



# Probing the Injected Particle Spectrum of the Mouse Pulsar Wind Nebula

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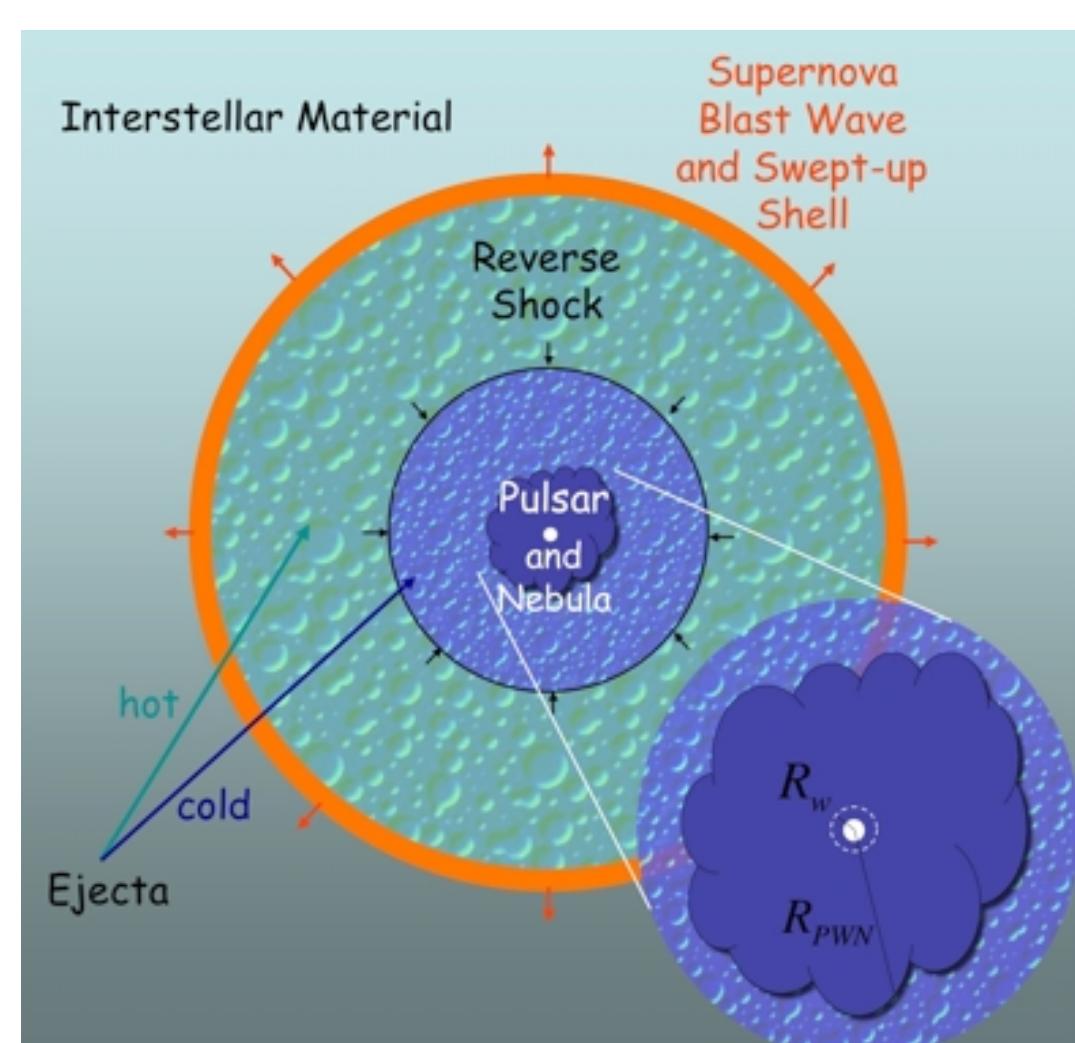
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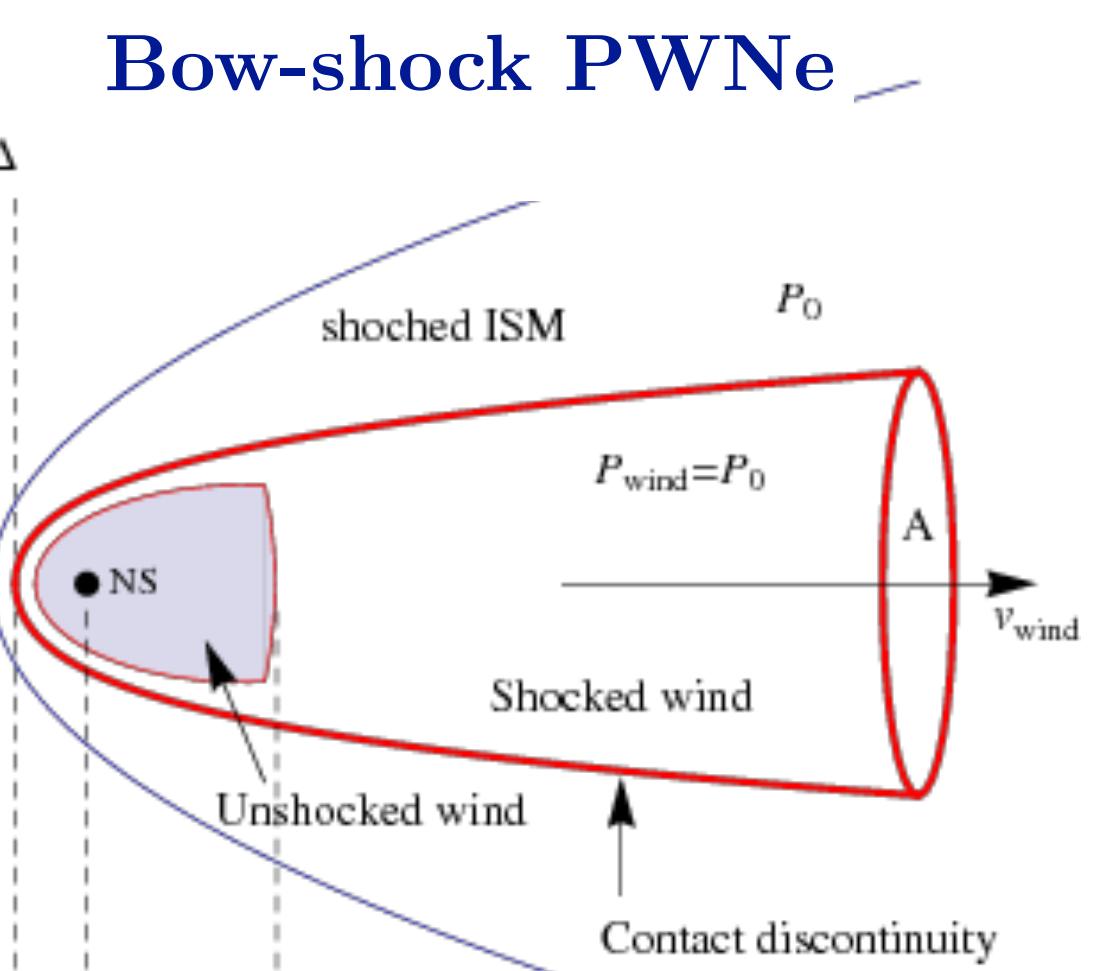
A pulsar wind nebula (PWN) is a synchrotron bubble formed when the relativistic outflow from a pulsar is shocked in the ambient medium. PWNe are relatively nearby objects, offering ideal laboratories for studying relativistic shocks. For a pulsar moving supersonically in the interstellar medium, the wind is confined by the ram pressure, resulting in a bow-shock PWN. These systems can be considered as in a steady state, thus, making the modeling much simpler than younger PWNe. We present a multi-wavelength study of the Mouse. We compile its spectral energy distribution using observations from VLA, GMRT, MOST, TMRT, Spitzer, *Chandra*, and *Fermi*. We then performed a detailed comparison with various injected particle distributions by taking into account synchrotron loss, synchrotron cooling as well as inverse Compton scattering.

