Fermi-LAT Observation of Extended Gamma-ray Emission from the G25.0+0.0 Region

γ-rays from a massive star forming region?

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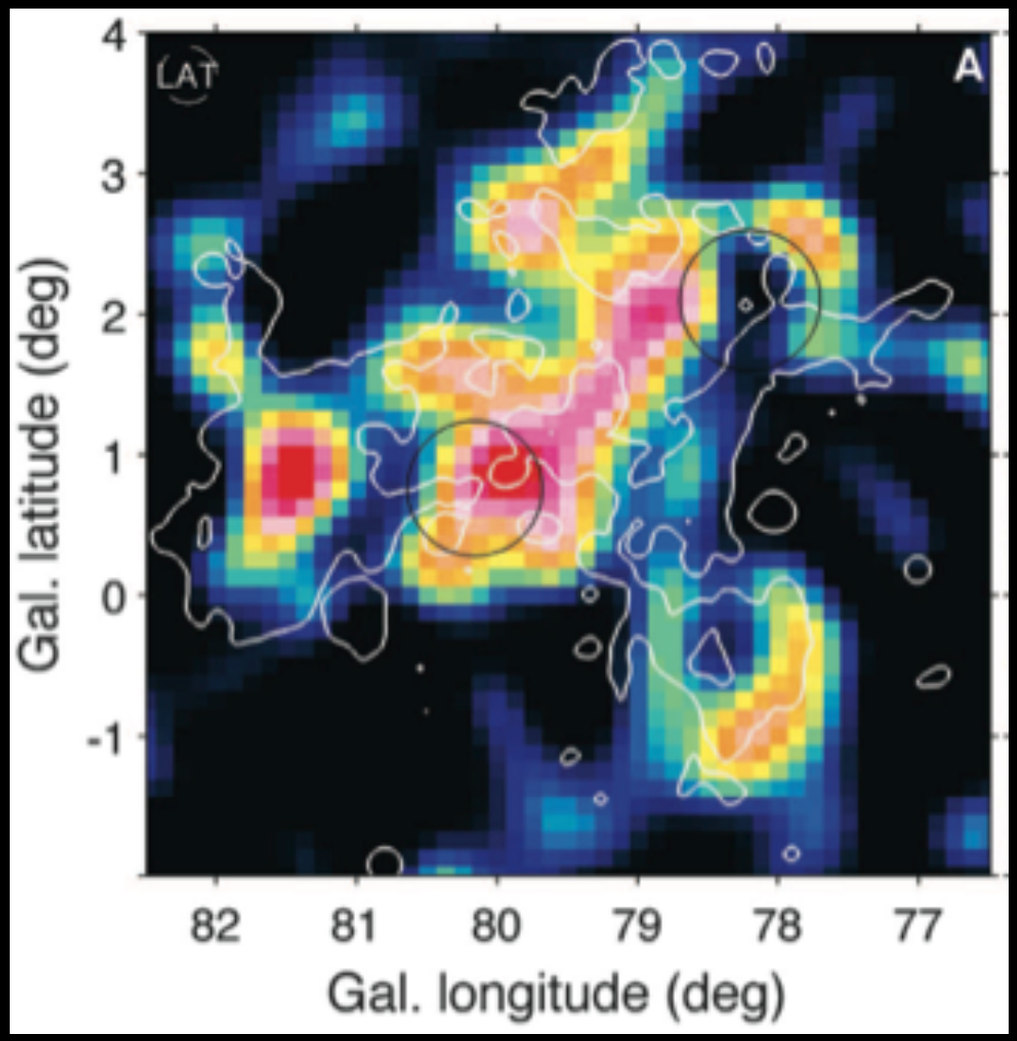
Gamma rays from SFR

Star forming region (SFR)

OB association
+
[Photons, stellar winds] x [gas]

Massive SFR

→ Particle acceleration?



Ackermann+ 2011

SFR Cygnus X

Fermi LAT & TeV telescopes

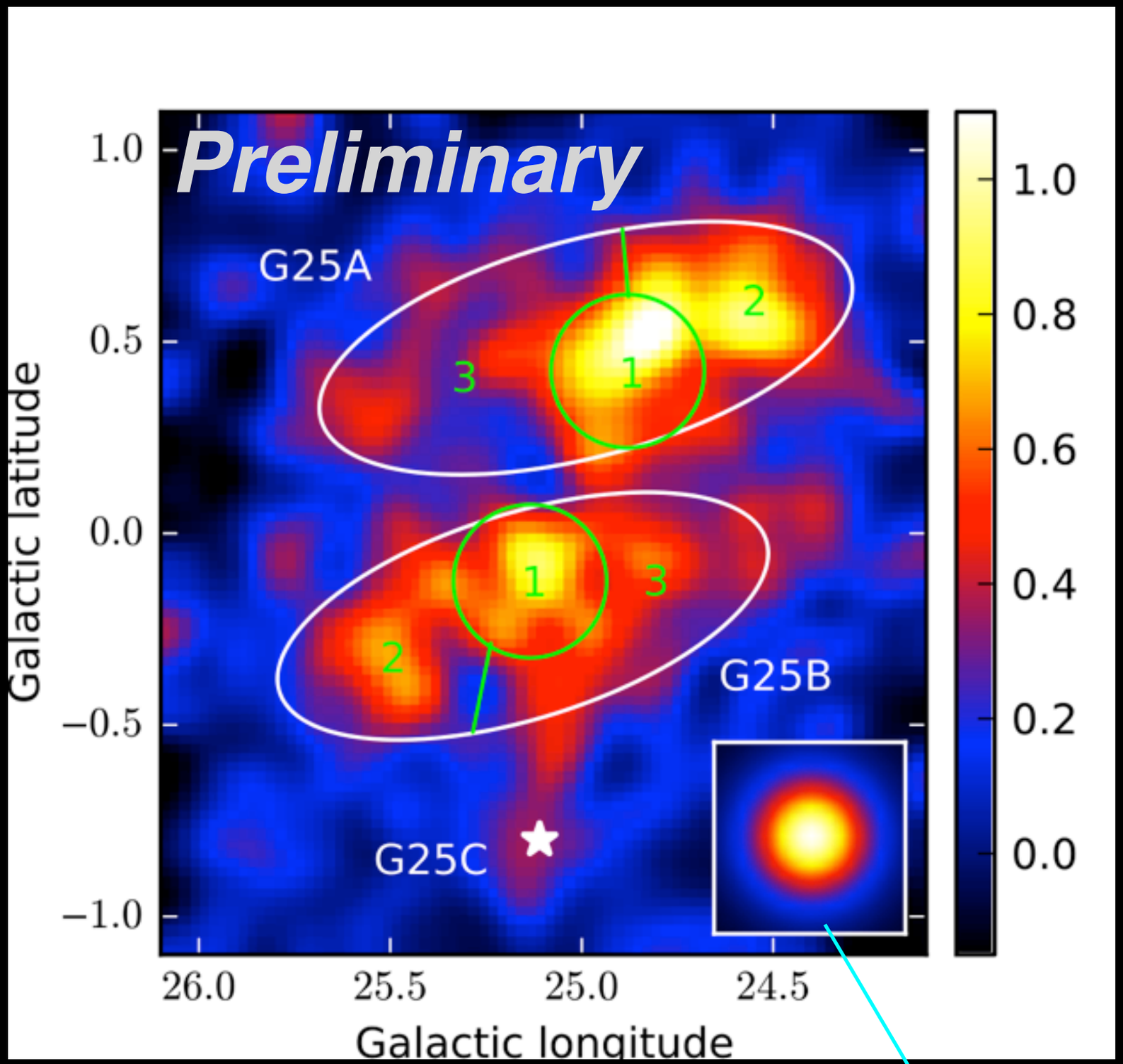
Extended γ-ray emission from SFR Cygnus X

The cavity probably created by Cygnus OB2

The only case of a firm detection

→ More examples are needed!

