fermi-lat observations of snr n132d in the lmc

8th Fermi Symposium

baltimore – october 2018

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pat slane, paul plucinsky, jack hughes

outline

why should you care about the connection between SNRs and cosmic rays?

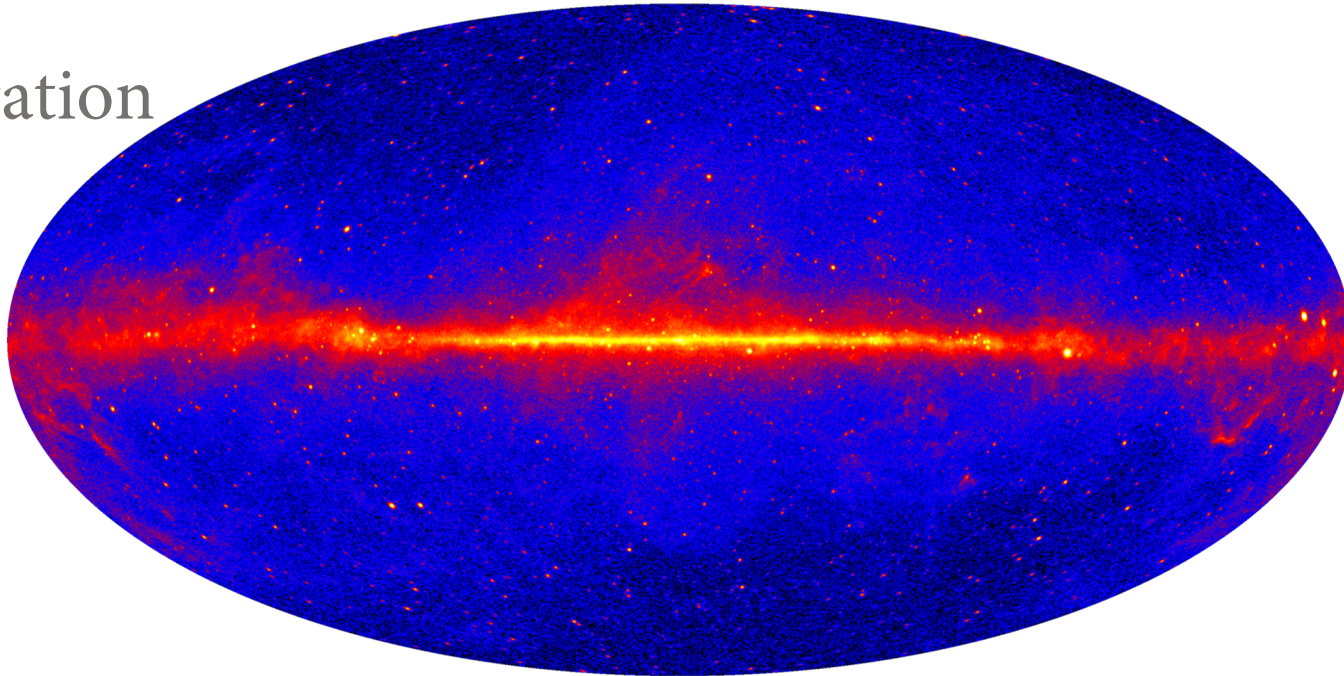
what evidence is there that SNRs accelerate cosmic rays?

what have we learnt recently by studying snrs in x-rays and gamma-rays?

| why?

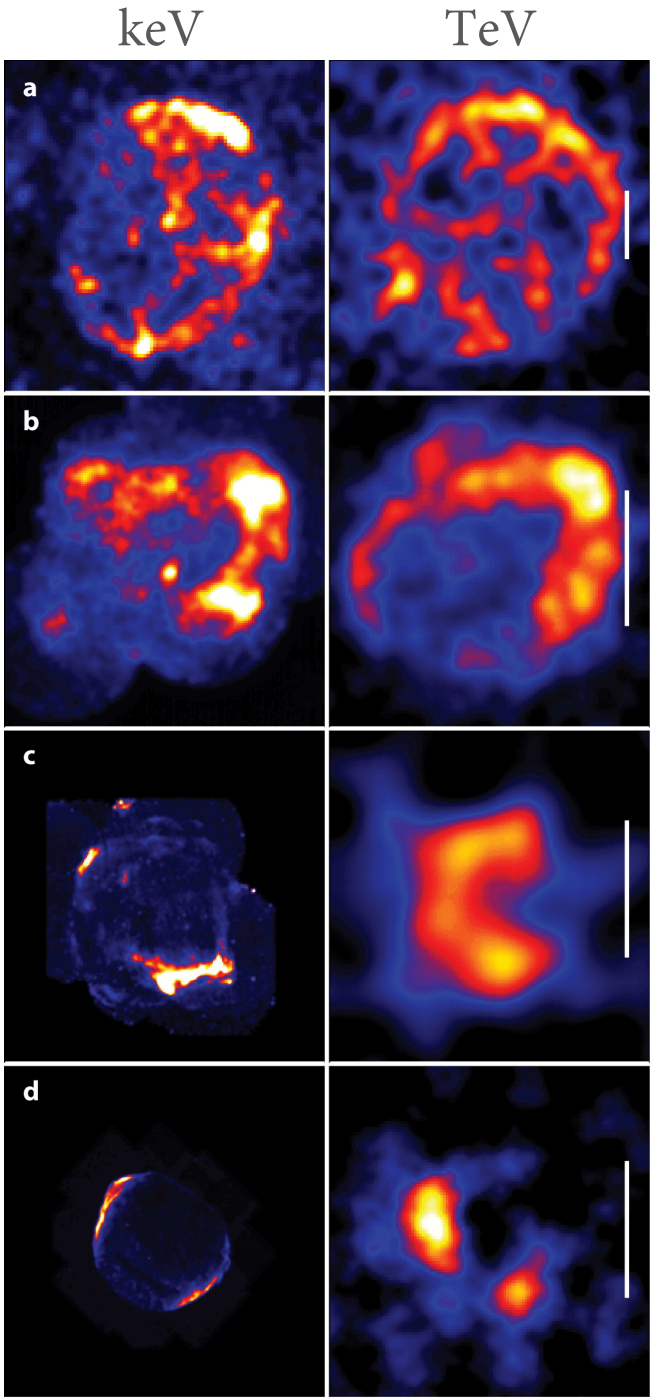
- origin
- γ-ray background
- particle acceleration
- snr evolution
- cr feedback

fermi-lat 10-year all-sky pass 8 intensity map (>1 GeV)



what evidence?

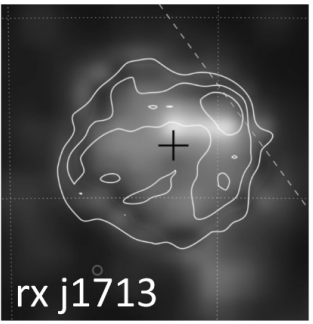
- shock structure
- non-thermal x-rays
  - synchrotron emission
  - magnetic field amplification
- ɣ-ray emission
  - leptonic vs hadronic