## Pulsar Wind Nebula



Structure of a newly formed PWN (adopted from Gaensler & Slane 2006).

## Bow-shock PWNe



Structure of a bow-shock PWN (Morlino et al. 2016).

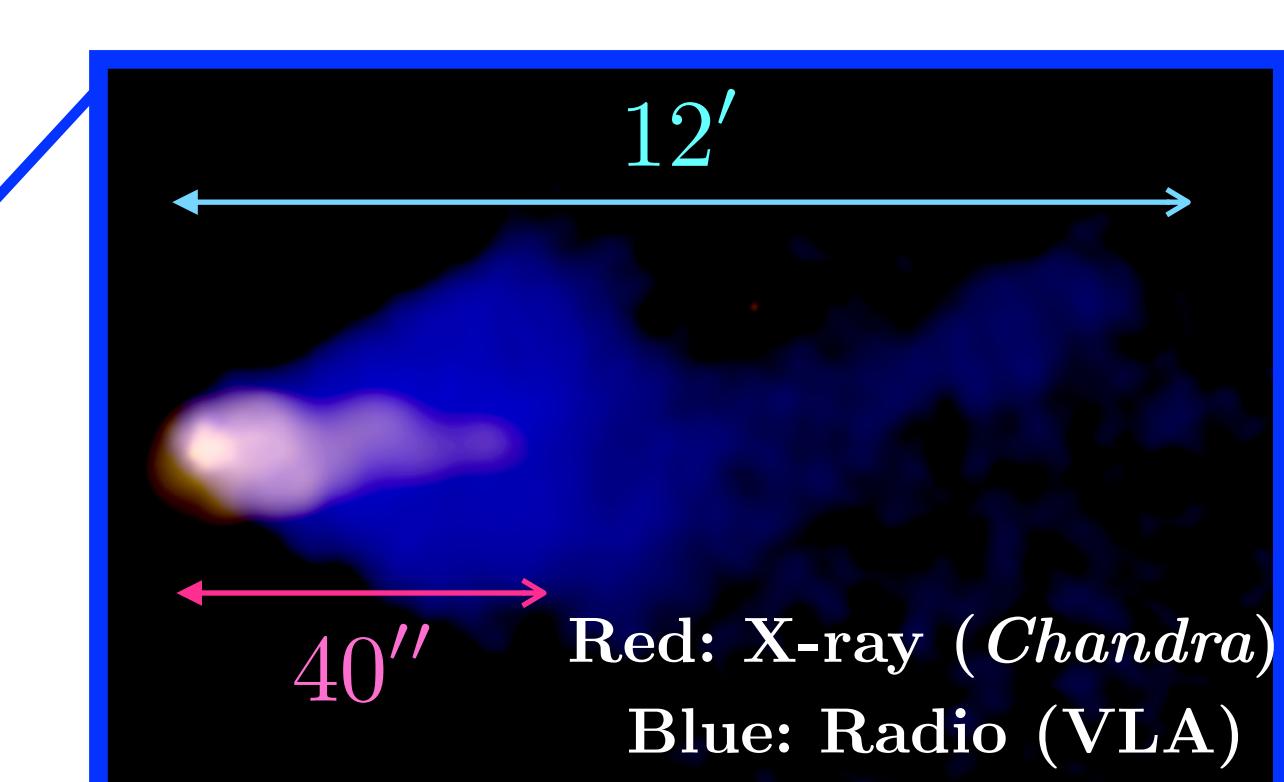
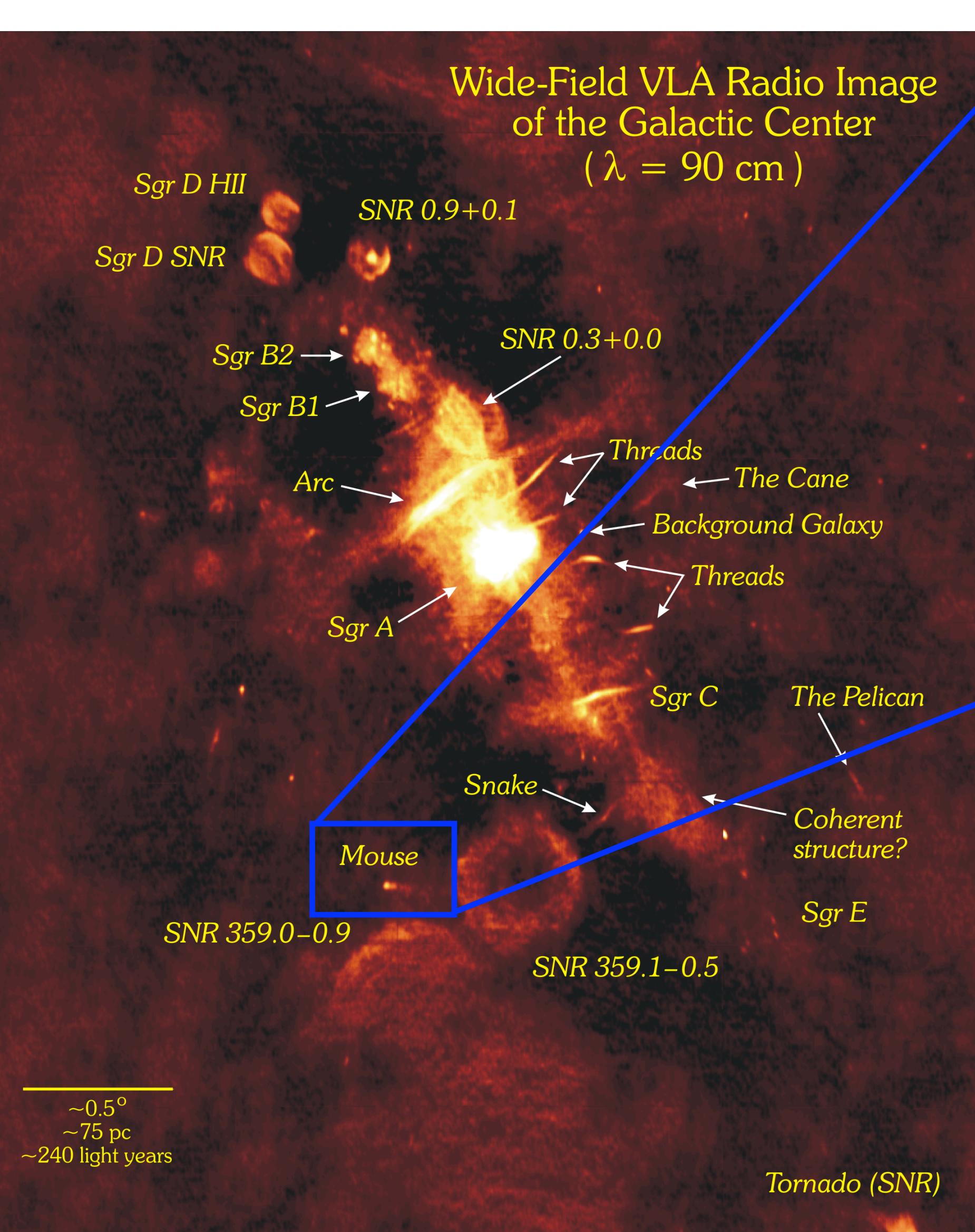
- synchrotron bubble when the relativistic outflow from a pulsar is shocked in the ambient medium

- Final phase in the PWN evolution
- The central pulsar is moving supersonically in ISM

## G359.23-0.82: The Mouse PWN

- Bow-shock PWNe
- Discovered by Yusef-Zadeh & Bally (1987)

- Powered by PSR J1747-2958
- distance: 5kpc



VLA-Chandra image of the mouse (Gaensler et al. 2004, Yusef-Zadeh & Bally 1987). The red and blue colour represent X-ray and radio images, respectively.