G25 region



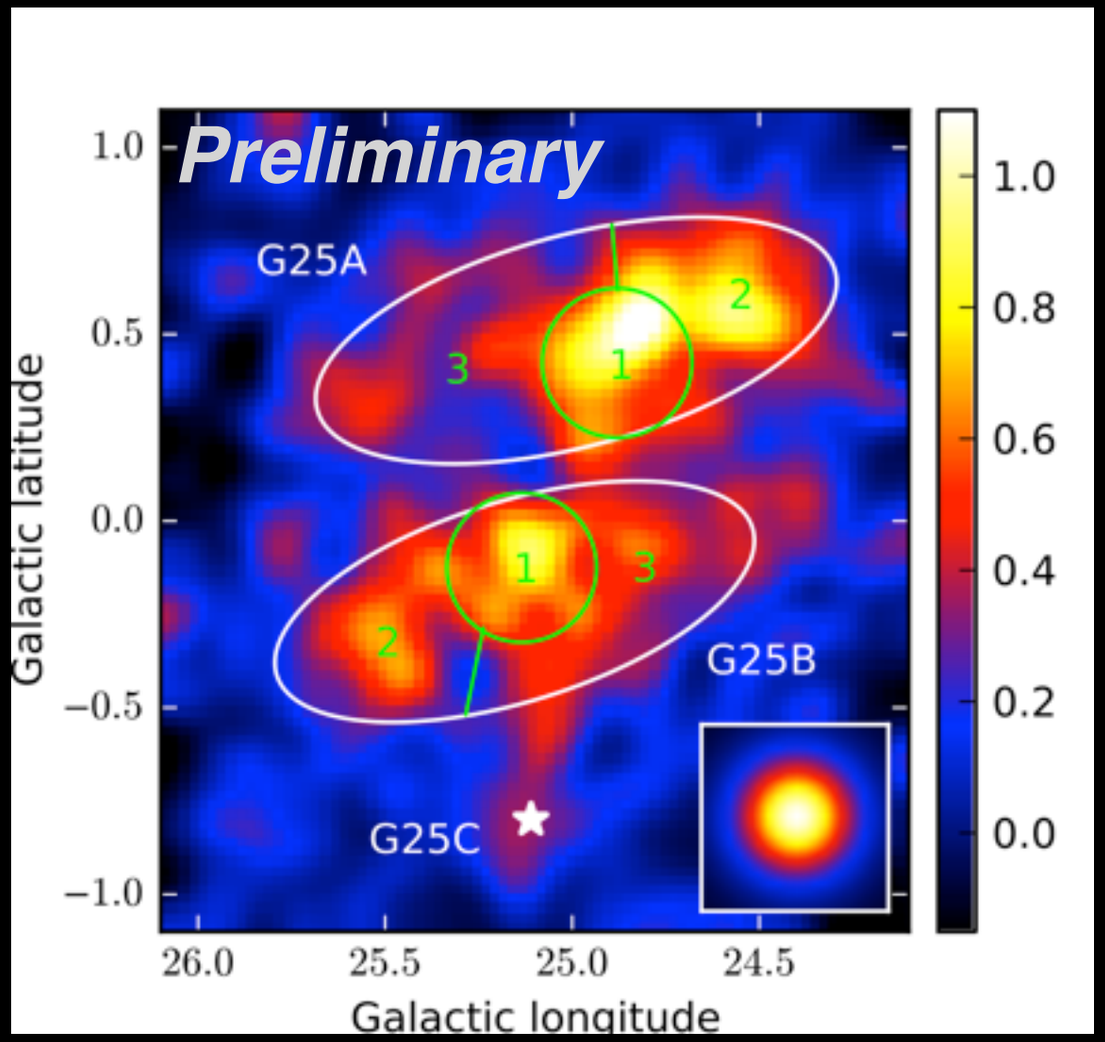
LAT residual map
>3 GeV

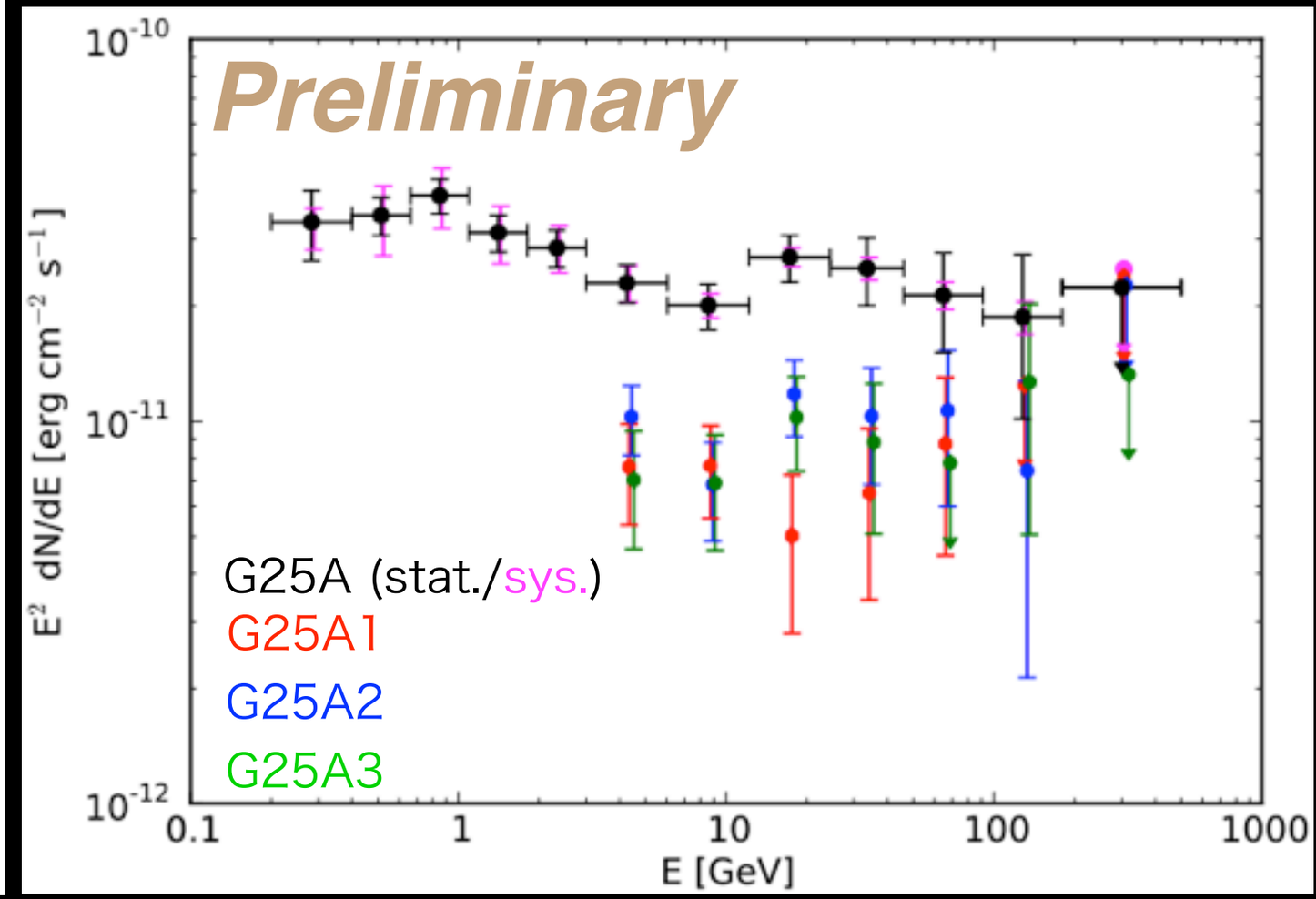
Pass7 Rep. data
~ 5 yr

- Extended (~1.5°)
- 2 elliptical disks
(+ 1 point source)

