosmic rays (Helder+ 2012) → Identification of radio synchrotron emission from electrons with energies of a few GeV was the first evidence of that

Part of the X-ray emission from young SNRs is synchrotron produced by electrons with energies of $10^{13} - 10^{14}$ eV → Presence of these electrons is very revealing about where and how fast the electrons are accelerated.

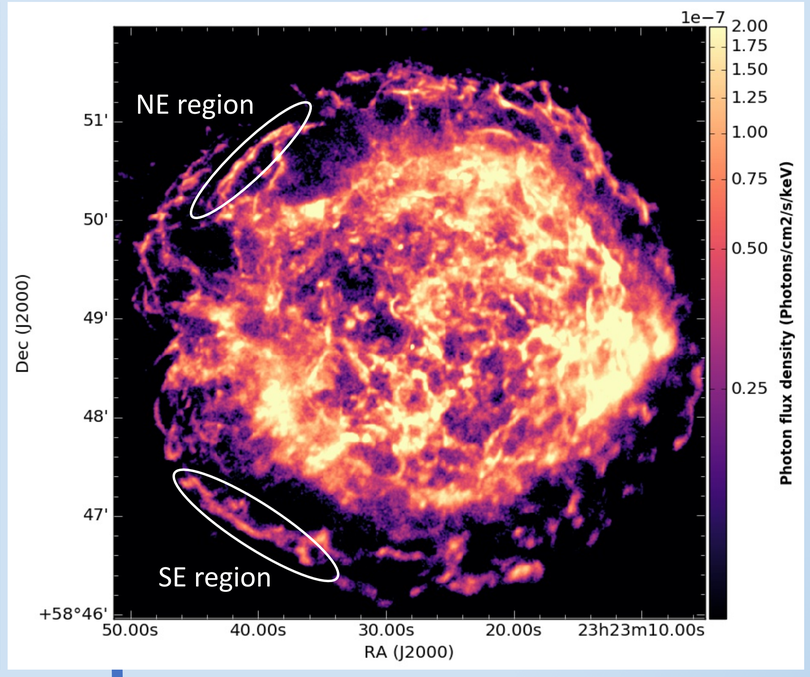
Radio
VLA, 4.72 GHz ($\sim 10^9$Hz)



Mid-Infrared
Spitzer, 4.5 μm ($\sim 10^{13}$Hz)



X-rays
Chandra, 4.2-6.2 keV ($\sim 10^{18}$Hz)



What do we look for?

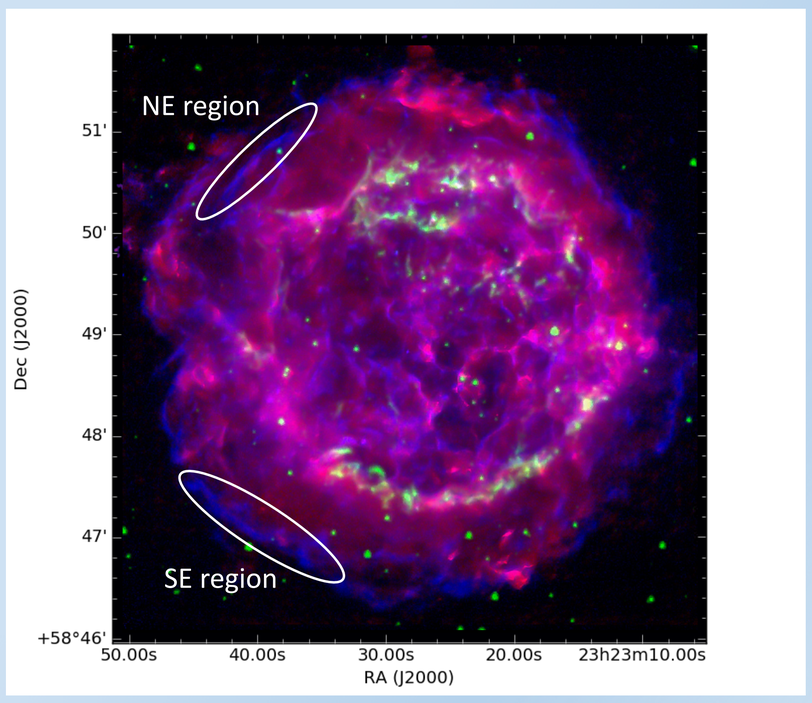
We investigate narrow regions of the SNR associated with the forward shock and X-ray synchrotron radiation to find out:

- whether the overall spectrum remains a power-law in the frequency range $10^8 - 10^{18}$ Hz,
- what is the shape of the power-law cut-off

