AGILE observations of MGRO J2019+37 and WR 140

Josep M. Paredes

Victor Zabalza

6th Science AGILE Workshop

Milano, 22-23 April 2009

In collaboration with:

M. Ribó, P. Bordas, J. Moldón (Universitat de Barcelona)
J. Martí (Universidad de Jaén)
V. Bosch-Ramon (MPIfK, Heidelberg)
G. Romero, P. Benaglia (IAR, Conicet, Argentina)
I. Chandra (Tata Institute, Pune)

OUTLINE

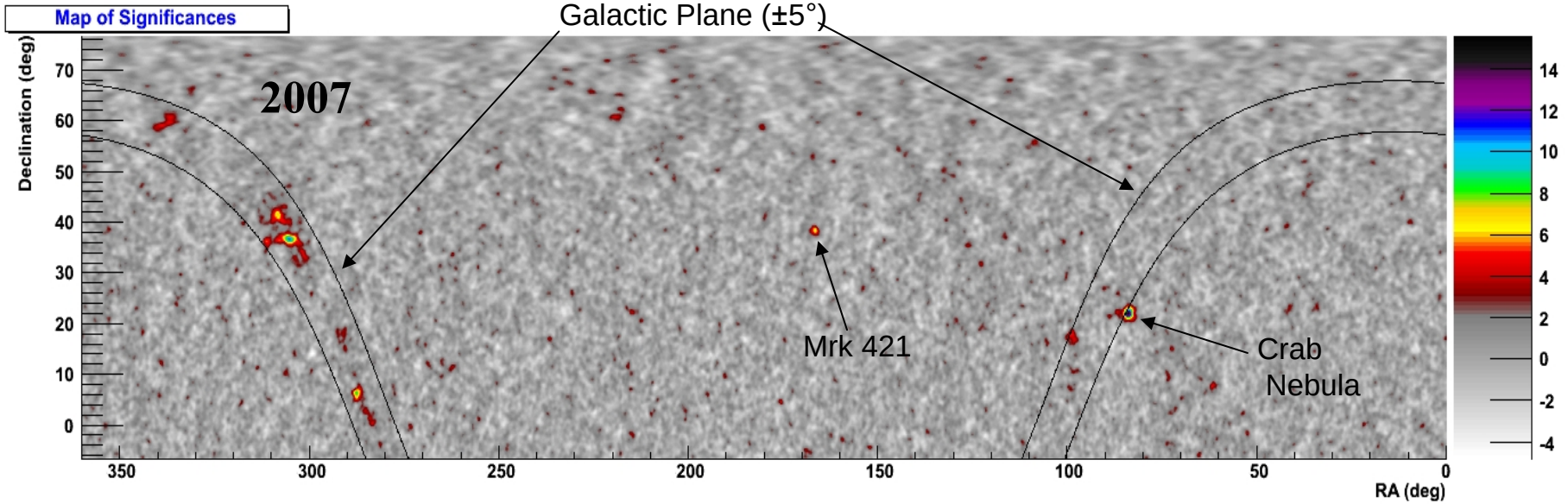
1. Introduction

2. MGRO J2019+37
   - Radio
   - near-IR
   - X-ray
   - Gamma

3. WR140

MILAGRO Sky Survey

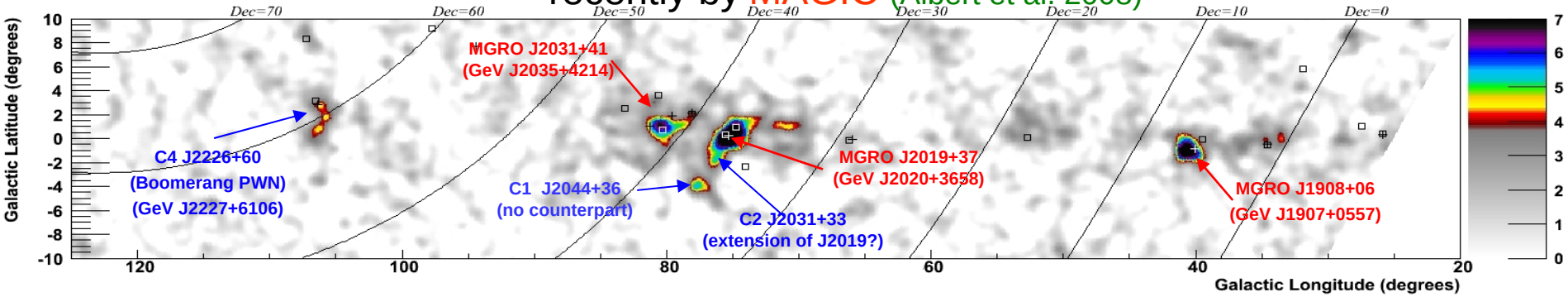
Energy range 4-150 TeV. 6.5 yr of data (July 2000 -January 2007). (Abdo et al. 2007).



MGRO J2019+37 has been detected by Tibet As-g (Wang et al. 2007)

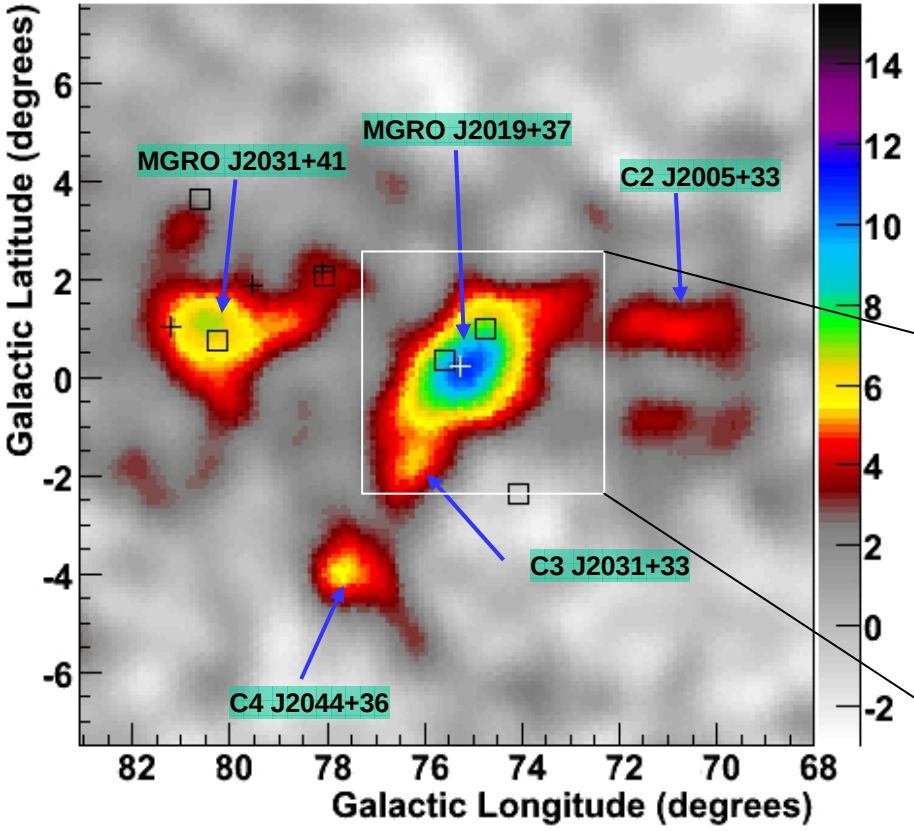
MGRO J1908+06 has been detected by HESS (Djannati-Atai et al. 2007)