A simulated point source

SEDs of G25A



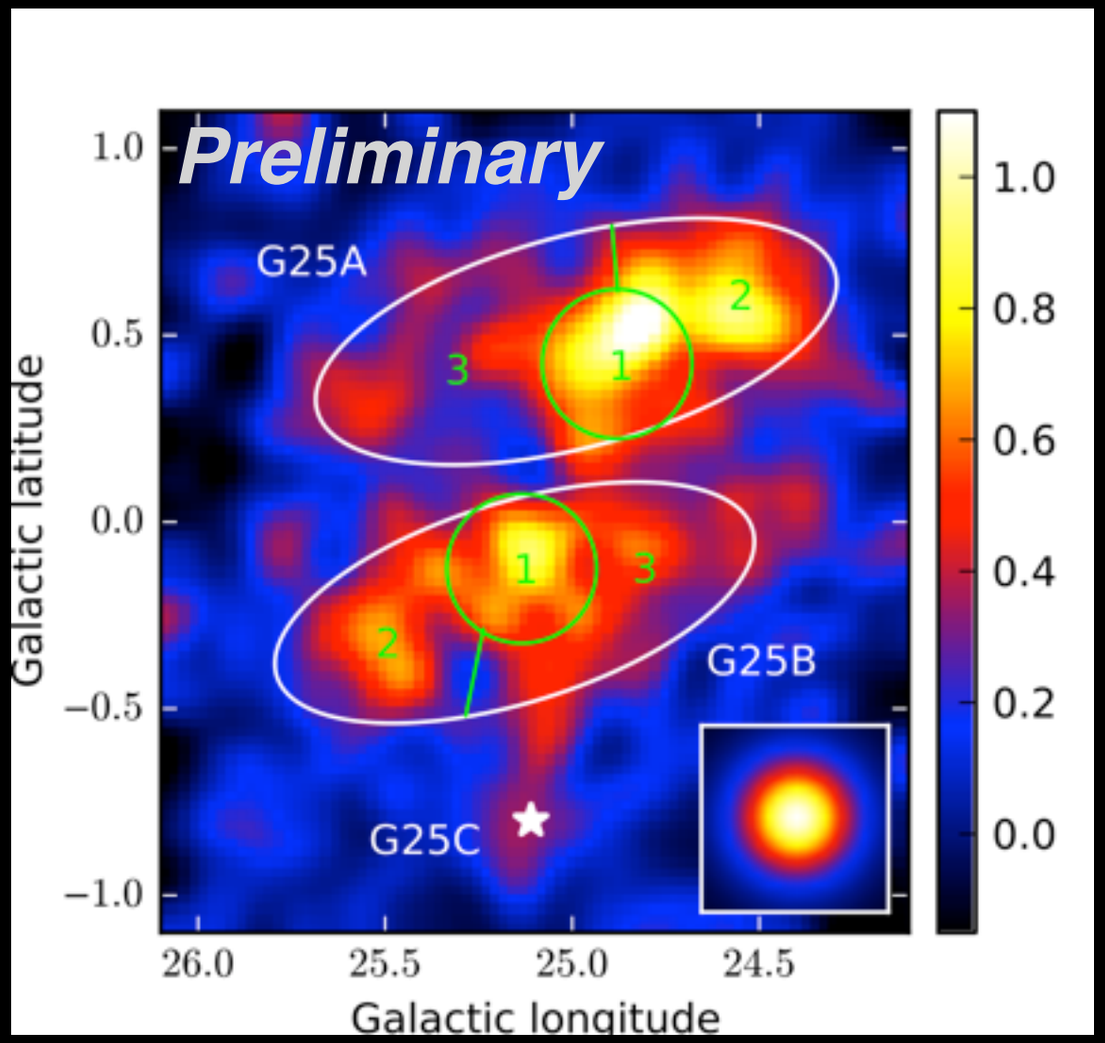


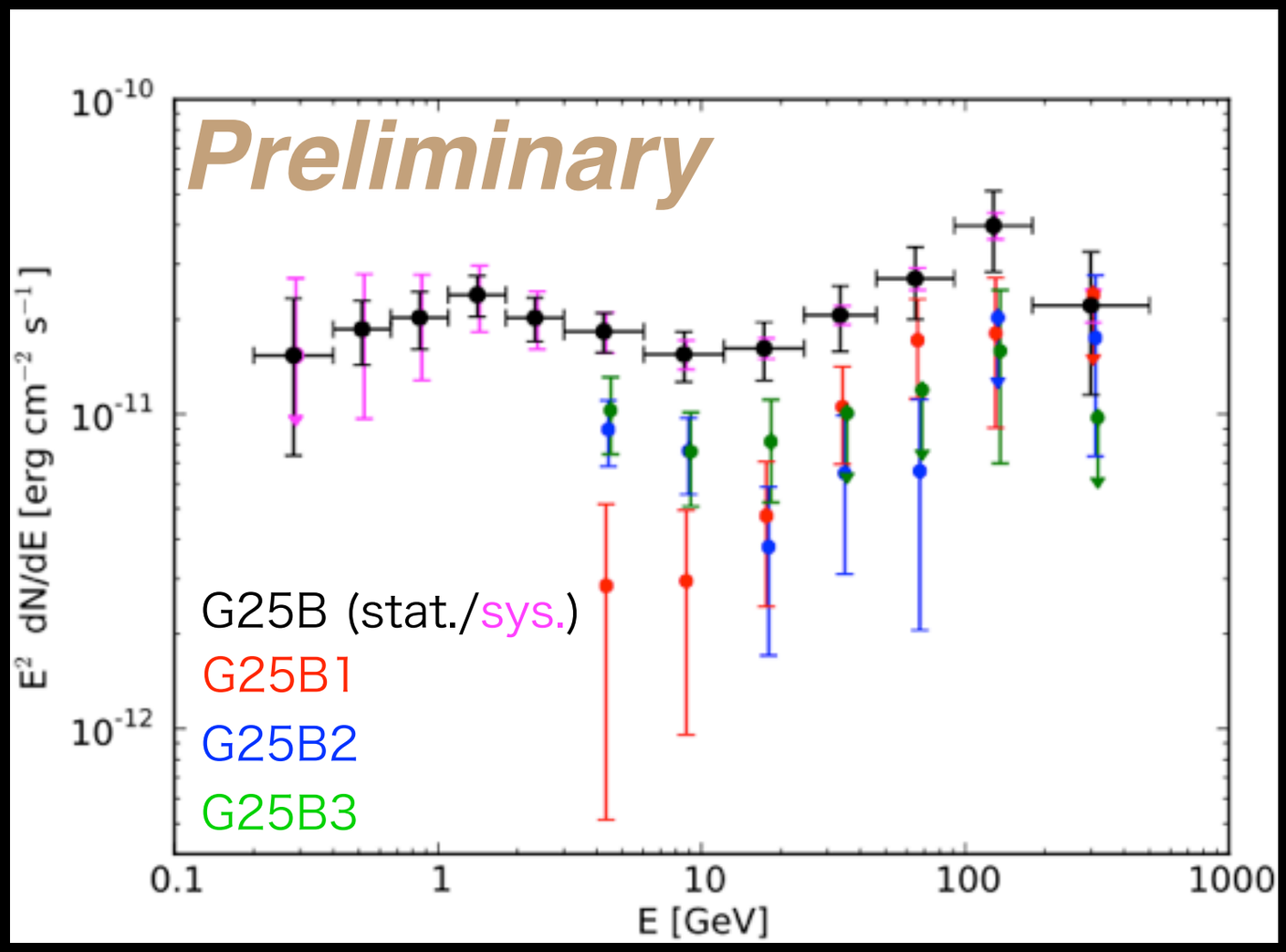
Name	Flux (10^{-9} ph cm^{-2} s^{-1})	Photon Index
G25A1	1.5 ± 0.3	2.08 ± 0.16
G25A2	2.0 ± 0.3	2.03 ± 0.12
G25A3	1.6 ± 0.3	2.12 ± 0.17

Preliminary

>3 GeV data

SEDs of G25B





Name	Flux (10^{-9} ph cm^{-2} s^{-1})	Photon Index
G25B1	1.0 ± 0.2	1.53 ± 0.15