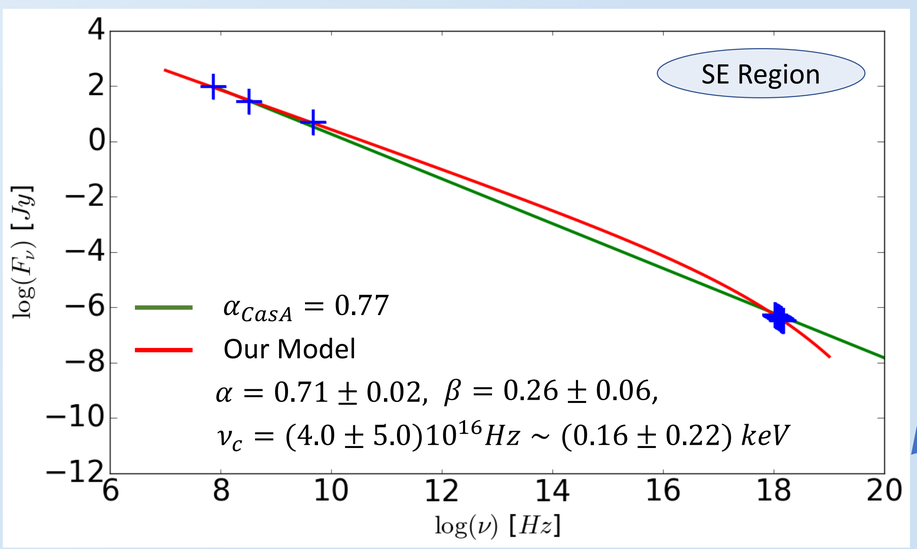
Why do we care?

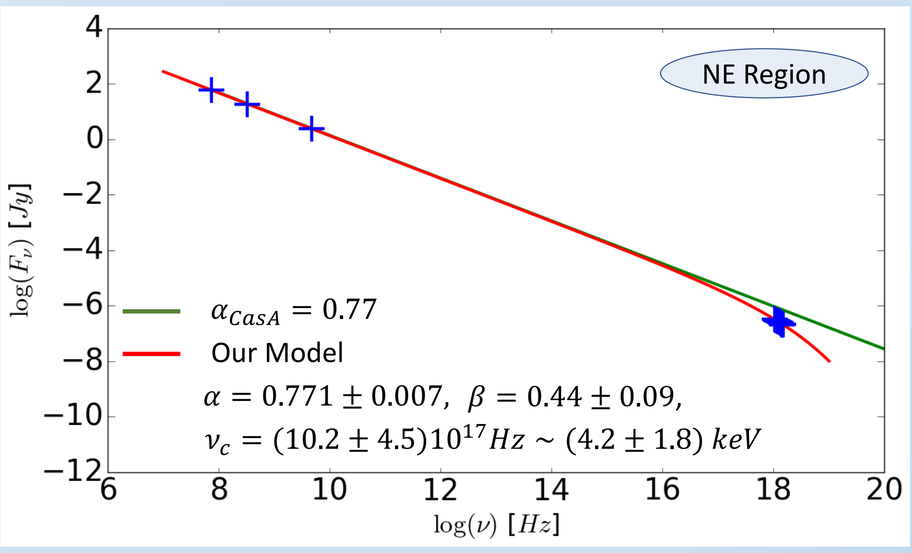
- Accelerated particles influence the shock itself, resulting in curved spectra (Malkov & Drury 2001)
- The cut-off shape can be indicative of what limits the maximum energy and the role of magnetic field fluctuations (Zirakashvili & Aharonian 07, Yamazaki+ 2014)

Combined color image



Highlighted regions are filaments associated with X-ray synchrotron radiation





Our approach?

- We extract fluxes in the filament regions and model the SED as power-law with an exponential cut-off

$$\ln(F_\nu) = -\alpha \ln(\nu) - \left(\frac{\nu}{\nu_c}\right)^\beta + K$$

Our SED analysis of the chosen extraction regions

Preliminary conclusions

- X-ray flux doesn't surpass the radio extrapolated power-law thus additional non-linear component with this data is not needed
- Cut-off parameter differs from the standardly used value β = 0.5
- We currently look into the mid-infrared and Nustar data to investigate the possible curvature of the spectra further

References

Helder et al. (2012), Space Science Reviews, 173, 369,
Malkov & Drury (2001), Report on Progress in Physics, 64, 429
Zirakashvili & Aharonian (2007), Astronomy & Astrophysics, 465, 695
Yamazaki et al. (2014), Research in Astronomy and Astrophysics, 14, 165-178