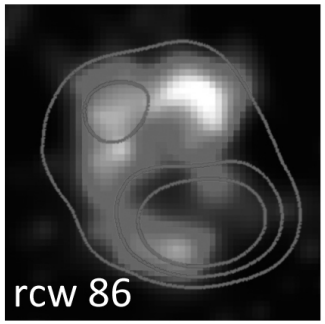


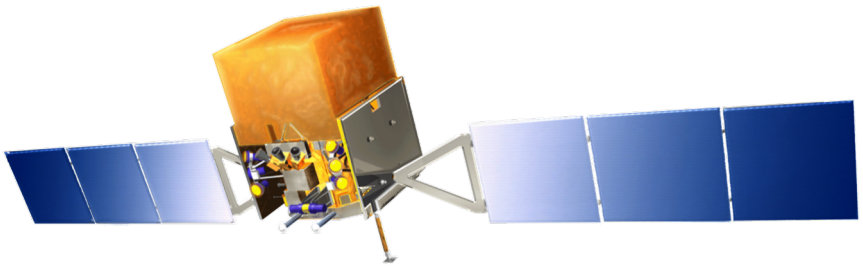
hinton & hofmann 2009

open questions

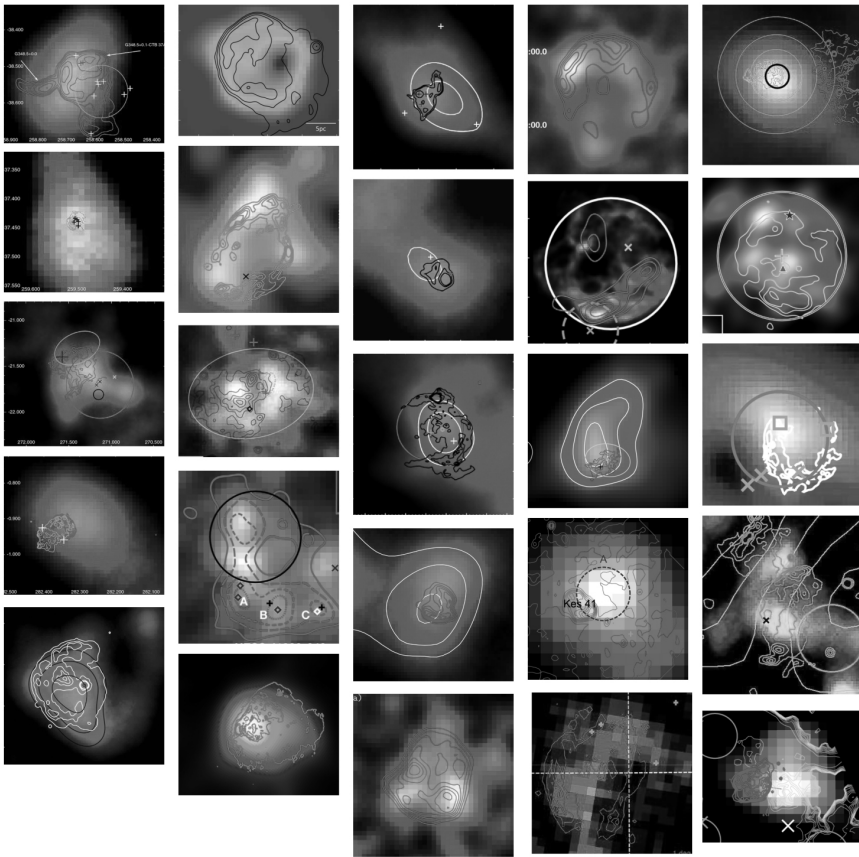
dynamically young + fast shocks



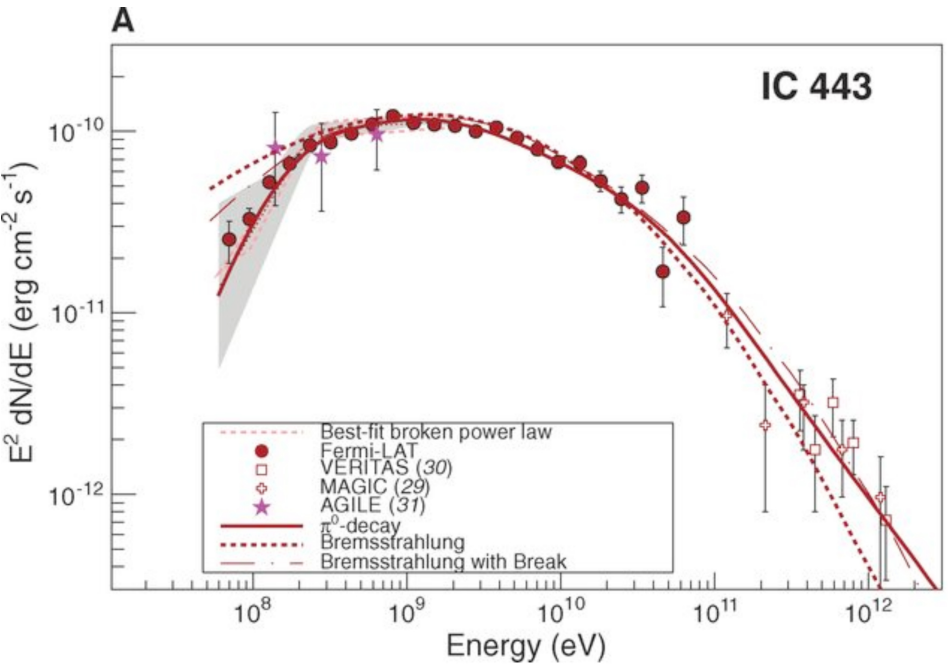


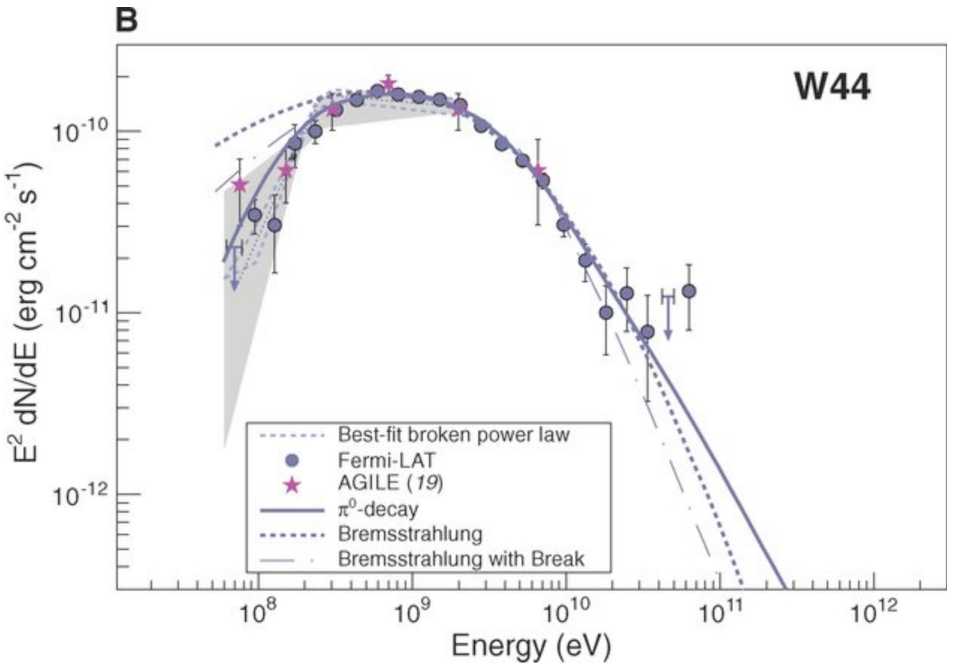


dynamically evolved + dense



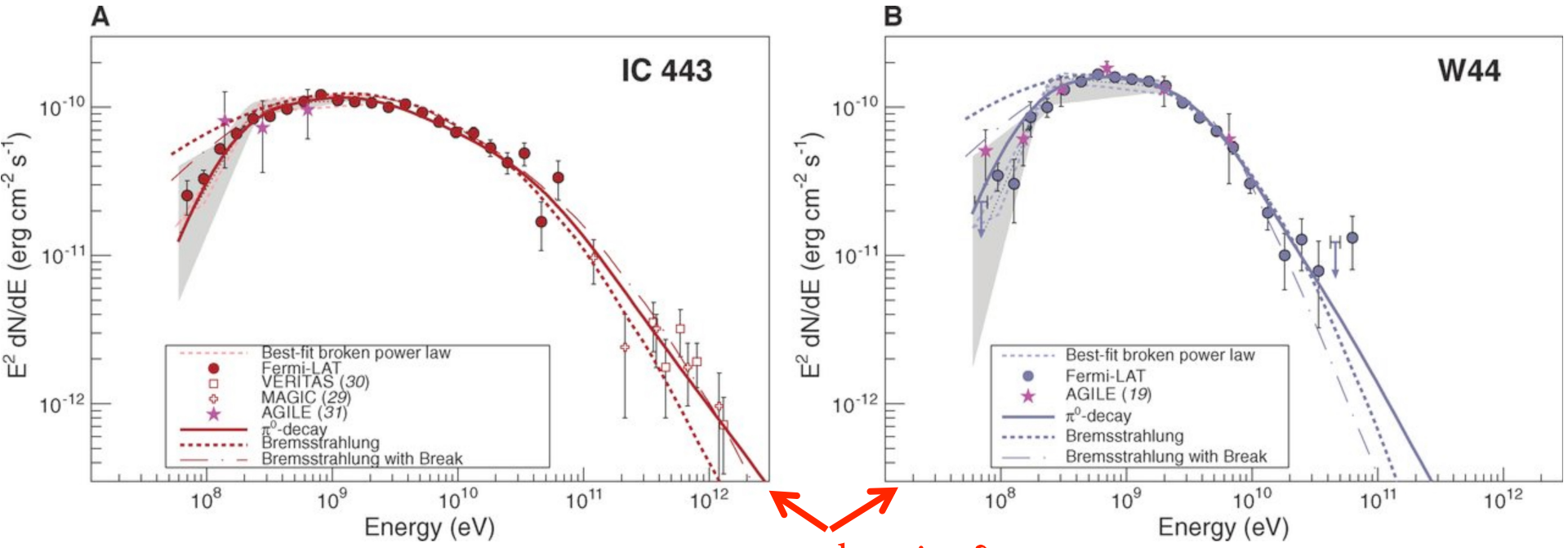
open questions





ackermann et al. 2013

open questions

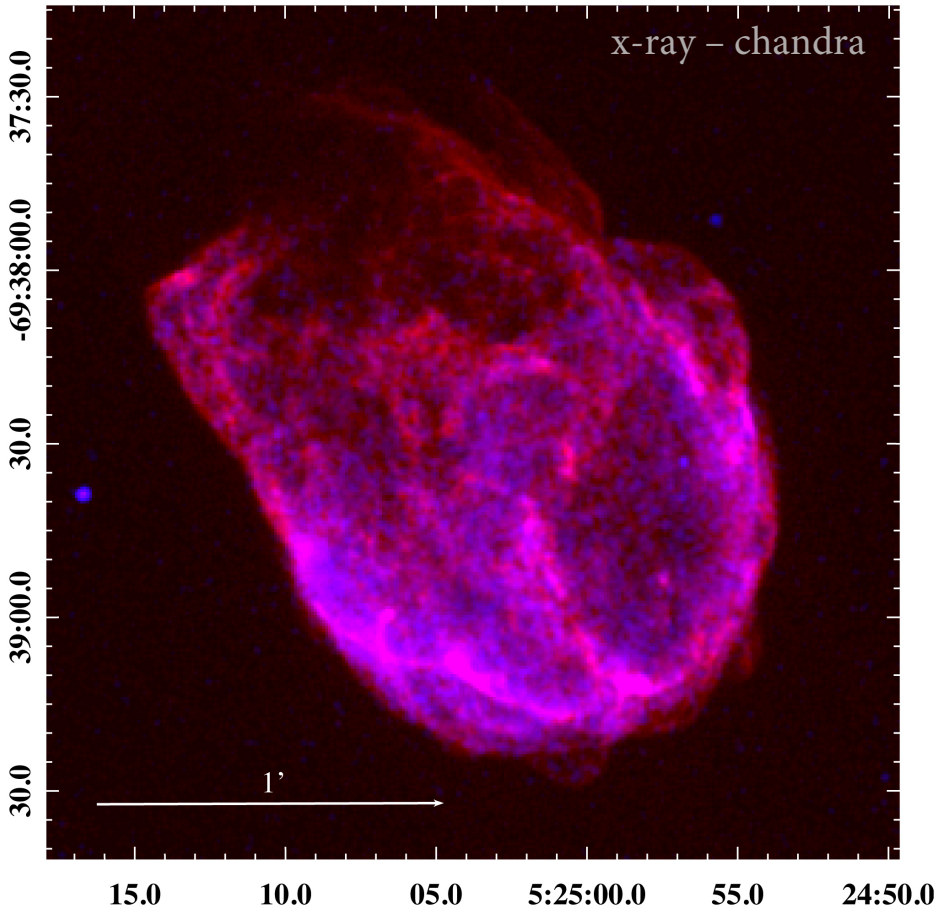


reacceleration?

uchiyama+2010, lee+2015

ackermann et al. 2013

n132d



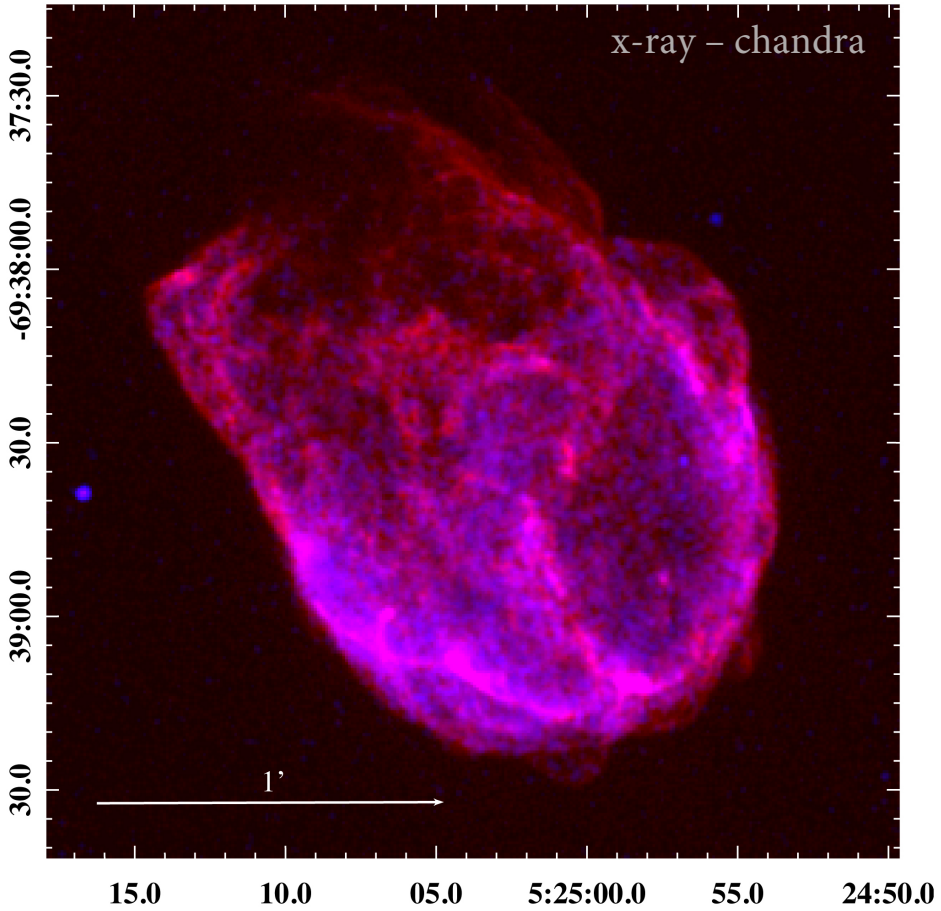
- brightest x-ray snr in the lmc – irregular shell of radius 50" (mathewson+ 1983, hughes+ 1987)
- morphology also matched by synchrotron radio emission (dickel+ 1995)