MGRO J2031+41 was detected by HEGRA (Aharonian et al. 2002) and recently by MAGIC (Albert et al. 2008)

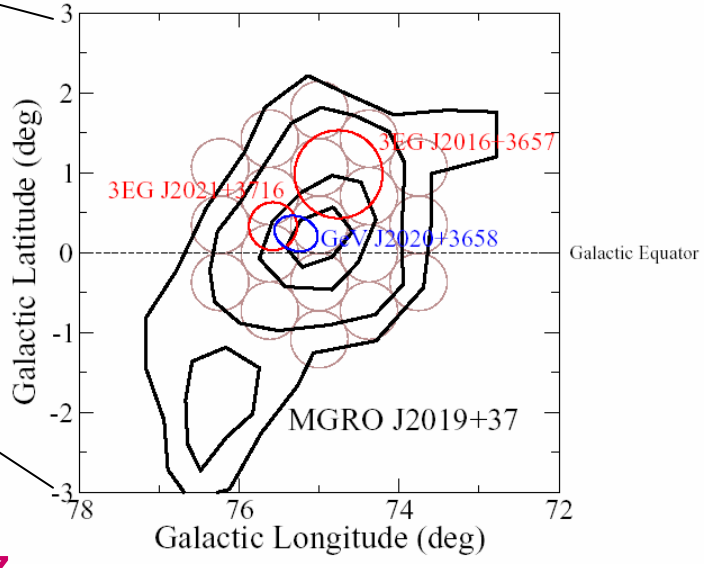


The Cygnus Region by MILAGRO

- Part of a complex TeV emission region partly correlated with molecular cloud density (CO data)
- Extended emission ($\sigma = 0.32^{o} \pm 0.12^{o}$)
- Centroid of TeV emission located within a $0.4^{o} \times 0.3^{o}$ error box