Parameters	Values
Right Ascension, $\alpha$ (J2000)	17 <sup>h</sup> 47 <sup>m</sup> 15 <sup>s</sup> .882
Declination, $\delta$ (J2000)	-29 <sup>h</sup> 58 <sup>m</sup> 01 <sup>s</sup> .07
Epoch of position (MJD)	52613
Spin period, $P$	98.8 ms
Spin period derivative, $\dot{P}$	$6.132 \times 10^{-14}$ ss <sup>-1</sup>
Dispersion measure, DM	101.5 pc cm <sup>-3</sup>
Spin-down power, $\dot{E}$	$2.5 \times 10^{36}$ erg s <sup>-1</sup>
characteristic age	25 kyr
Surface magnetic field, $B$	$2.5 \times 10^{12}$ G

Physical parameters of the central pulsar, PSR J1747-2958 (Camilo et al. 2002); Hales et al. 2009; Manchester et al. 2005).

90-cm VLA image of the Galactic center region (from LaRosa et al. 2000); The blue box indicates the location of the Mouse.

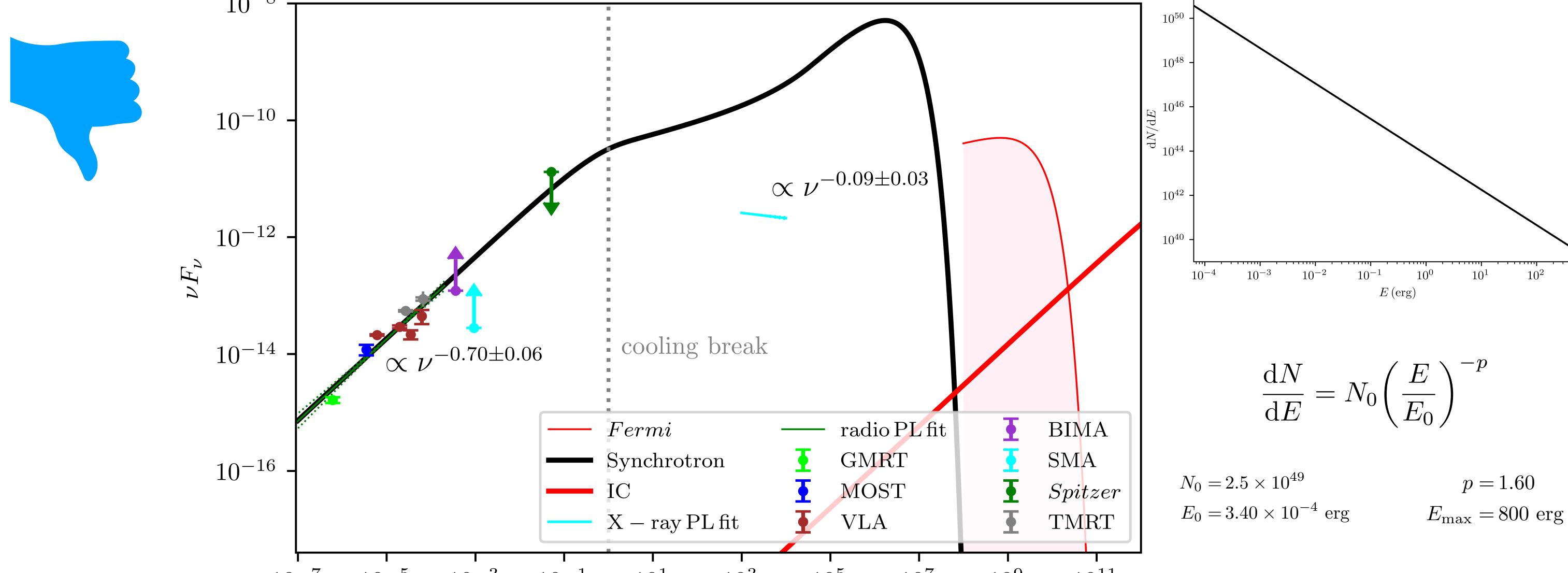
## WHY 'THE MOUSE'?