- like cas a – prototypical example of oxygen-rich class

  ↳origin: collapse of very massive stars.
- from x-rays: pre-shock densities of 2 – 3 cm^{-3} (south)
- sedov similarity:

  explosion energy E = 2.3 – 11.4 x 10^{51} ergs

  age t = 4300 – 7200 yr
- detected at TeV ɣ–ray energies with hess

n132d



	luminosities (erg/s)		
	radio 1 GHz	**x-ray** 0.1-10 keV	**γ–ray** 0.1-100 GeV
n132d	1.3 x 10^{33}	**9.9 x 10^{37}**	**?**
w49b	4.4 x 10^{32}	4.5 x 10^{37}	**2 x 10^{36}**
cas a	**3.6 x 10^{33}**	2.6 x 10^{37}	8 x 10^{34}
w51c	5.5 x 10^{32}	~9 x 10^{36}	8 x 10^{35}
w44	1.9 x 10^{32}	~2 x 10^{36}	5 x 10^{35}
ic443	6.1 x 10^{31}	~1 x 10^{36}	1 x 10^{35}

n132d

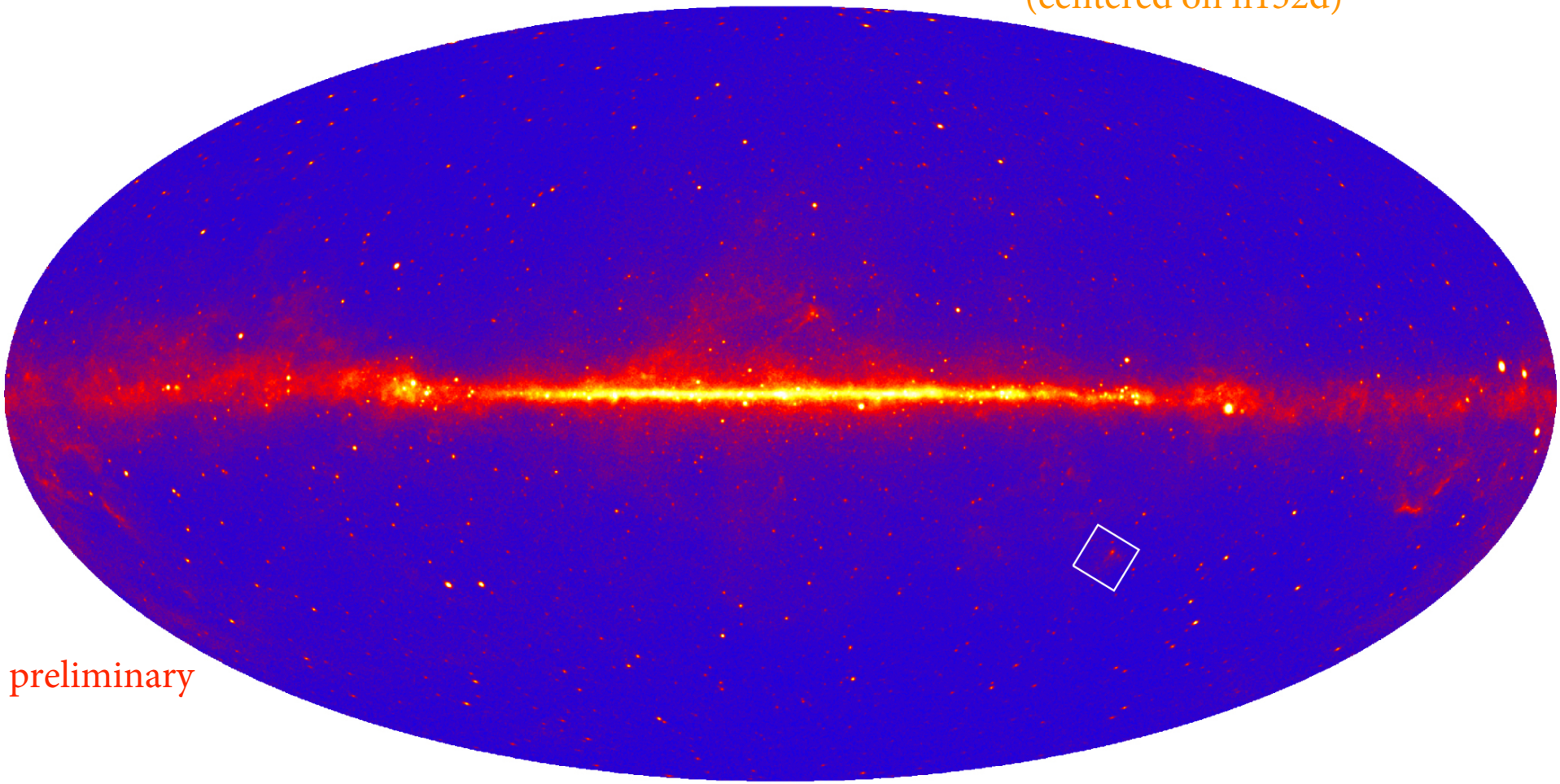
fermi-lat 10-year all-sky pass 8 intensity map