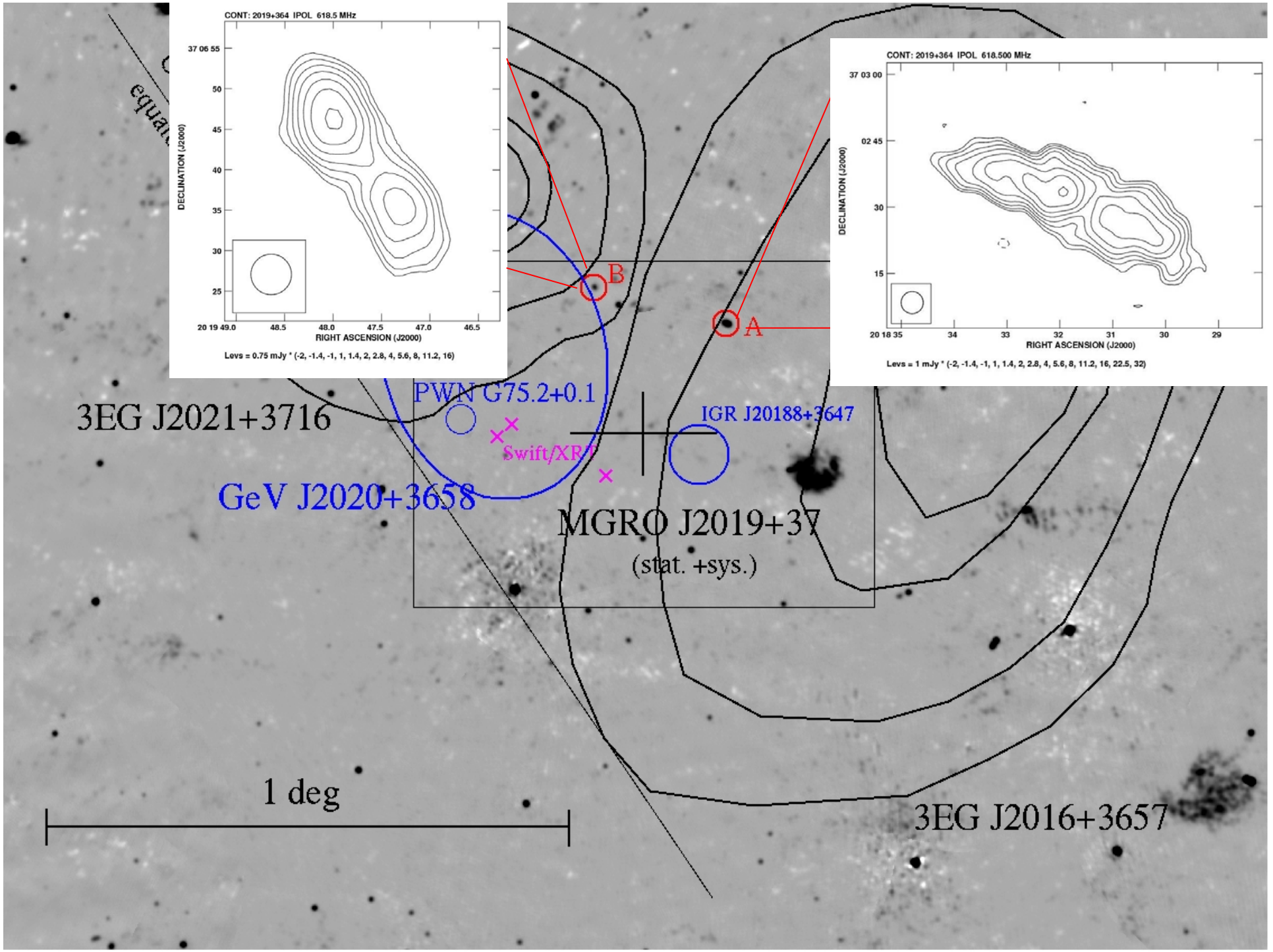


MGRO J2019+37 Region



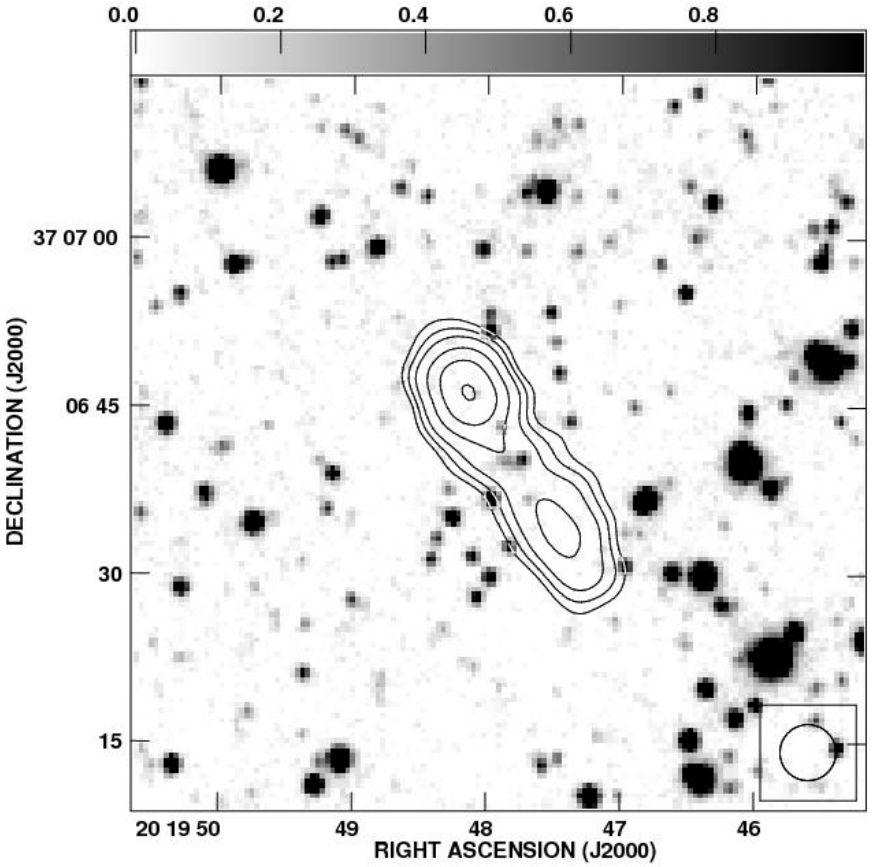
Radio survey GMRT, 610 MHz

- Identify the radio counterpart of MGRO J2019+37
- Provide candidate radio counterparts for 3EG J2016+3657, 3EG J2021+3716, GeVJ2020+37
- Provide a template database for future identification of the several γ-ray to be detected by *Fermi*

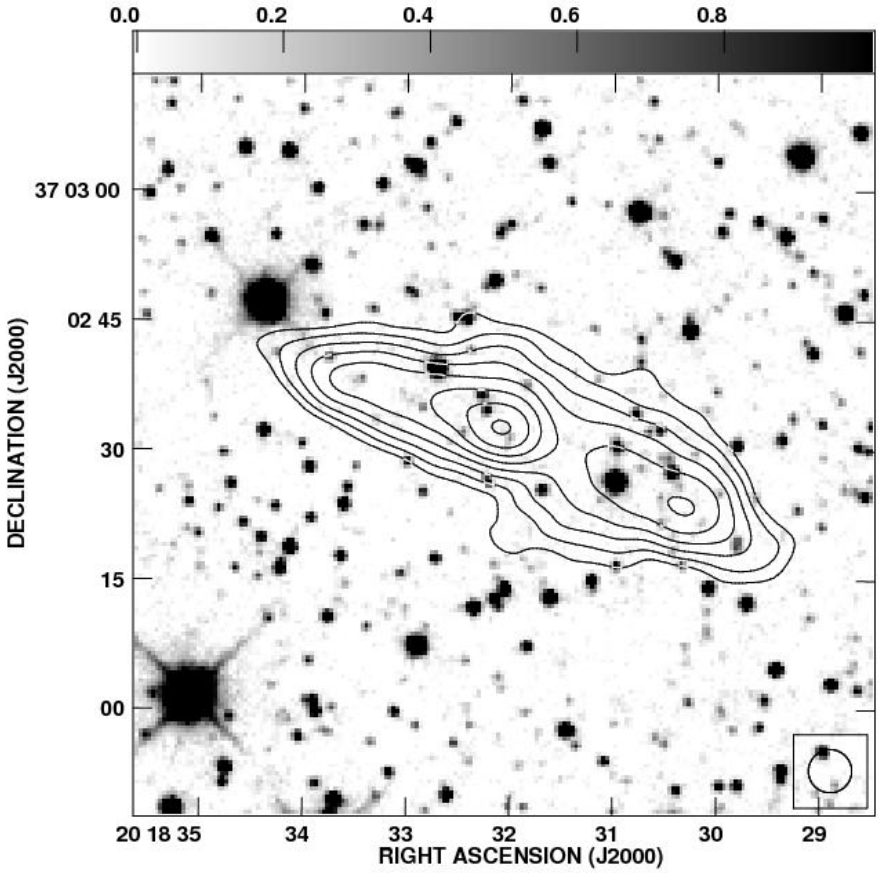

CONT: 2019+364 IPOL 618.5 MHz
DECLINATION (J2000)
RIGHT ASCENSION (J2000)
Levs = 0.75 mJy * (-2, -1.4, -1, 1, 1.4, 2, 2.8, 4, 5.6, 8, 11.2, 16)
CONT: 2019+364 IPOL 618.500 MHz
DECLINATION (J2000)
RIGHT ASCENSION (J2000)
Levs = 1 mJy * (-2, -1.4, -1, 1, 1.4, 2, 2.8, 4, 5.6, 8, 11.2, 16, 22.5, 32)
B
A
PWN G75.2+0.1
IGR J20188+3647
Swift/XRT
3EG J2021+3716
GeV J2020+3658
MGRO J2019+37
(stat. +sys.)
1 deg
3EG J2016+3657

Galactic or Extragalactic ?