G25B2	1.5 ± 0.3	2.06 ± 0.18
G25B3	1.7 ± 0.3	2.14 ± 0.18

Preliminary

>3 GeV data

Sources associated with G25A

G25A1, A2, A3

- Extended sources
- Similar spectral shapes

→ **The same celestial object**

PWN/SNR/Molecular clouds?

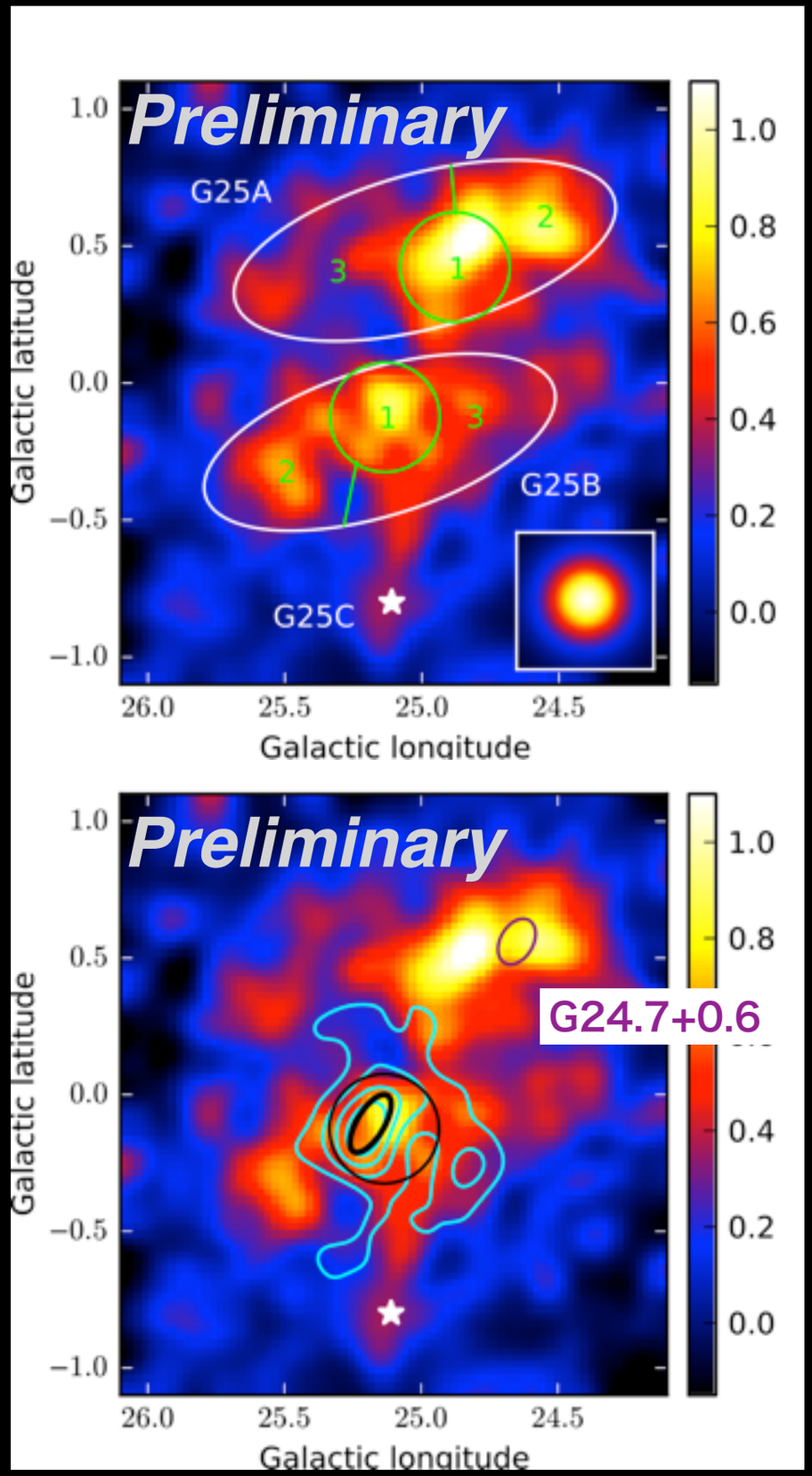
A candidate PWN G24.7+0.6

- No X-ray or TeV detection
- Much smaller than the γ-rays
- Position off the center