>1 GeV

10 years of data

region = 10^{o} x 10^{o} of lmc

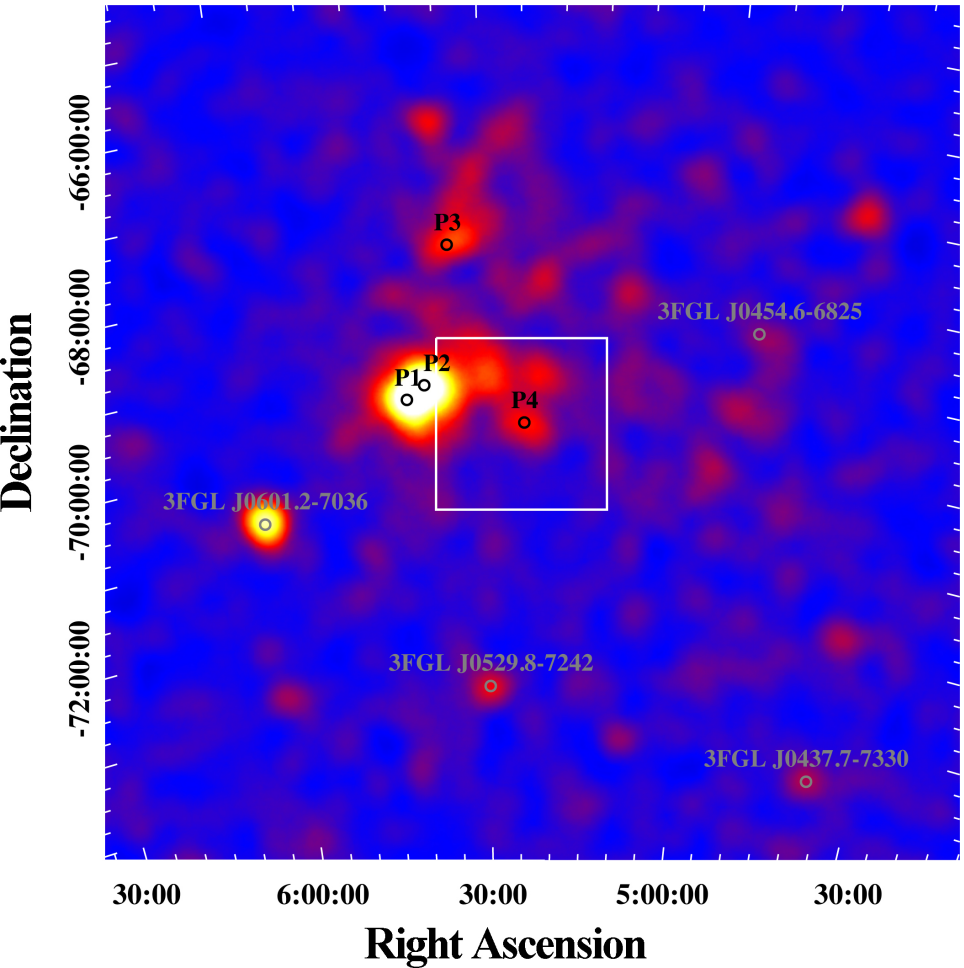
(centered on n132d)



preliminary

n132d

preliminary



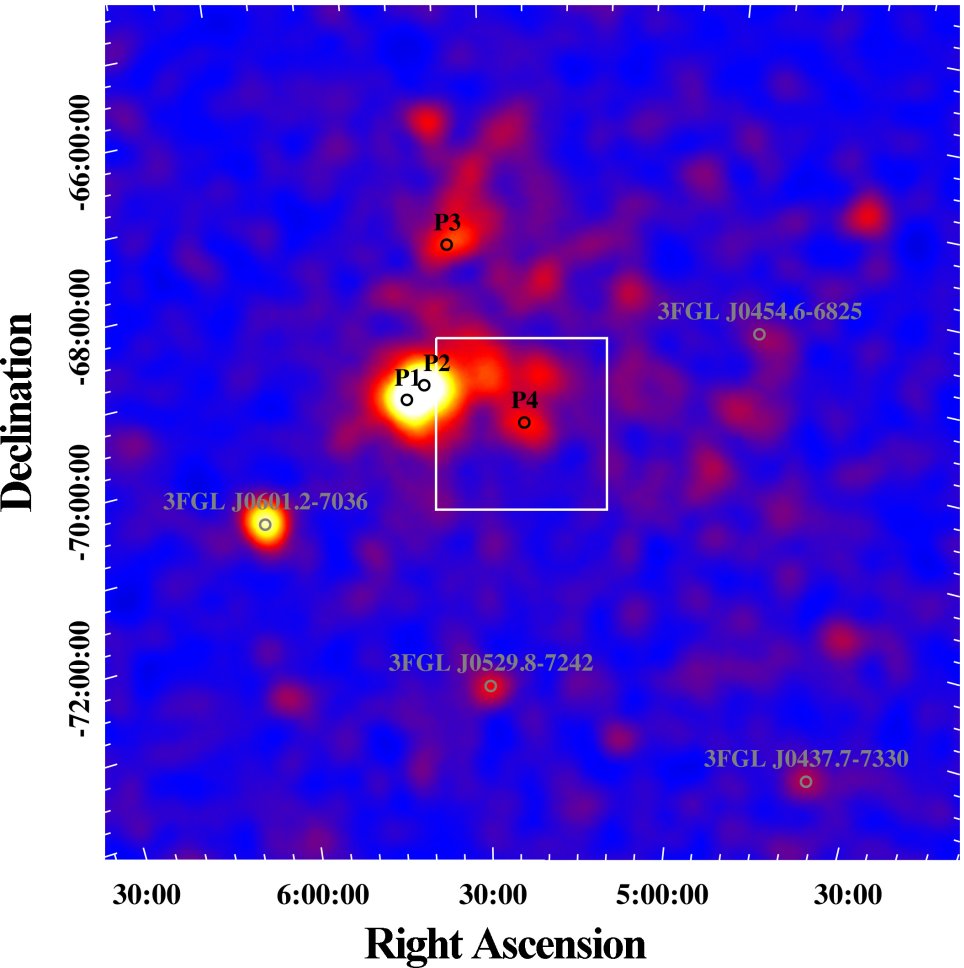
fermi-lat γ–ray count map of lmc

2 – 200 GeV
9.5 years of data
10^o x 10^o of lmc
(centered on n132d)
smoothed to $\boldsymbol{\sigma} = 0.3^o$

pass8 data
front only

n132d

preliminary



fermi-lat ɣ–ray count map of lmc

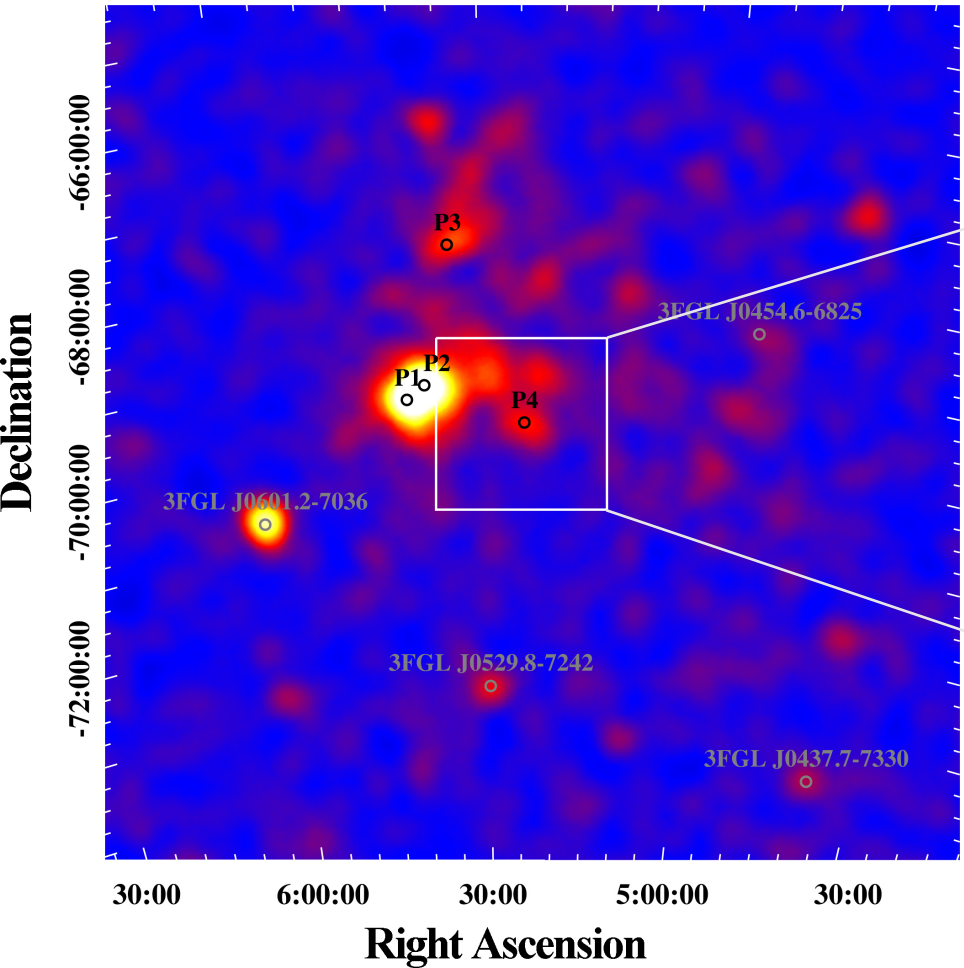
combination of diffuse emission and point sources.