B



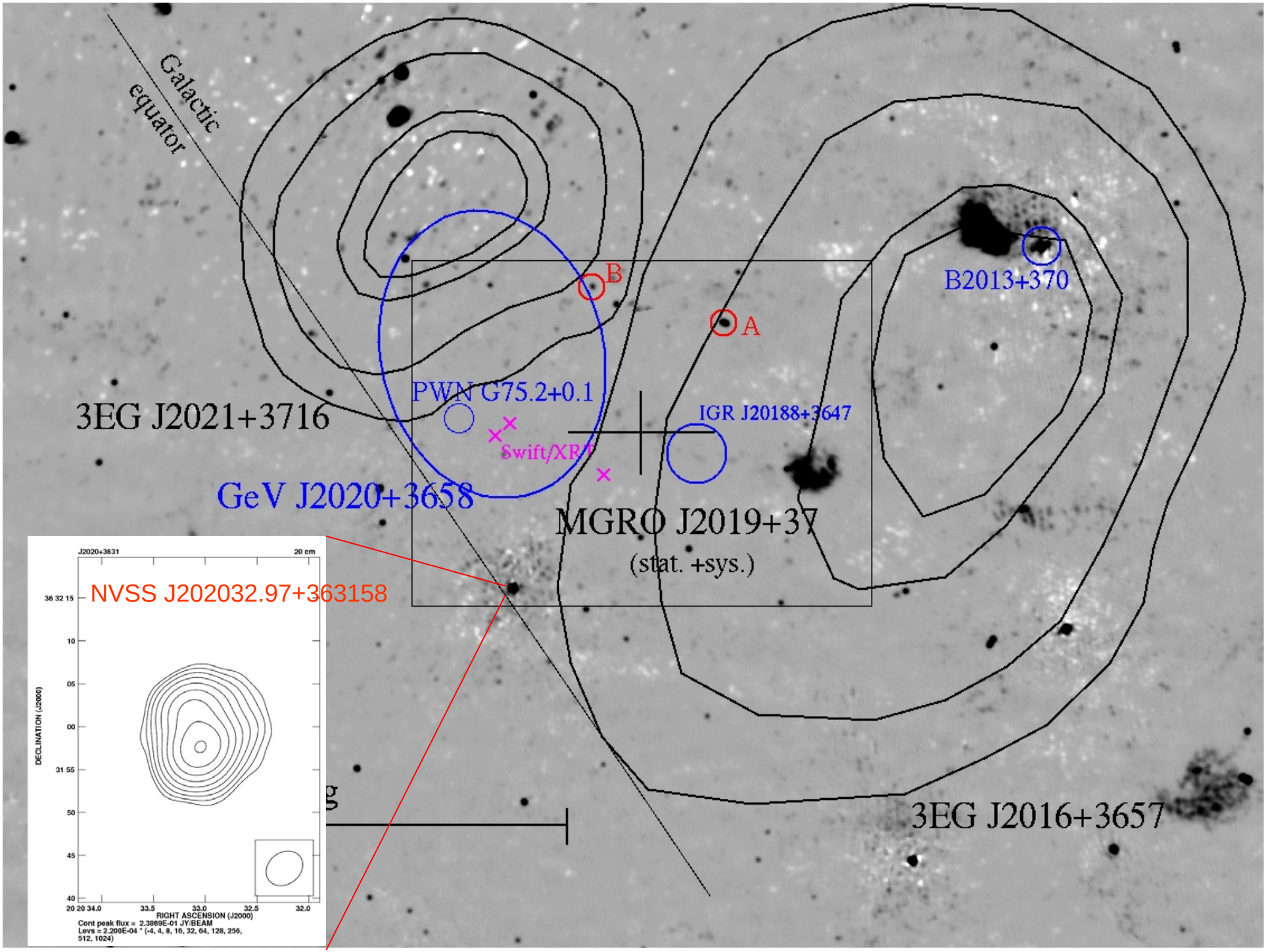
A



Spectral index B: - 0.7 A: -1.2

B → morphological and spectral similarity to the radio lobes of the Great Annihilator 1E 1740-2942, a microquasar in the Galactic Center (Mirabel et al. 1992)