→ **Not associated**

No other association

→ **Unidentified source**



Sources associated with G25B

G25B1

HESS J1837-069

- Spatially coincident
- SEDs are smoothly connected

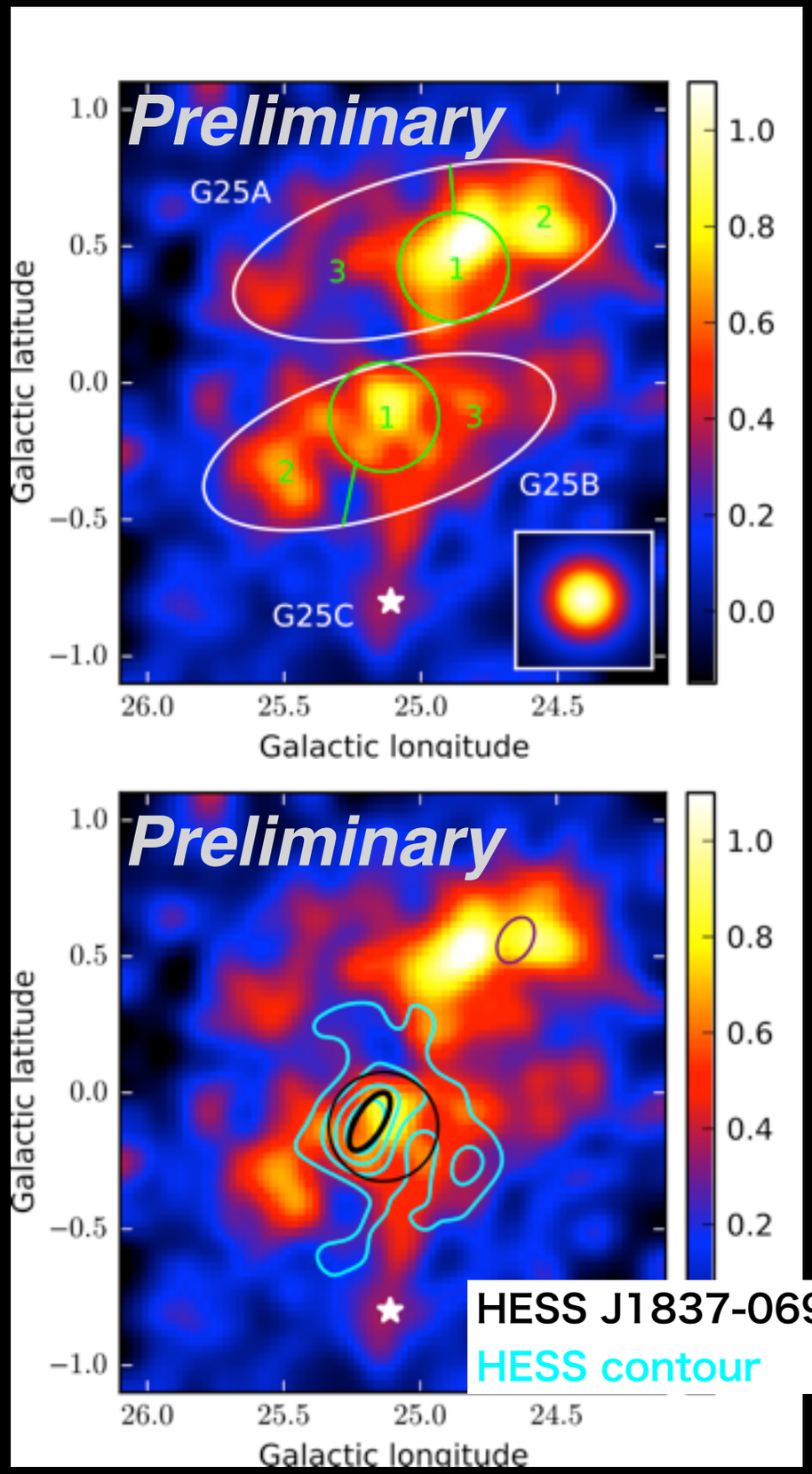
→ **Association**

- The HESS source is a candidate PWN
- Photon index ~ 1.5 at the LAT band

→ **PWN**

G25B2 & B3 (= G25B´)