p1 – p4 detected in ackermann+16

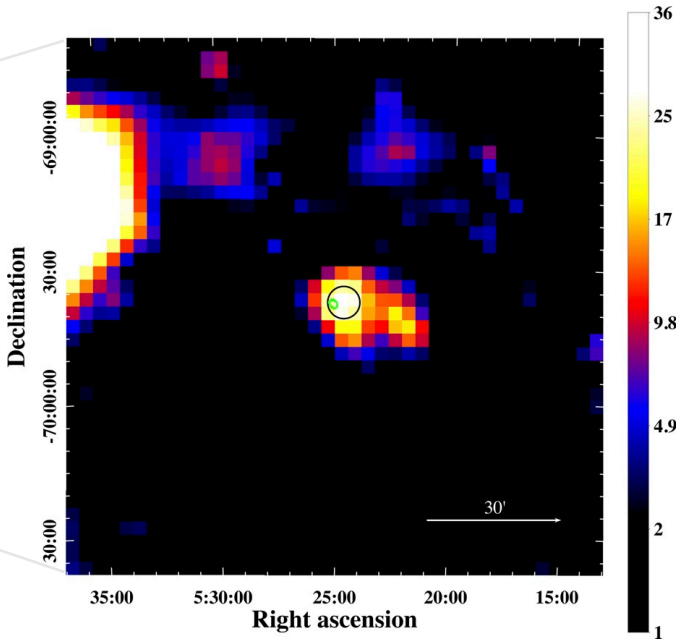
p1 – psr b0540-69
p2 – pwn n157b
p3 – cxou j053600.0-67350 (ɣ–ray binary)
p4 – n132d

n132d

preliminary – count map



preliminary – test statistic map

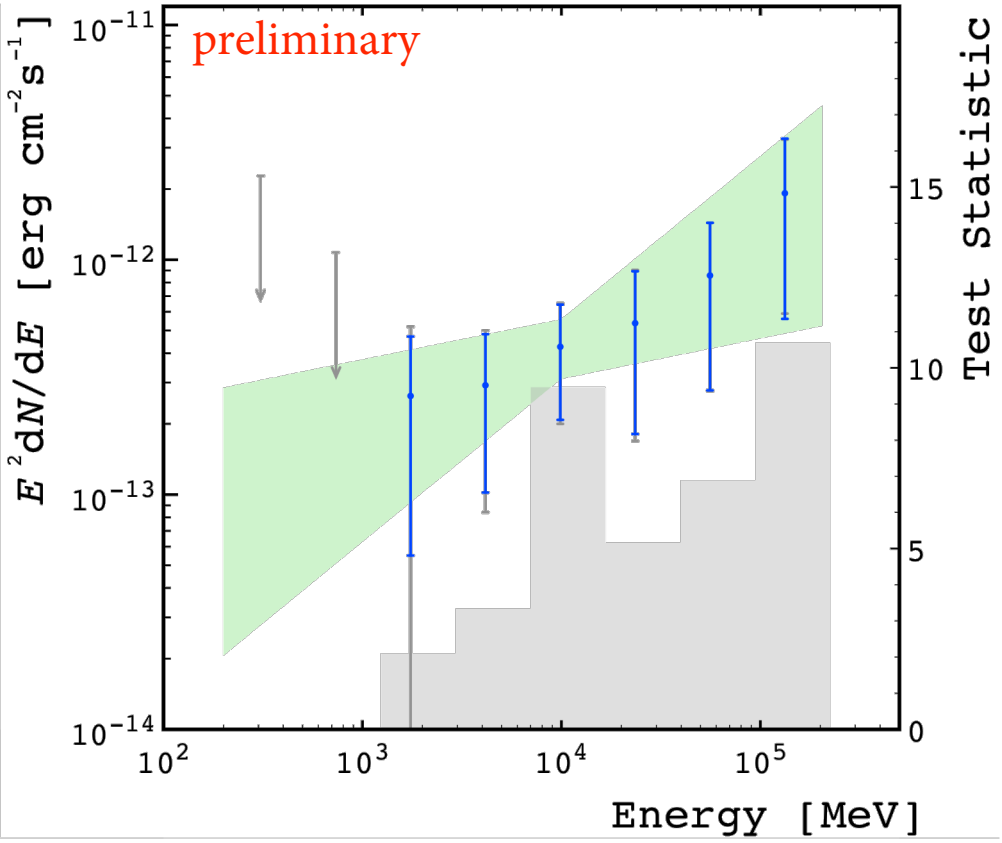


ts peaks at 26 (roughly 5σ)

x-ray extent in green (chandra)

TeV extent in black (hess)

n132d

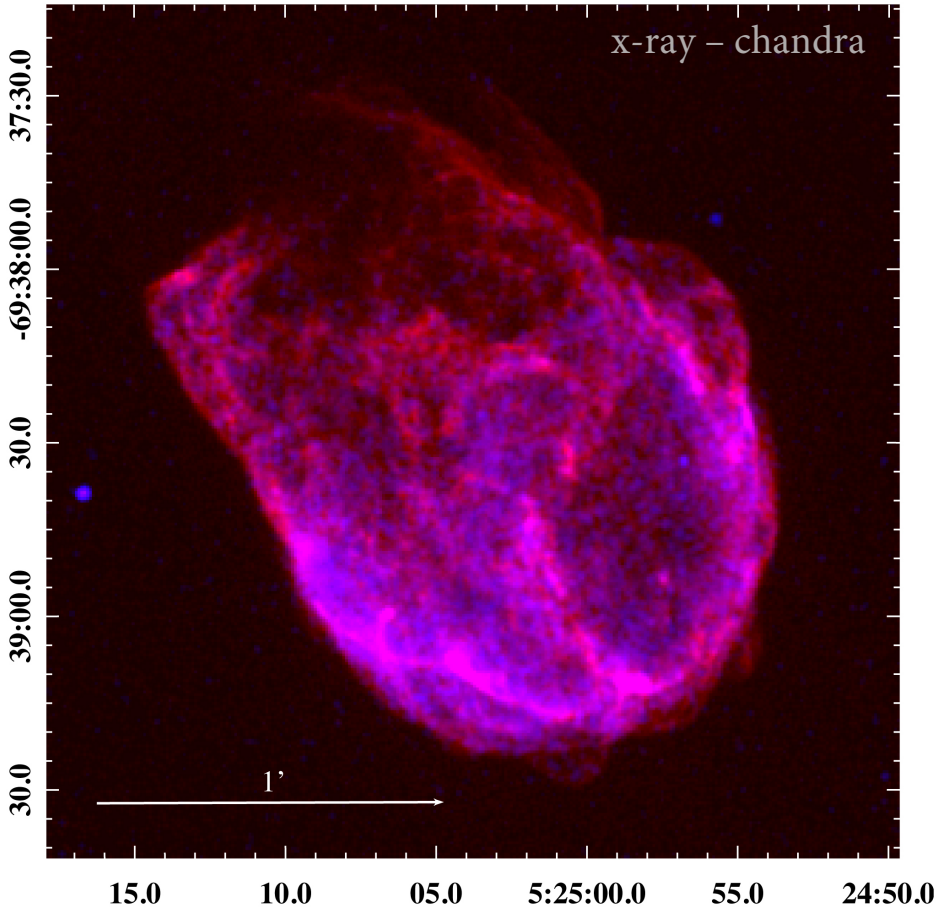


fermi-lat γ–ray spectrum of lmc n132d

- 9.5 years of data
- lmc background from emissivity model in ackermann+16
- pass8 data
- front+back events
- best fit model powerlaw:

$\Gamma = 1.6 \pm 0.3$

n132d



preliminary

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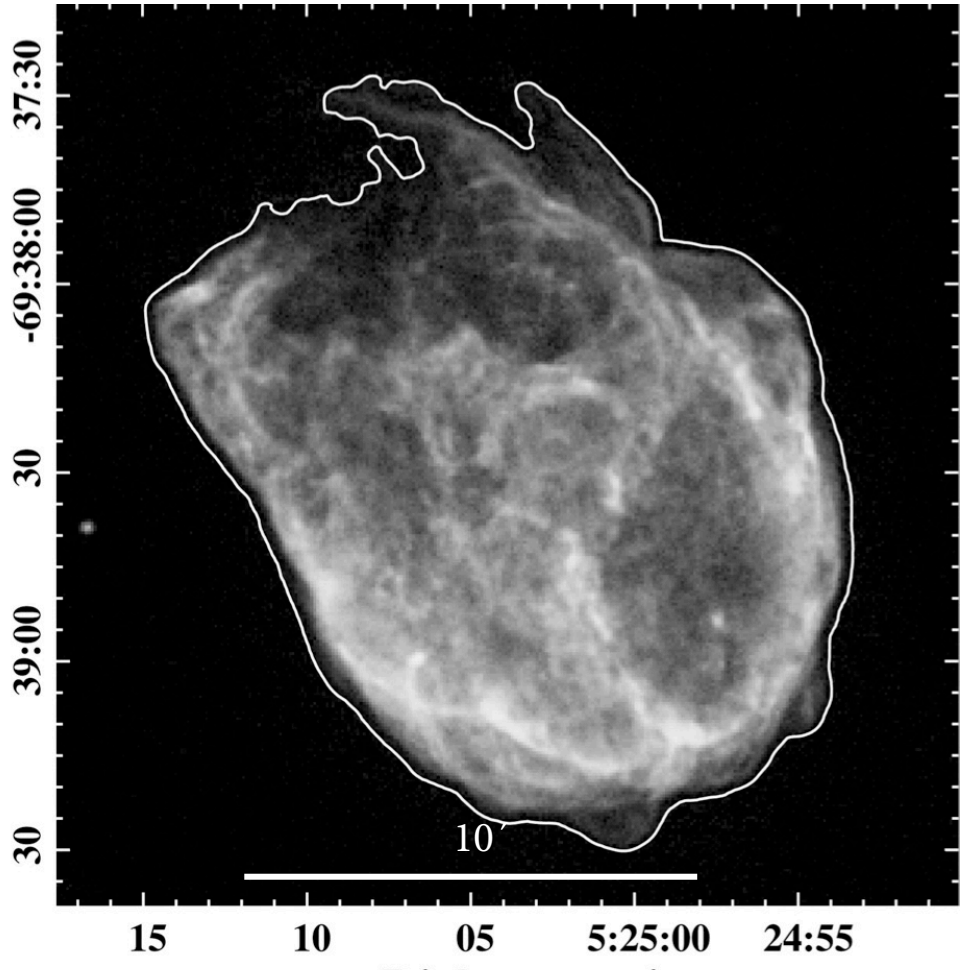
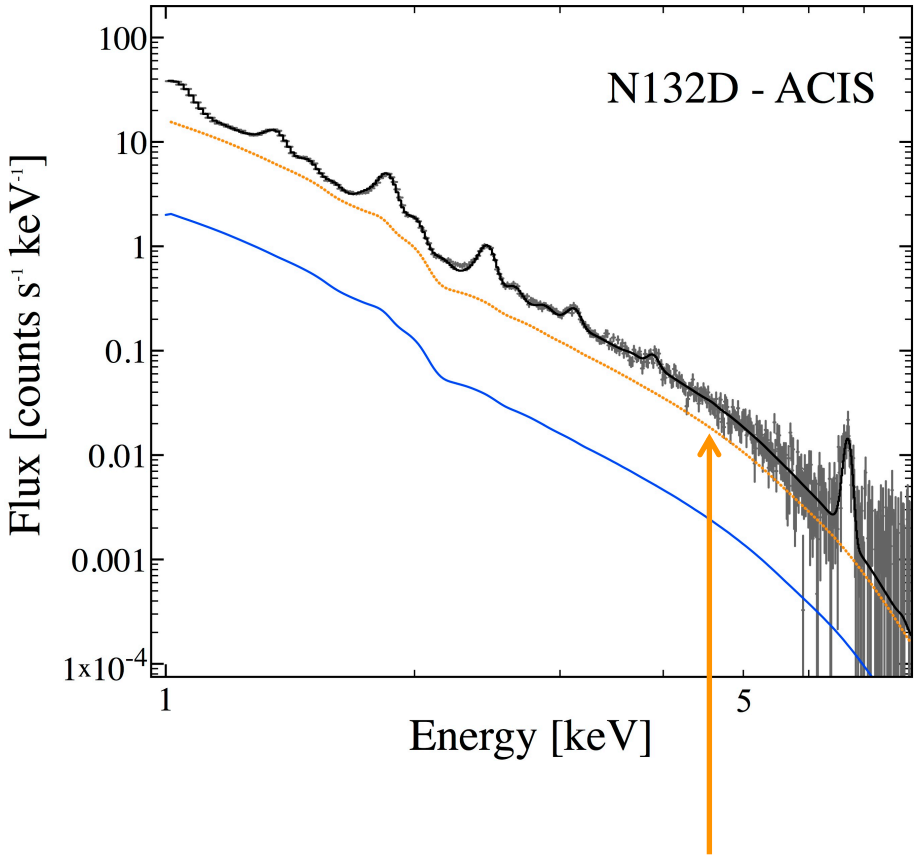
n132d