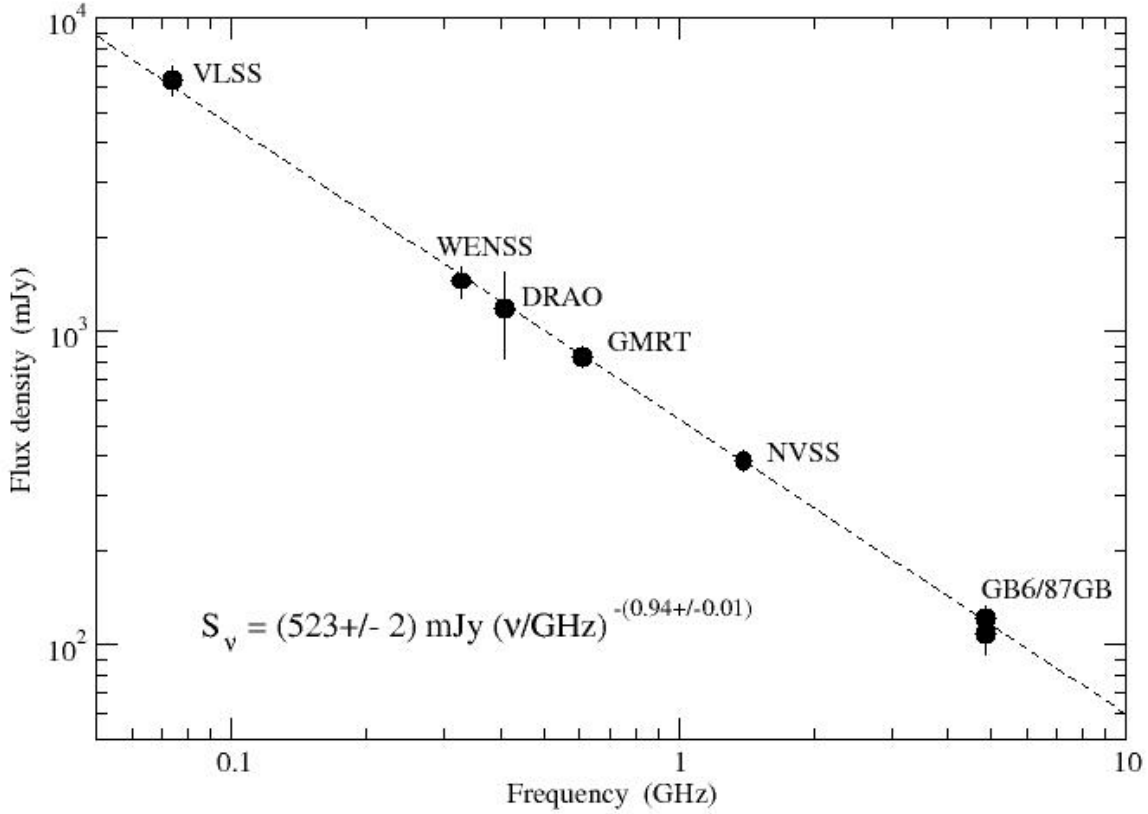
GMRT, 610 MHz & 3.5m CAHA, K band

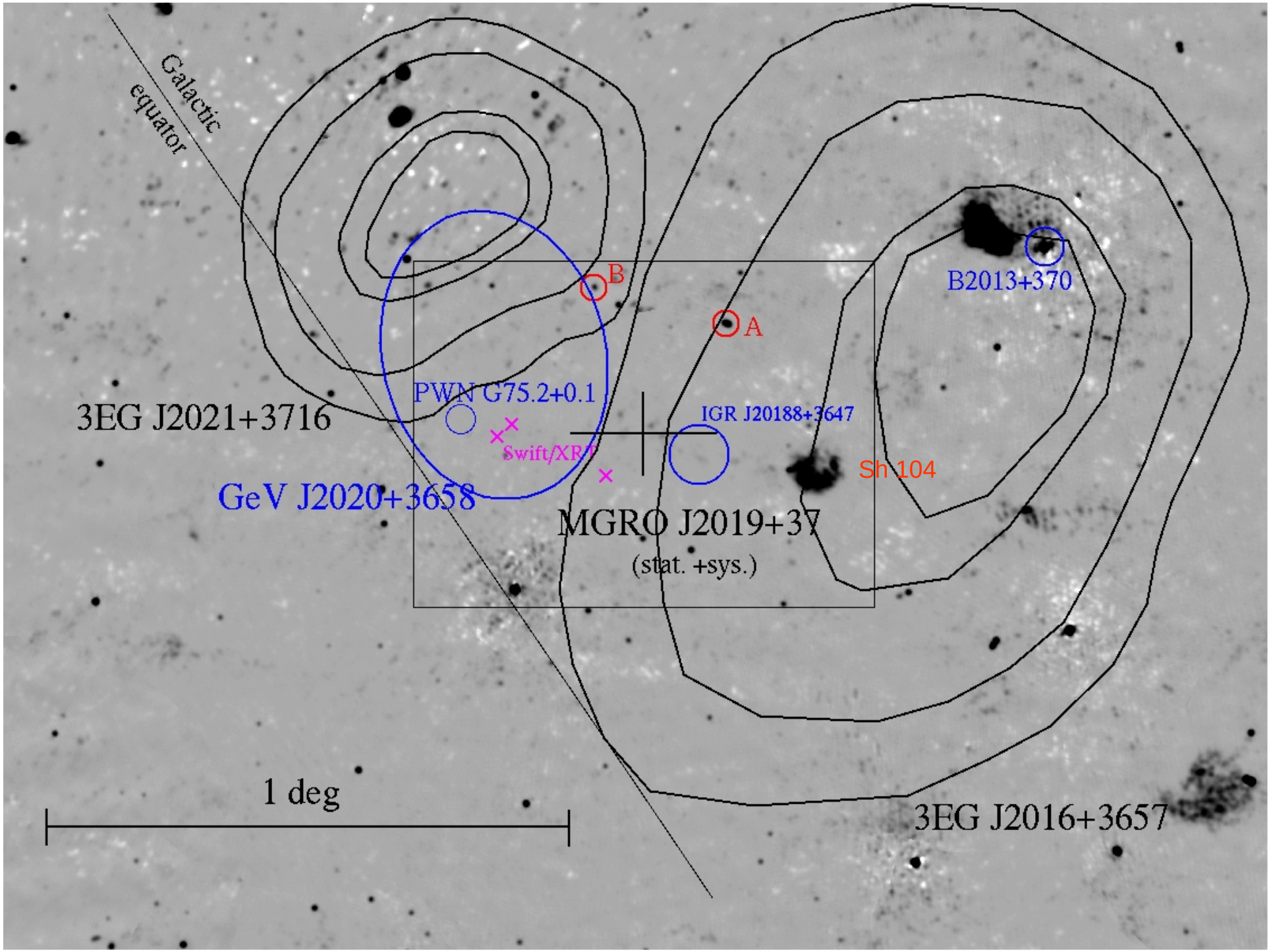

Galactic equator
B
A
B2013+370
PWN G75.2+0.1
Swift/XRT
IGR J20188+3647
3EG J2021+3716
GeV J2020+3658
MGRO J2019+37
(stat. +sys.)
NVSS J202032.97+363158
3EG J2016+3657
J2020+3631
20 cm
DECLINATION (J2000)
RIGHT ASCENSION (J2000)
Cont peak flux = 2.3869E-01 JY/BEAM
Levs = 2.200E-04 * (-4, 4, 8, 16, 32, 64, 128, 256, 512, 1024)

NVSS J202032.97+363158

Brightest compact radio source within the error box of the gamma-ray peak emission of MGRO J2019+37