→ **Unidentified source**



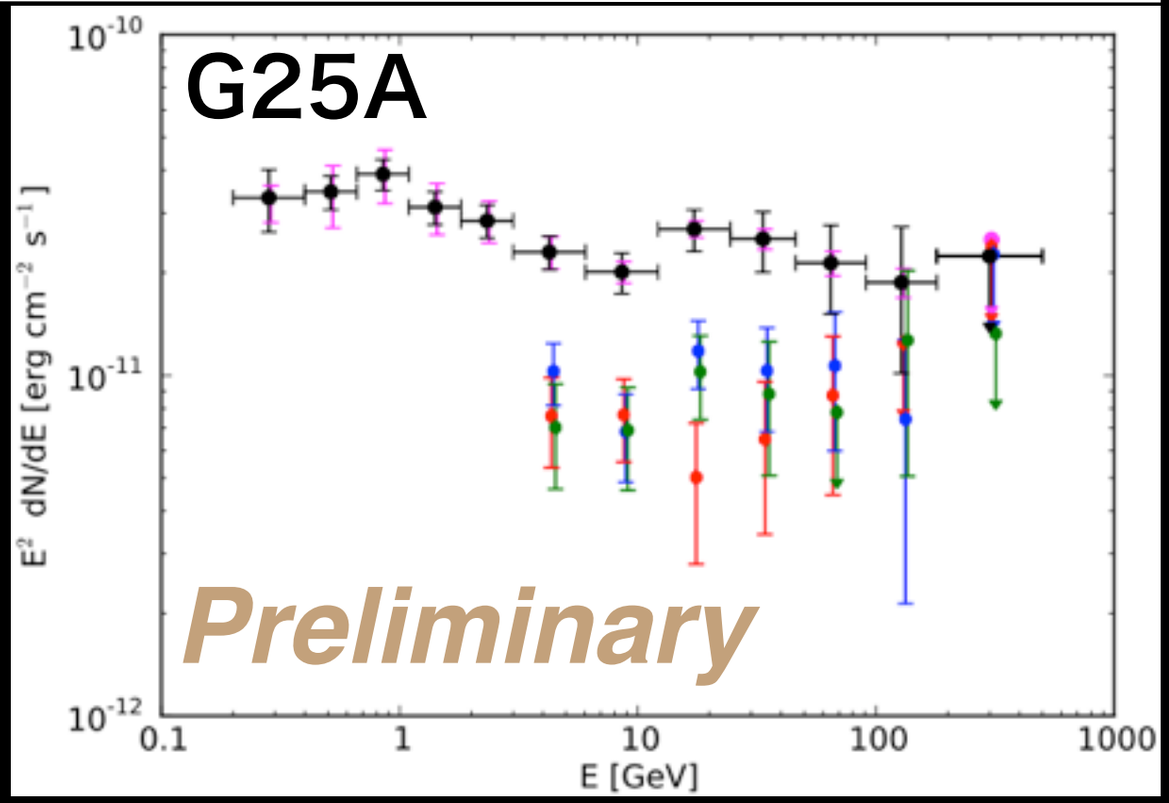
SFR scenario

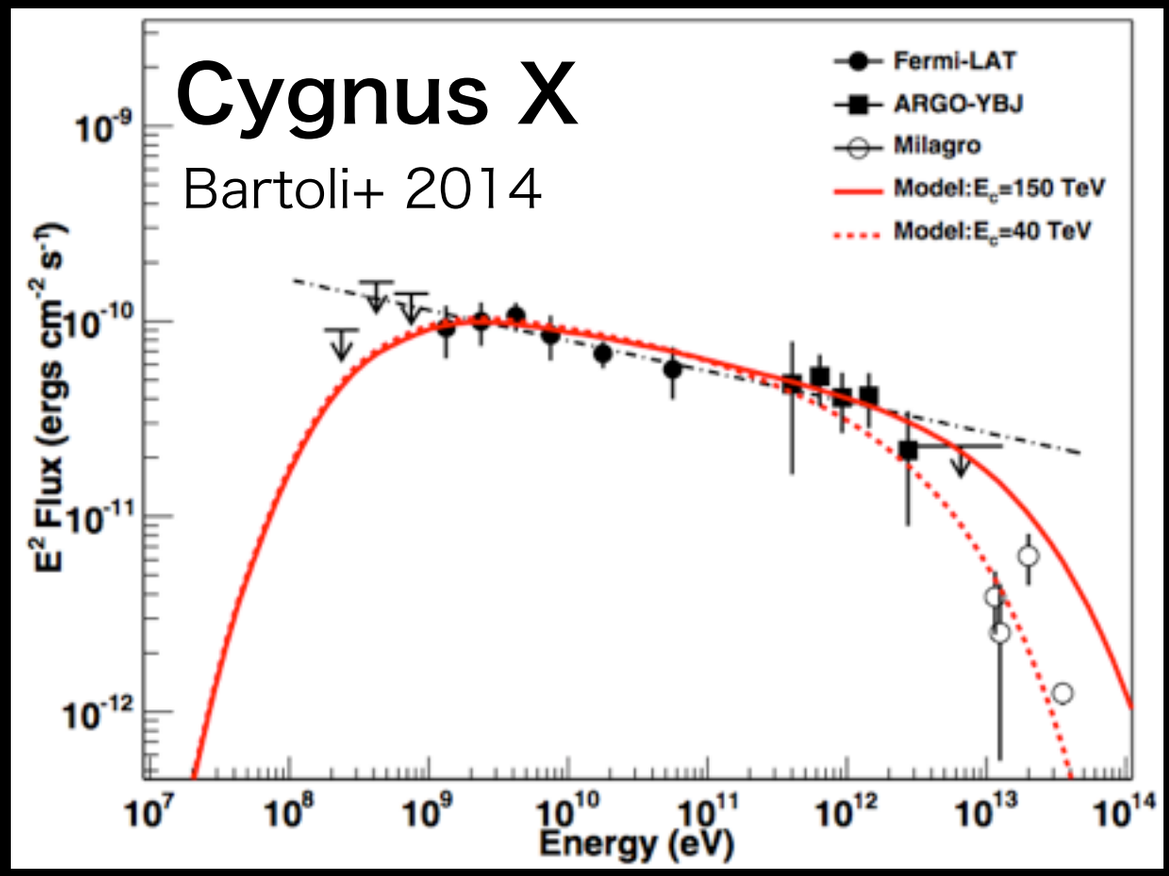
Similarities of γ ray-properties

- Extended
- Hard photon index (2.1-2.2)
- No cutoff or break (up to ~0.5 TeV)
- Spatially-uniform spectral shape

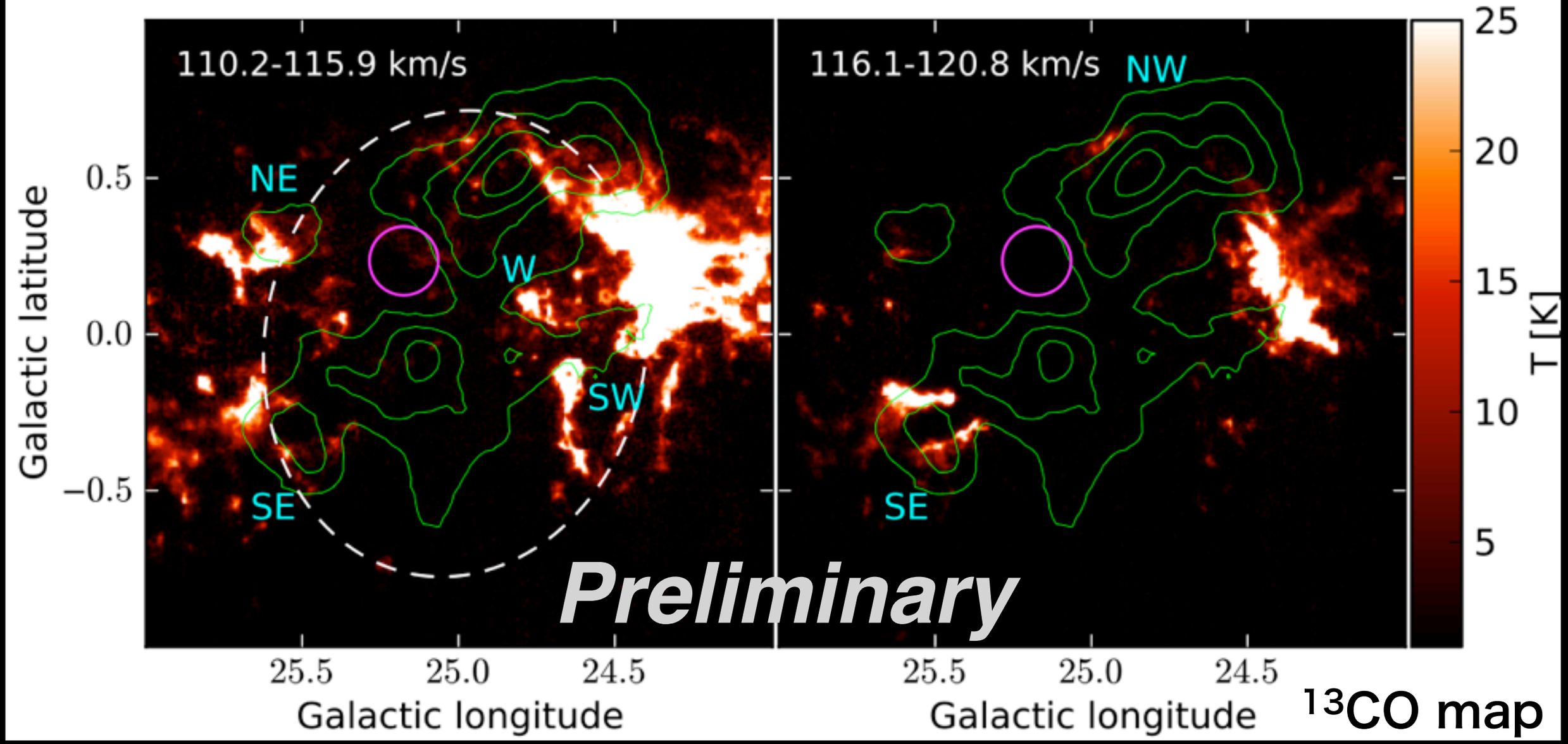
→ **Same kind of source?**

The 2nd case of a detection from SFRs?





SFR scenario



^{13}CO map

- Bubble-like structure (CO & HI maps) at 7.7 kpc
- Candidate OB association
- γ rays appear to be confined within the bubble.