- Good object for studying relativistic shock
  - bright
  - Well-defined
- Can be considered as steady state
  - simple modeling

## Testing Acceleration Theories

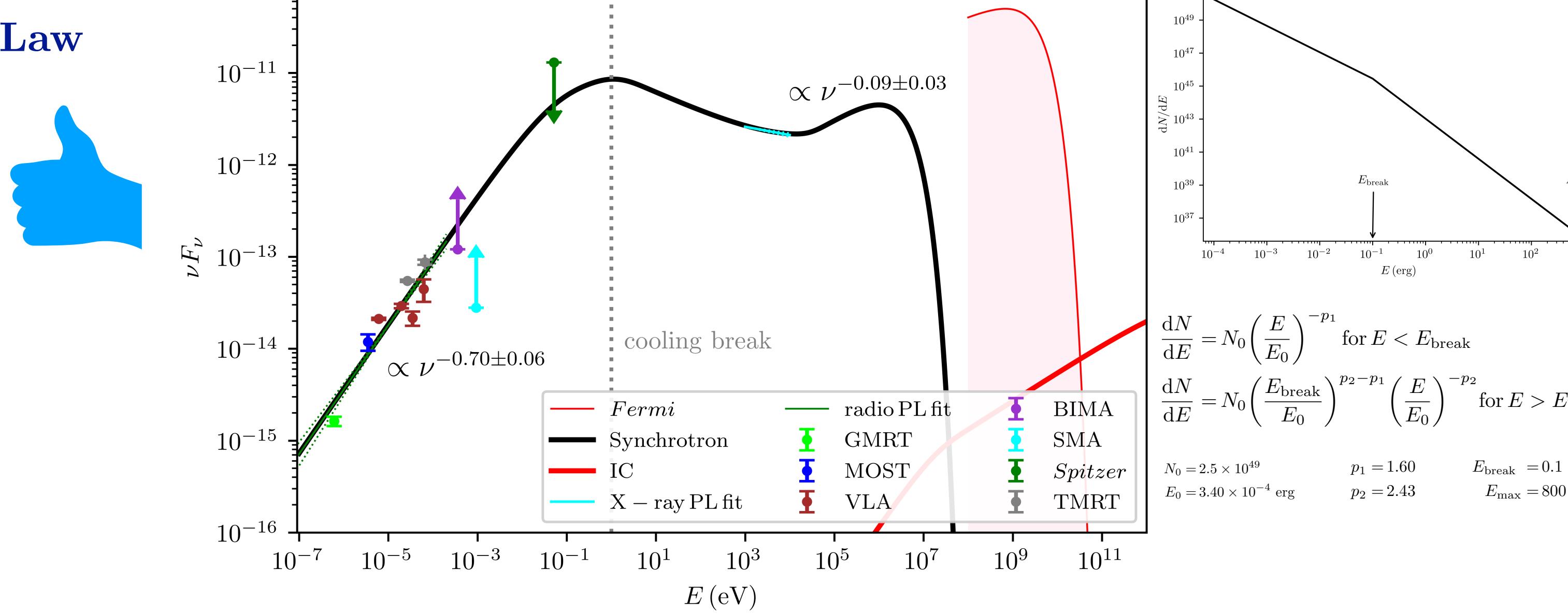
Power Law? Broken Power Law ? Maxwellian + Power Law?