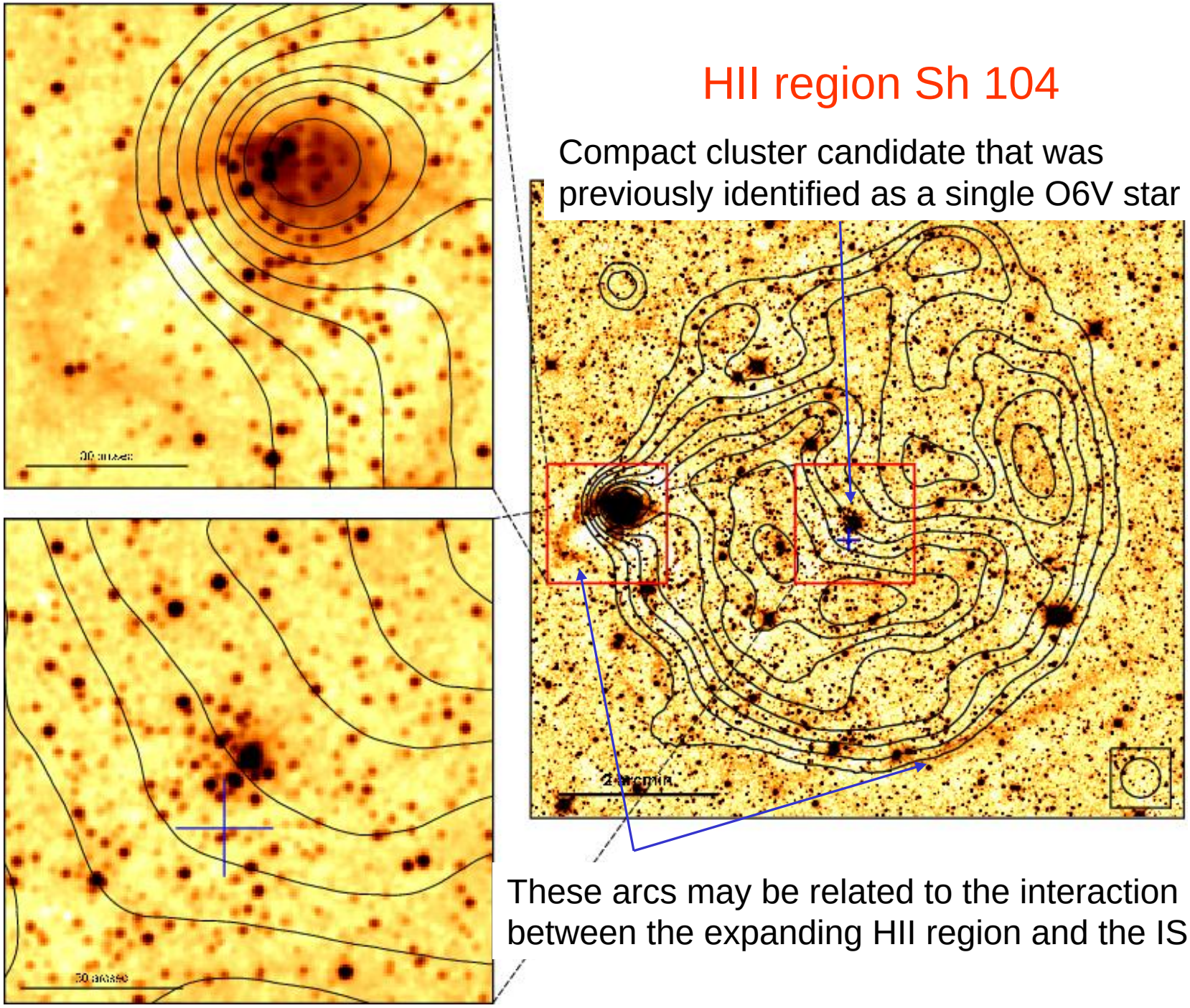
No near-IR counterpart candidate



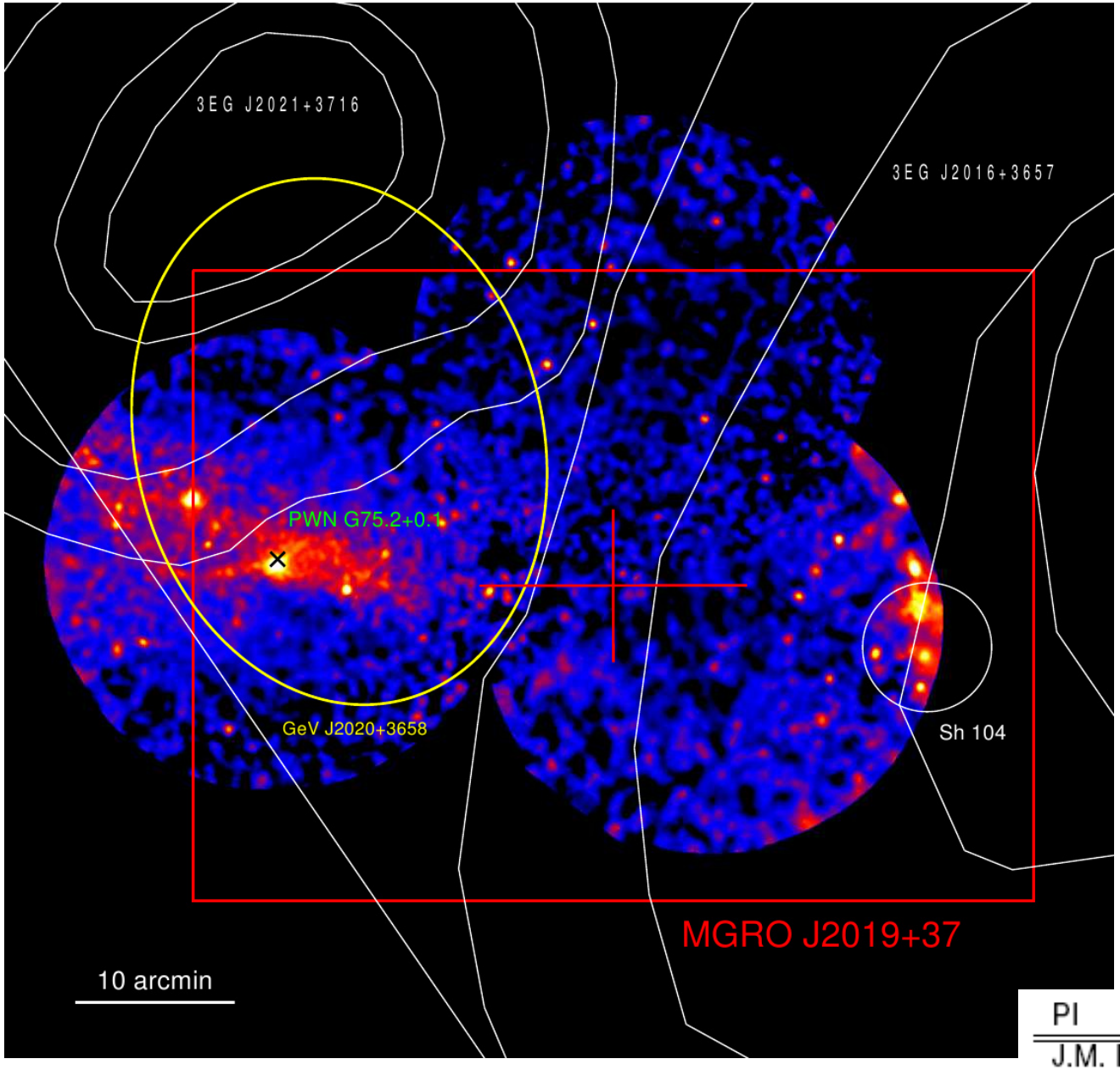

Galactic
equator
B
A
B2013+370
PWN G75.2+0.1
3EG J2021+3716
IGR J20188+3647
Swift/XRT
Sh 104
GeV J2020+3658
MGRO J2019+37
(stat. +sys.)
1 deg
3EG J2016+3657

HII region Sh 104

Compact cluster candidate that was previously identified as a single O6V star



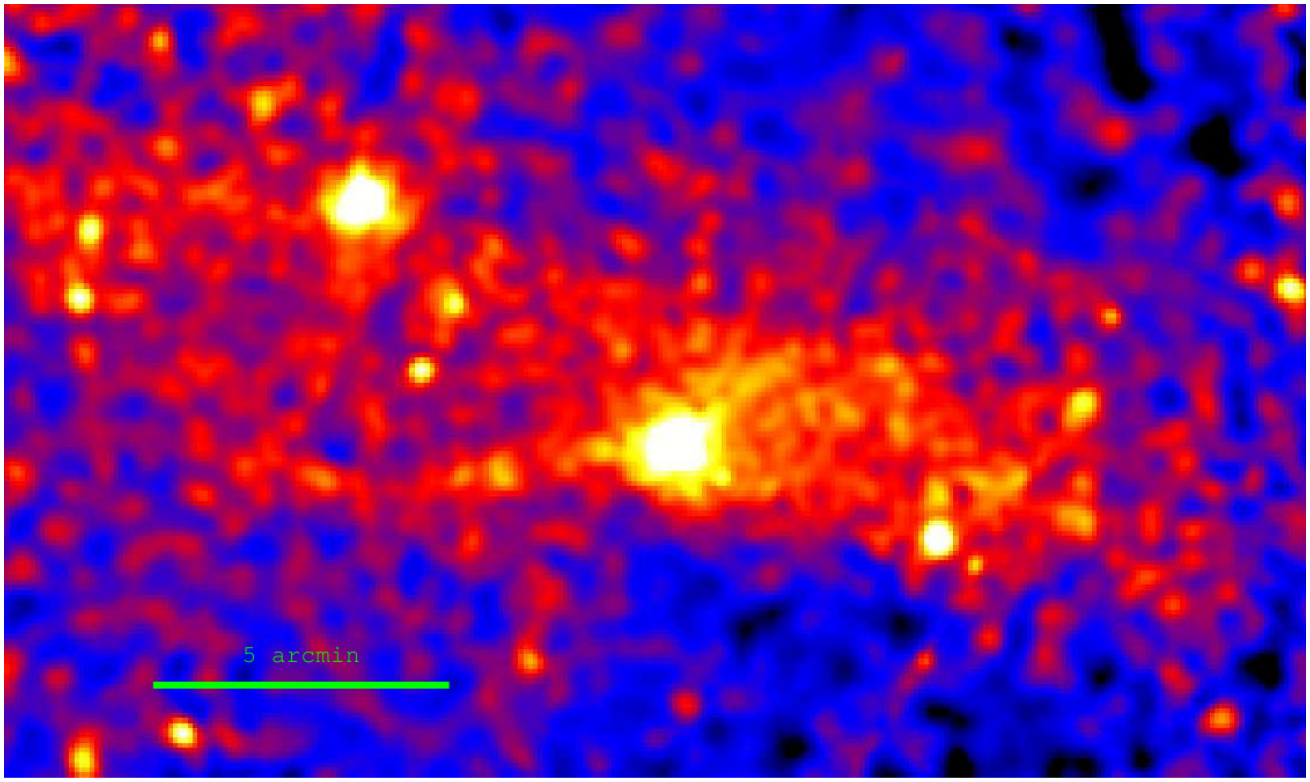
These arcs may be related to the interaction between the expanding HII region and the ISM



XMM-*Newton* X-ray mosaic

PI	Length	Clean time
J.M. Paredes	50 ks	44 ks
M.S. Roberts	2x20 ks	27 ks
N. Schartel	15 ks	14 ks