Galactic Ring Survey (Jackson+ 2006)

Modeling for G25A and G25B´

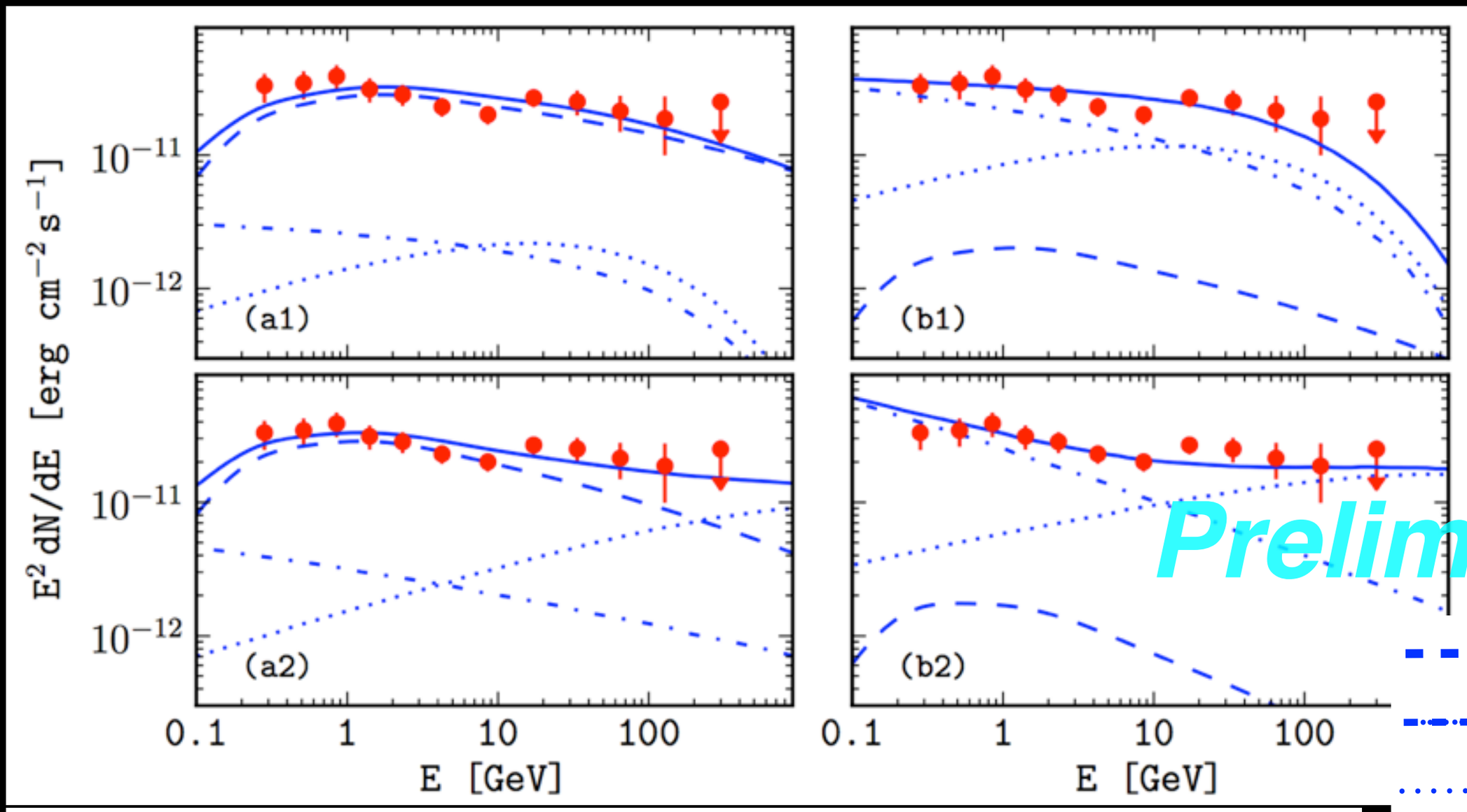
SFR scenario

- Distance: 7.7 kpc
- Target gas density: 20 cm^{-3}
- Target photon field:
  Star light + dust emission + CMB

Particle distribution

- Power law with an exponential cutoff
- Hadronic (K_{ep} = 0.01) and Leptonic (K_{ep} = 1)
- Electrons' P_{cut} = 100 TeV c^{-1} and 1 TeV c^{-1}
- P_{cut} = 1 TeV c^{-1} ~ a break due to the synchrotron loss (B = 10 μG, Time = 0.1 Myr)