### Power Law



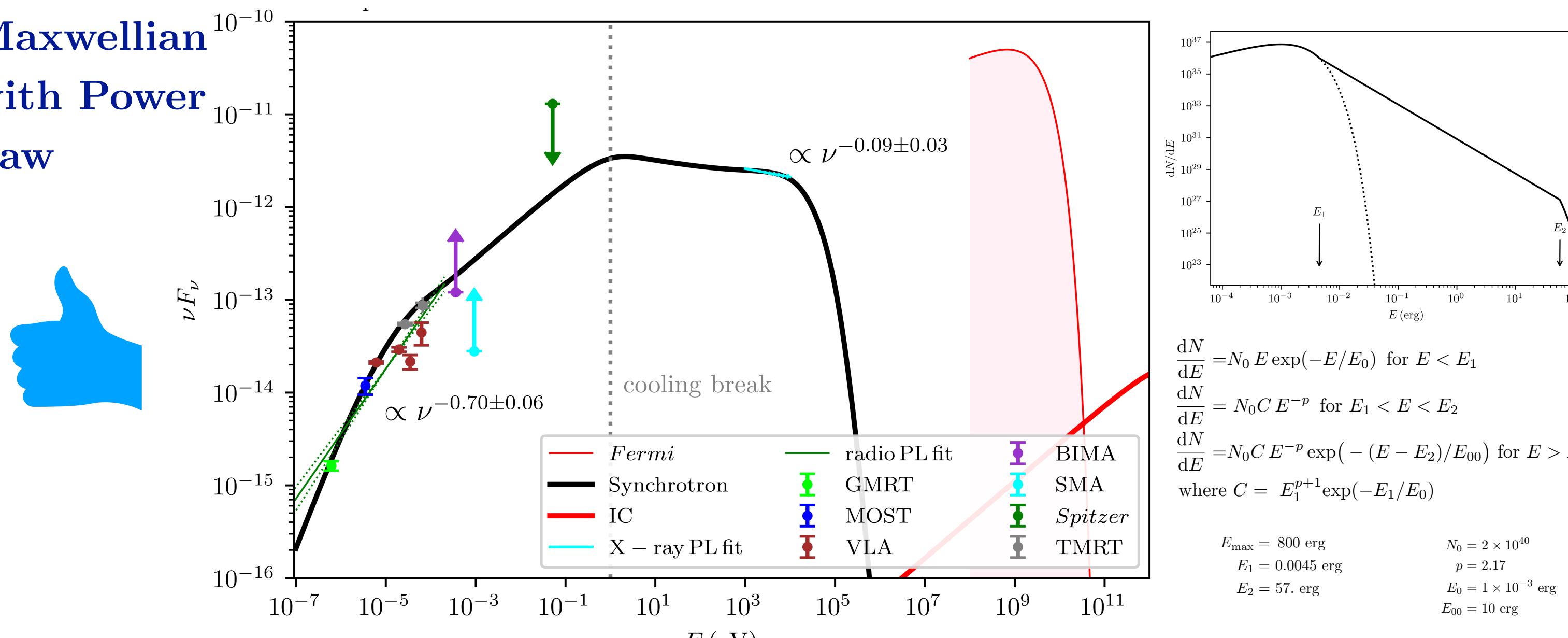
- Suggested by Fermi acceleration
- Cannot reproduce the X-ray spectrum

### Broken Power Law



- Suggested by magnetic reconnection
- Fits both radio and X-ray data

### Maxwellian with Power Law



- Suggested by Weibel instability
- Fits both radio and X-ray data

## Conclusion & Future Work

- Rule out simple predictions from Fermi acceleration
- Since we do not have enough data to provide constraints on the multi-wavelength SED, we cannot tell which one is the best model.
- If more data are provided, we can use formal  $\chi^2$  fit to determine which model is the best.

## References

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## Acknowledgment

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Like the poster?