x-ray – chandra

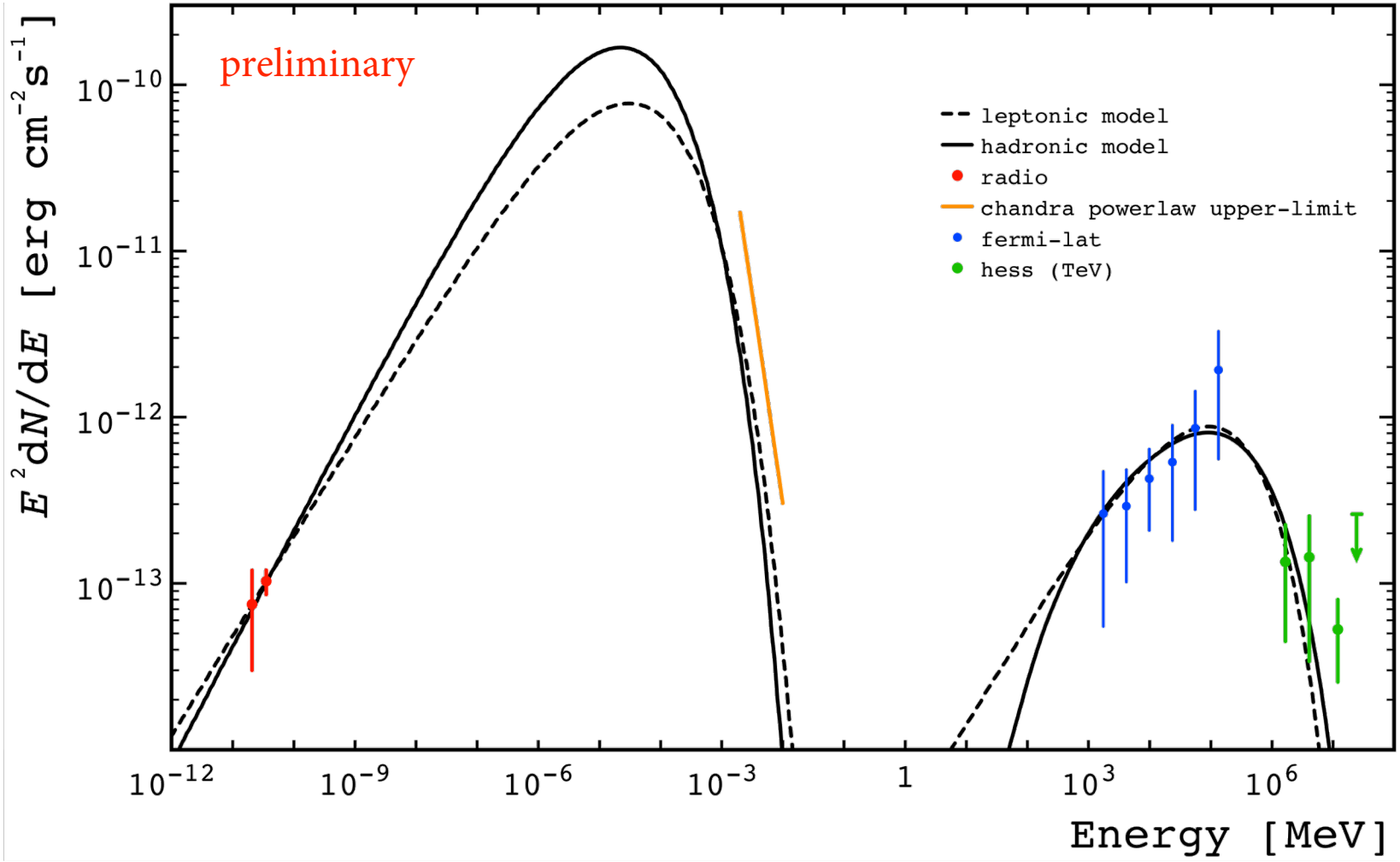




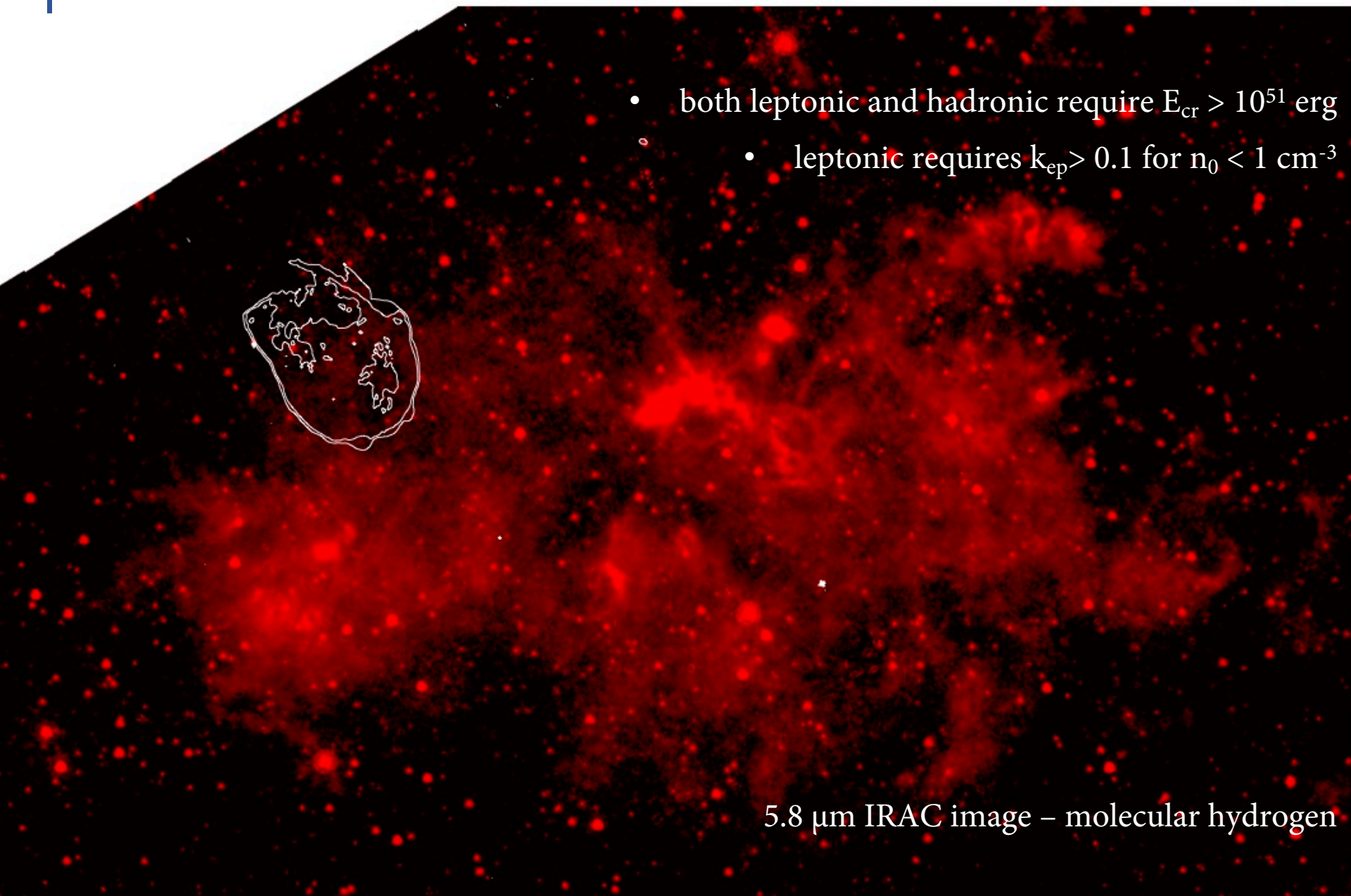
max possible powerlaw component

n132d

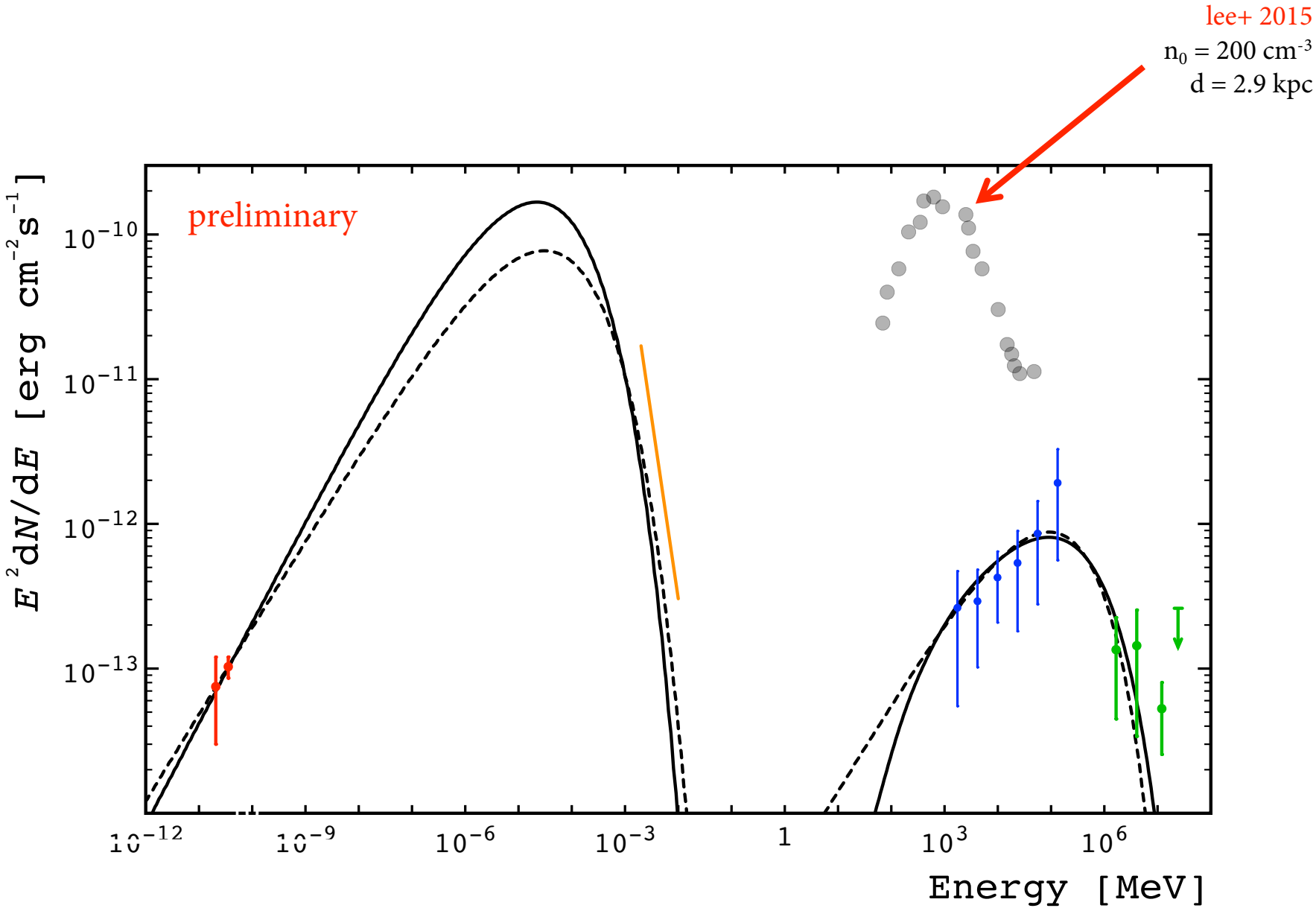
- both leptonic and hadronic require $E_{cr} > 10^{51}$ erg
  - leptonic requires $k_{ep} > 0.1$ for $n_0 < 1$ cm^{-3}



n132d

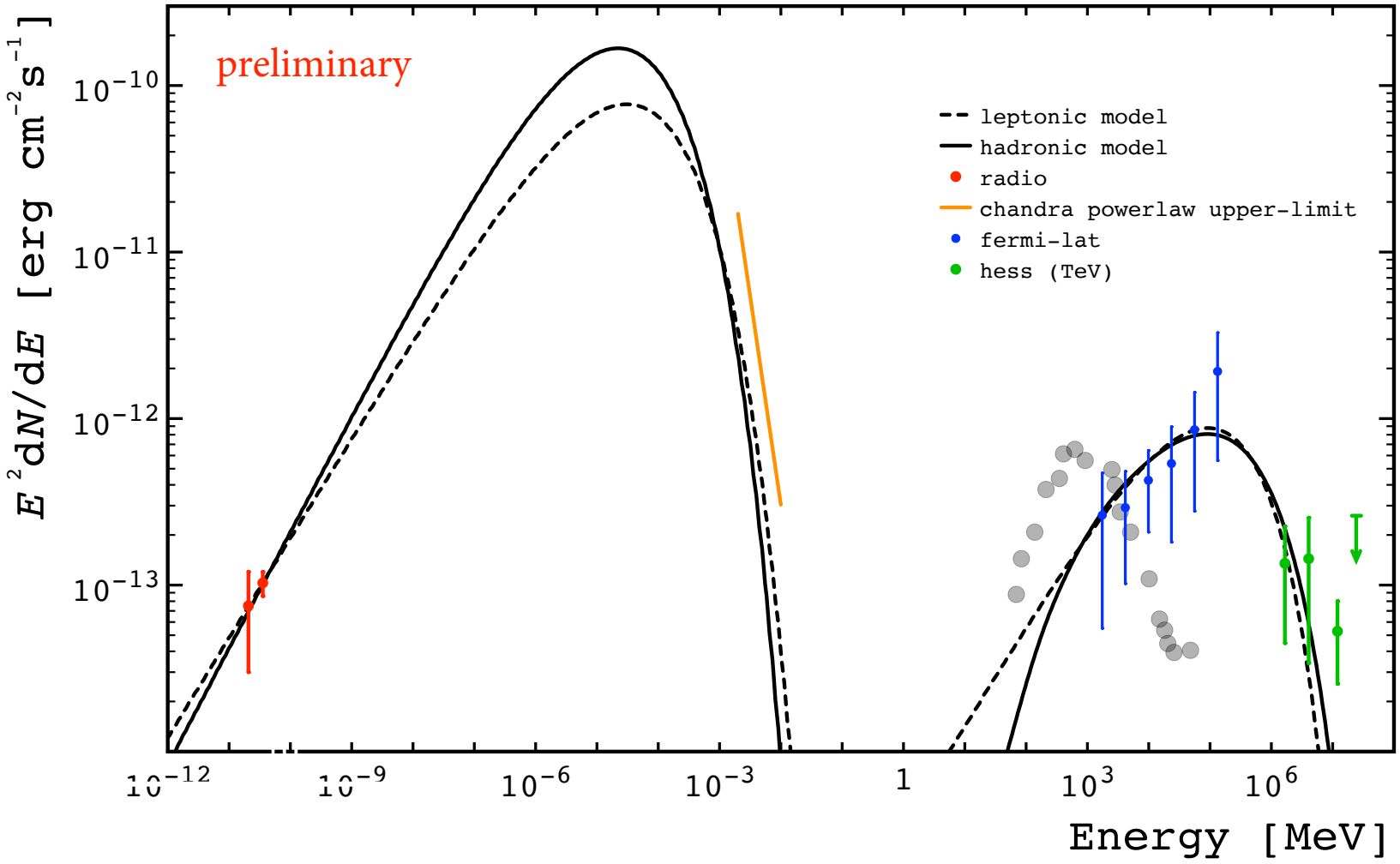

• both leptonic and hadronic require $E_{cr} > 10^{51}$ erg
• leptonic requires $k_{ep} > 0.1$ for $n_0 < 1$ cm^{-3}
5.8 μm IRAC image – molecular hydrogen

n132d


lee+ 2015
n_0 = 200 cm^{-3}
d = 2.9 kpc
preliminary
$E^2 dN/dE$ [erg cm^{-2}s^{-1}]
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-12}
10^{-9}
10^{-6}
10^{-3}
1
10^{3}
10^{6}
Energy [MeV]