Modeling for G25A



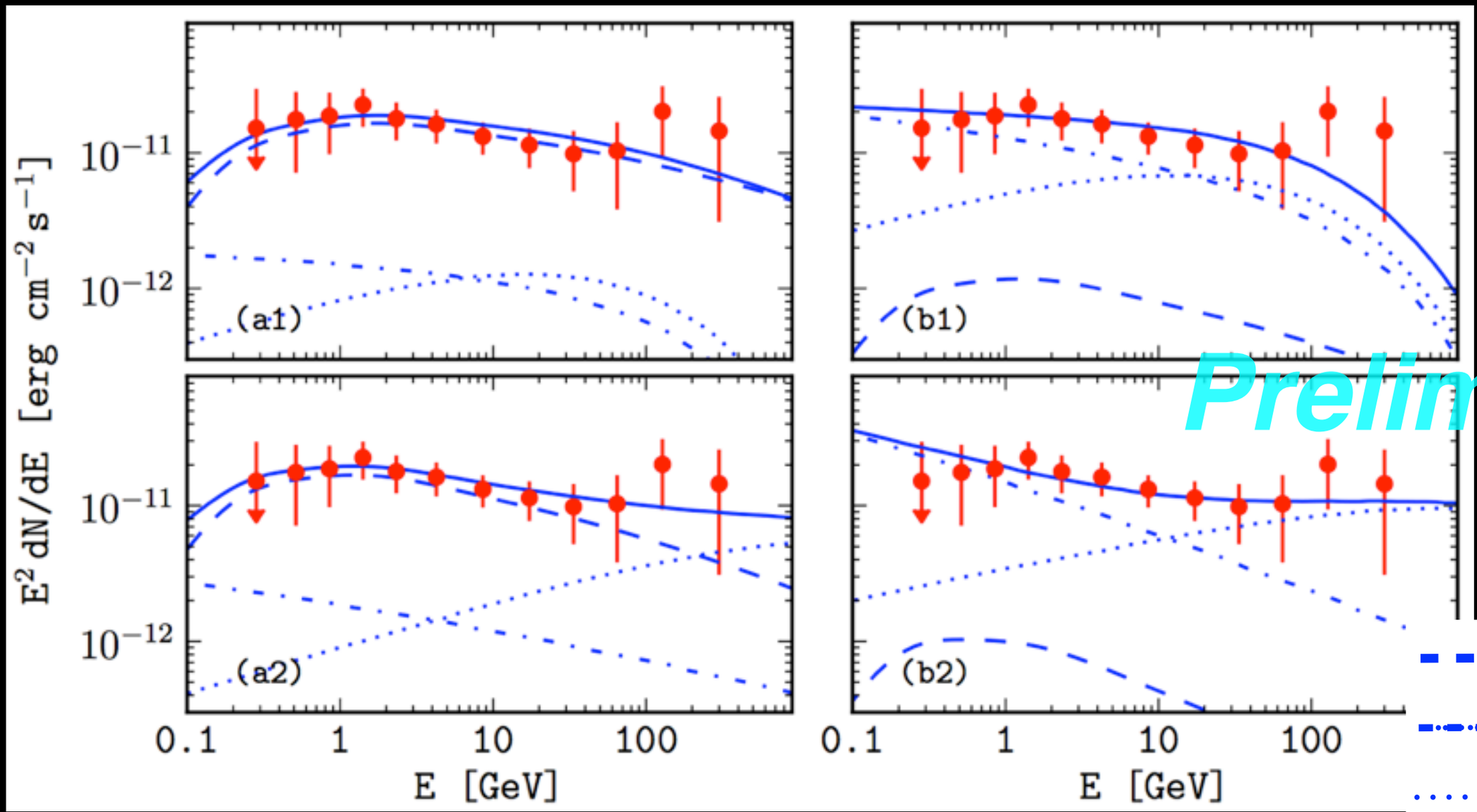
Preliminary

- - - π^0-decay
-·-·- Brems.
····· IC

Model	K_{ep}	s	$p_{\mathrm{cut}(e)}$ (TeV c^{-1})	$p_{\mathrm{cut}(p)}$ (TeV c^{-1})	(a)W_p/(b)W_e (10^{50} erg)	(a)U_p/(b)U_e (eV cm^{-3})
G25A						
(a1)	0.01	2.2	1.0	100	2.7	6.2
(a2)	0.01	2.3	100	100	2.5	5.8
(b1)	1	2.3	1.0	100	0.19	0.44
(b2)	1	2.5	100	100	0.19	0.44

Preliminary

Modeling for G25B´



Preliminary

π^0-decay
Brems.
IC

Model	K_{ep}	s	$p_{\mathrm{cut}(e)}$ (TeV c^{-1})	$p_{\mathrm{cut}(p)}$ (TeV c^{-1})	(a)W_p/(b)W_e (10^{50} erg)	(a)U_p/(b)U_e (eV cm^{-3})
G25B′						
(a1)	0.01	2.2	1.0	100	1.6	5.9
(a2)	0.01	2.3	100	100	1.5	5.5
(b1)	1	2.3	1.0	100	0.11	0.40
(b2)	1	2.5	100	100	0.11	0.40

Preliminary

Physical properties

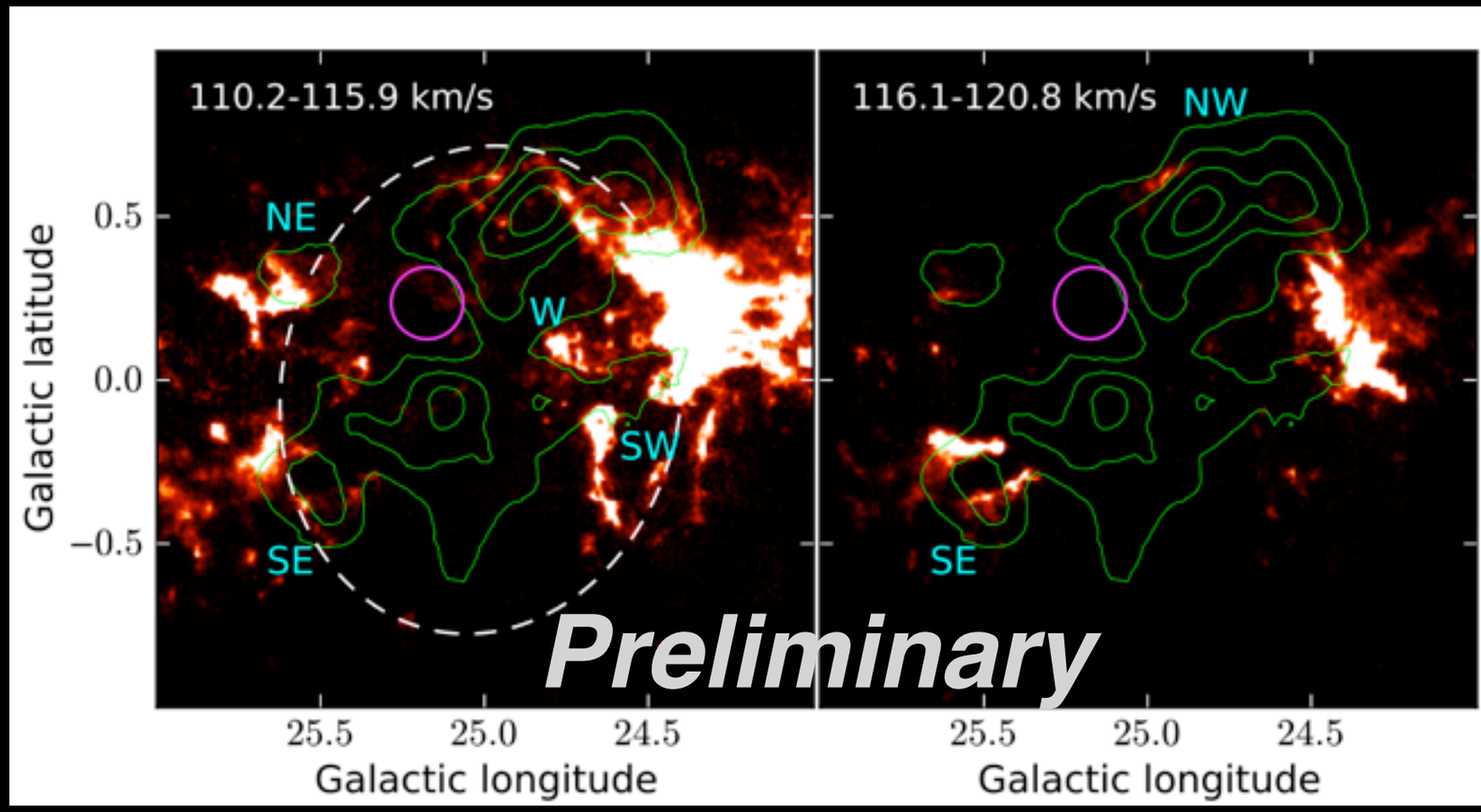
Parameter	Value
Photon index	2.1
Diameter (pc)	~180
L_γ (erg s^{-1})	2.2 x 10^{36}
W_p (erg)	4.3 (20 cm^{-3}/n) x 10^{50}
U_p (eV cm^{-3})	6.1 (20 cm^{-3}/n)

Preliminary

d = 7.7 kpc

The particles **cannot penetrate** the dense shells?

→ Reason for **the efficient confinement?**



Summary

- LAT detection of **extended** (~1.5°) γ-ray emissions from the G25.0+0.0 region.
- **Hard spectrum** (photon index ~ 2.1) without any significant curvature (up to ~ 0.5 TeV)
- SFR is the plausible candidate for the detected γ-ray emissions.
- G25.0+0.0 may be the 2nd case of a detection of γ rays from SFRs.