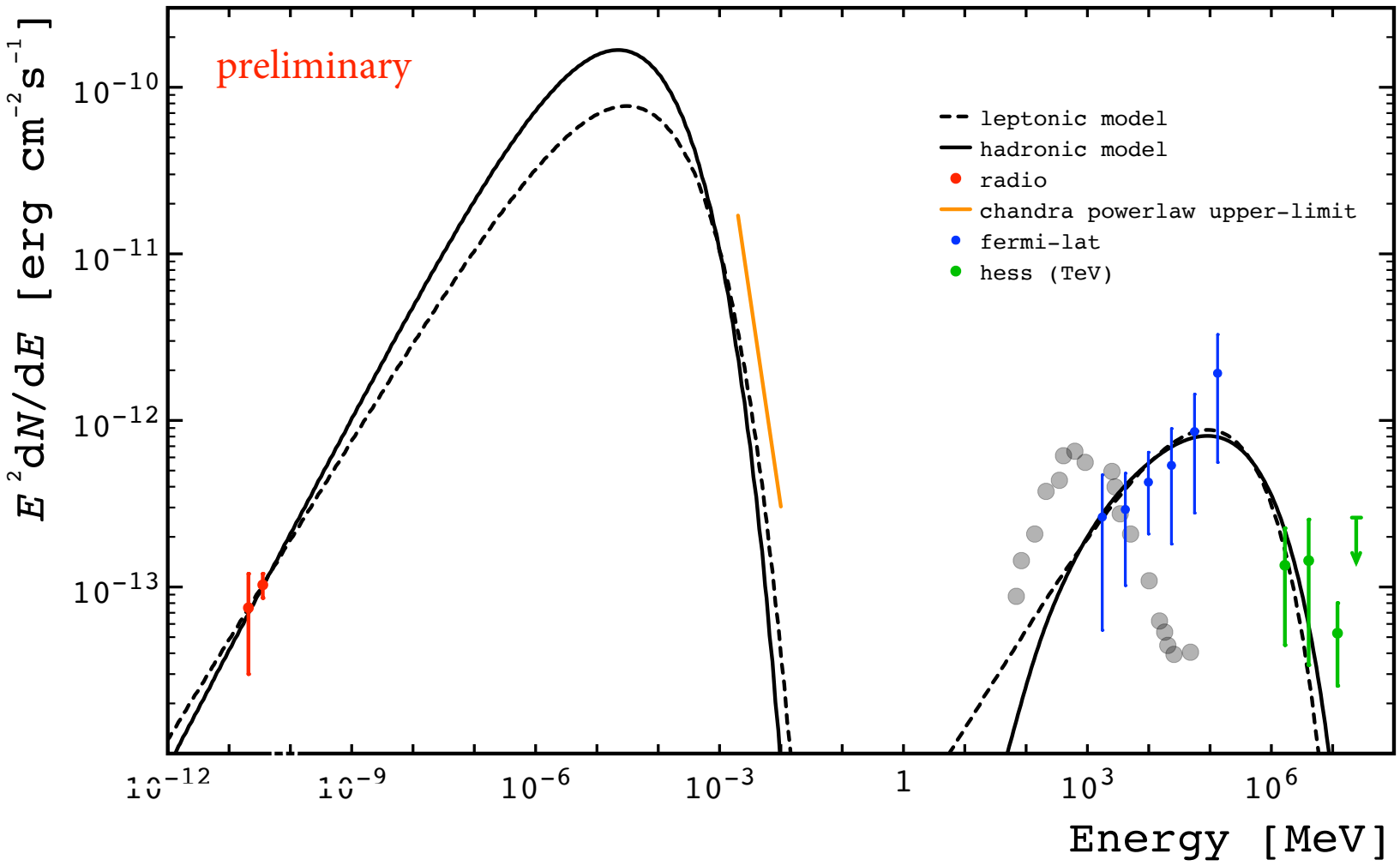
n132d

$n_0 = 200\ cm^{-3}$
d = 50 kpc



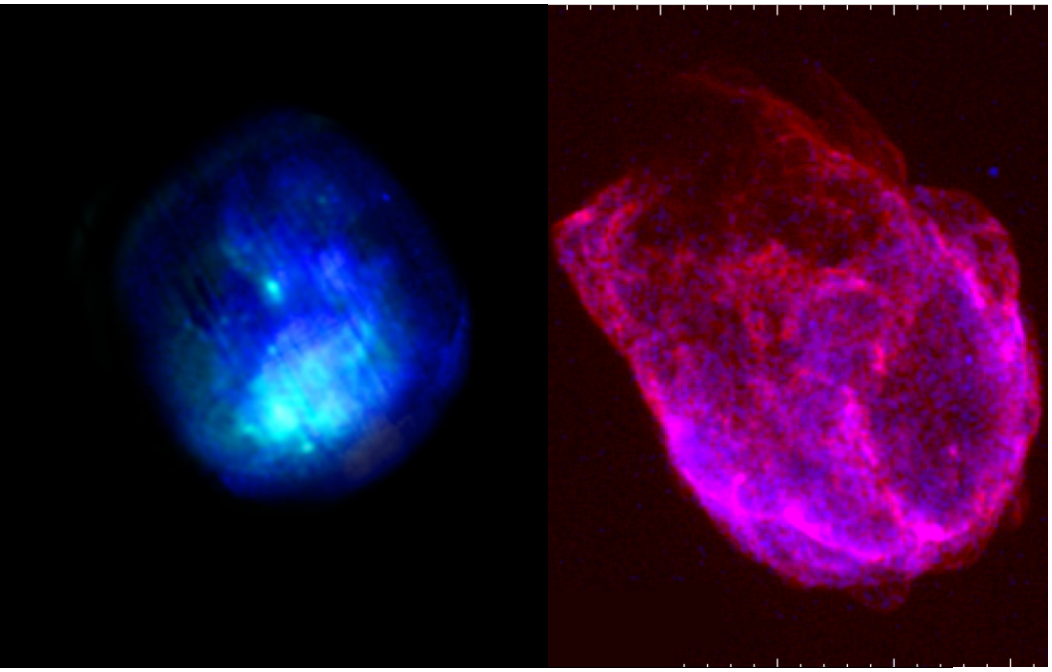
n132d

not re-acceleration?



n132d

w44 n132d



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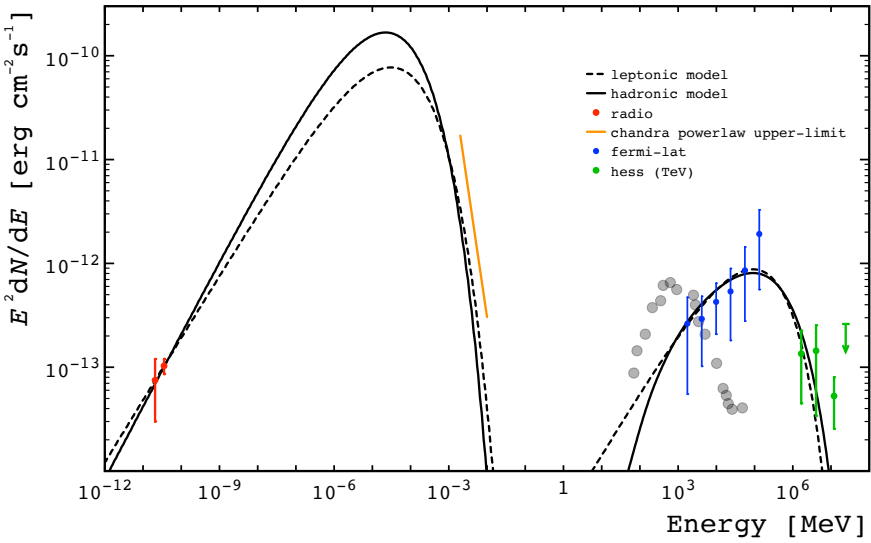

fin

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don ellison – ncsu
herman lee – kyoto
katie auchettl – osu
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tea temim – stsci

Additional thanks to
stefan funk + yasu uchiyama + tim joubert + ashley carlton + kris eriksen + brian williams + bryan gaensler + john raymond + dave green + steven ng + bettina posselt + tali figueroa-feliciano+ enrico ramirez-ruiz