PWN G75.2+0.1

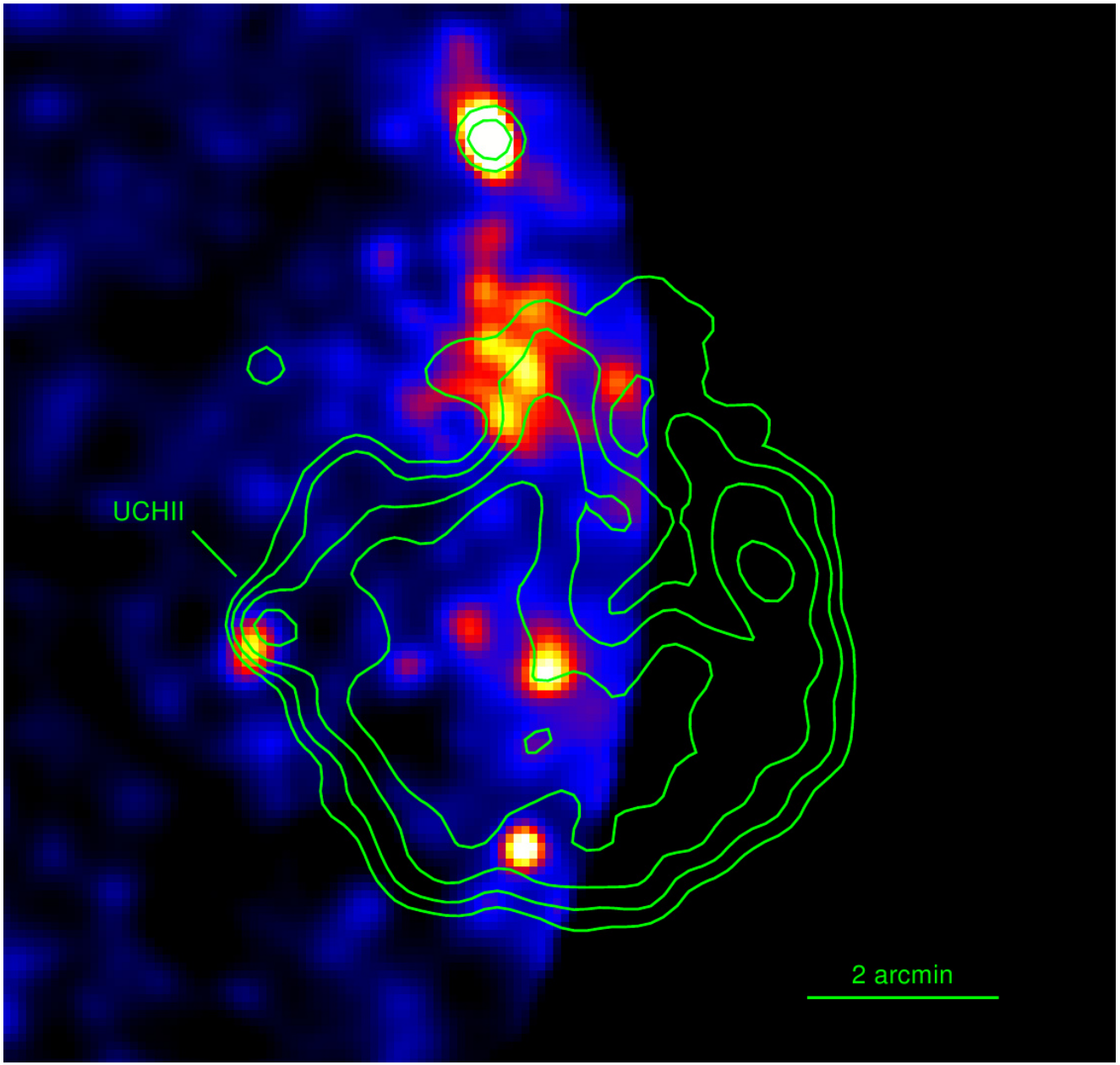


Coincident with EGRET GeV source
X-ray PWN with torus plus jet morphology (Hessels et al. 2004, Van Etten et al. 2008)

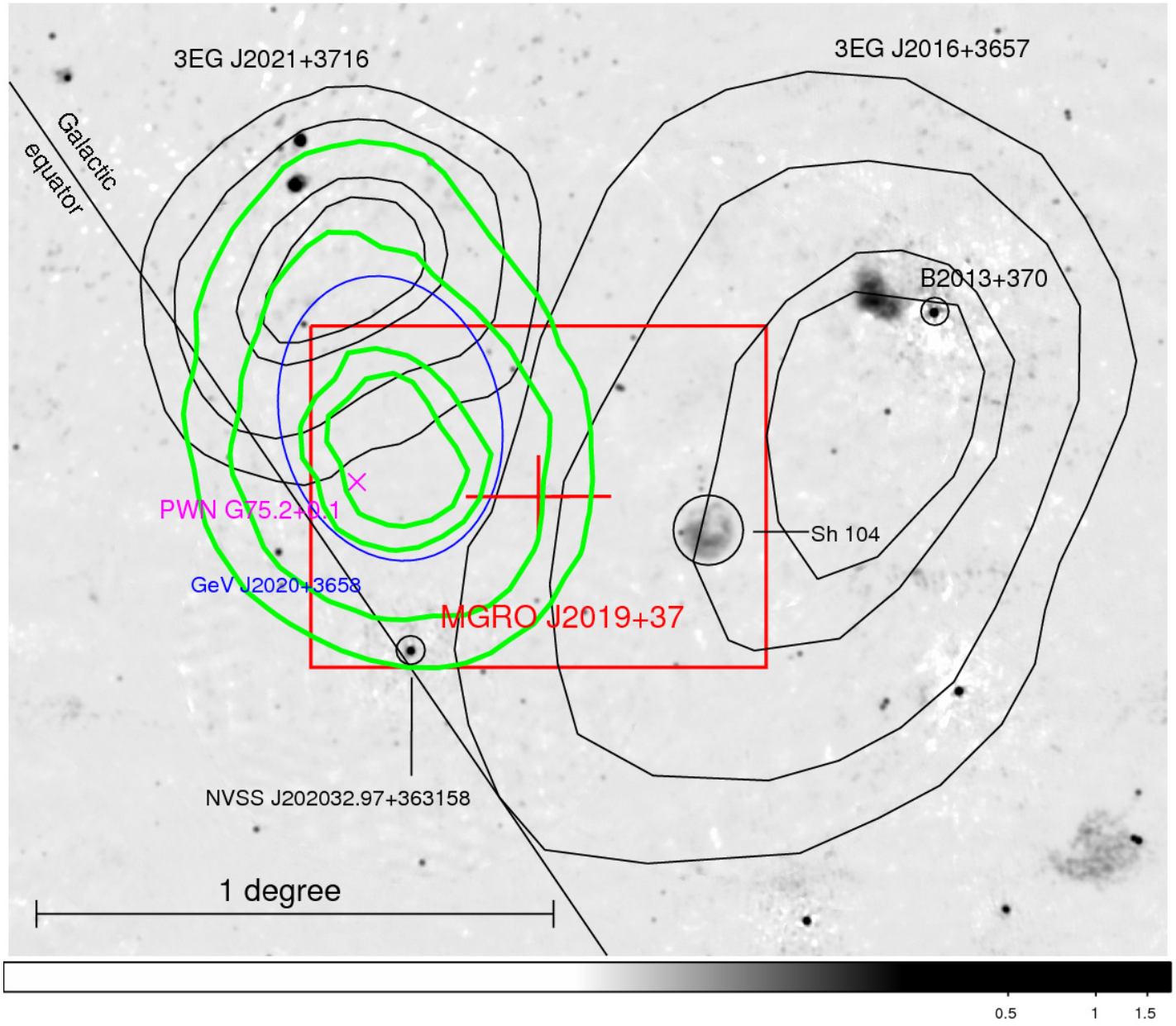
Our X-ray view of MGRO J2019+37:

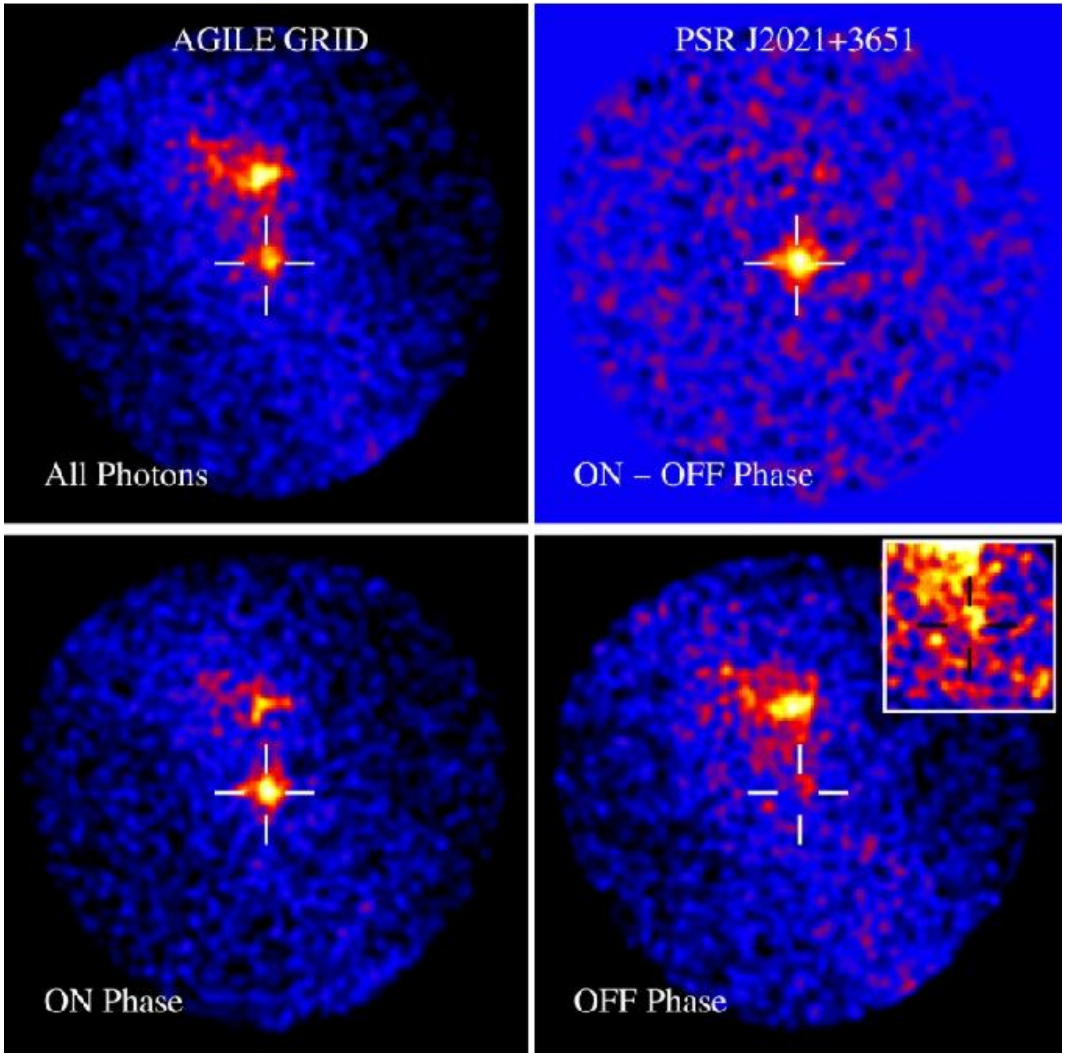
- PWN G75.2+0.1 has extended X-ray emission up to ~7 arcmin away
- No X-ray extended emission with similar extension as TeV emission

Sh 104



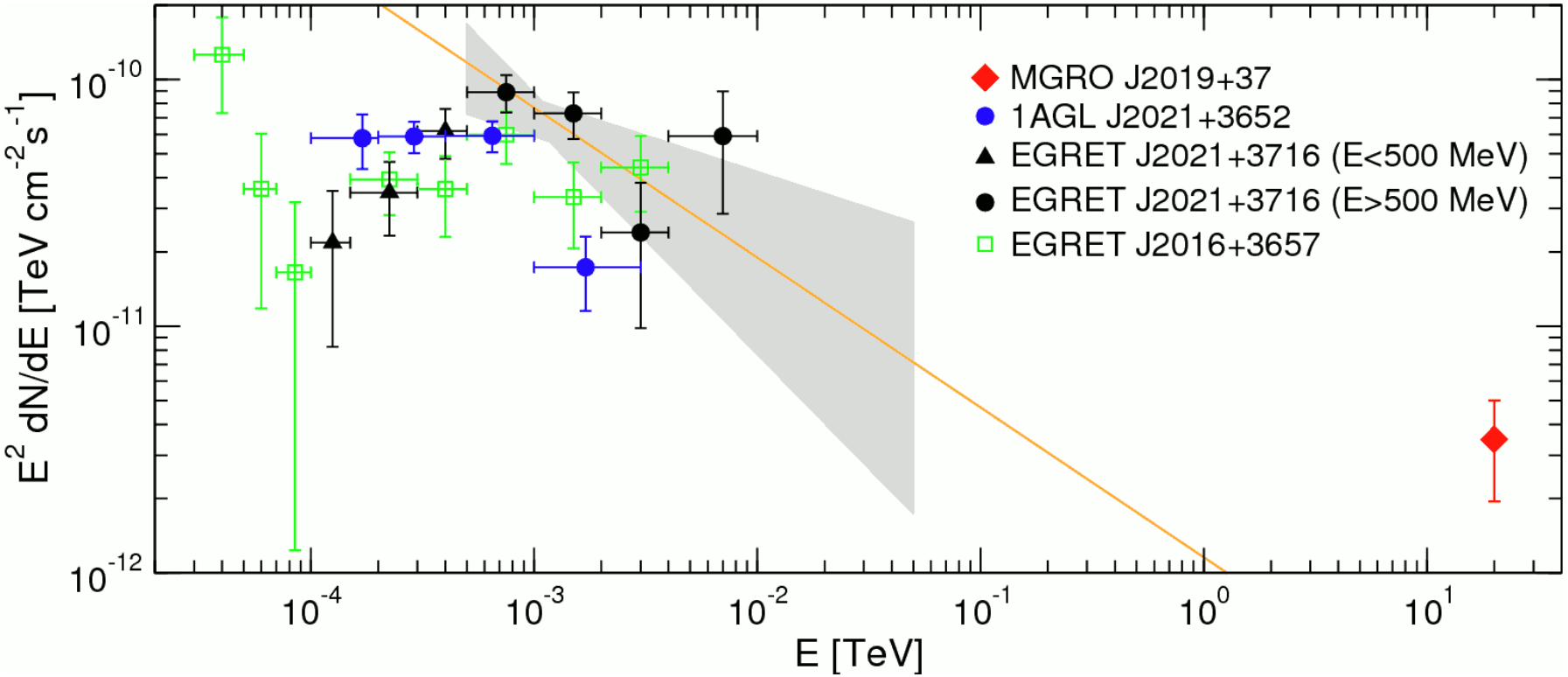
AGILE


3EG J2021+3716
3EG J2016+3657
Galactic equator
B2013+370
PWN G75.2+0.1
Sh 104
GeV J2020+3653
MGRO J2019+37
NVSS J202032.97+363158
1 degree
0.5
1
1.5



Halpern et al. 2008 detect gamma-ray pulsed emission from PSR J2021+3657 with AGILE (Halpern et al. 2008, ApJ, 688, L33)

Detected recently by *Fermi* (Abdo et al. 2009, arxiv:0902.1340)



Sources A, B, NVSS J2020 and Sh104 might contribute to the global TeV emission

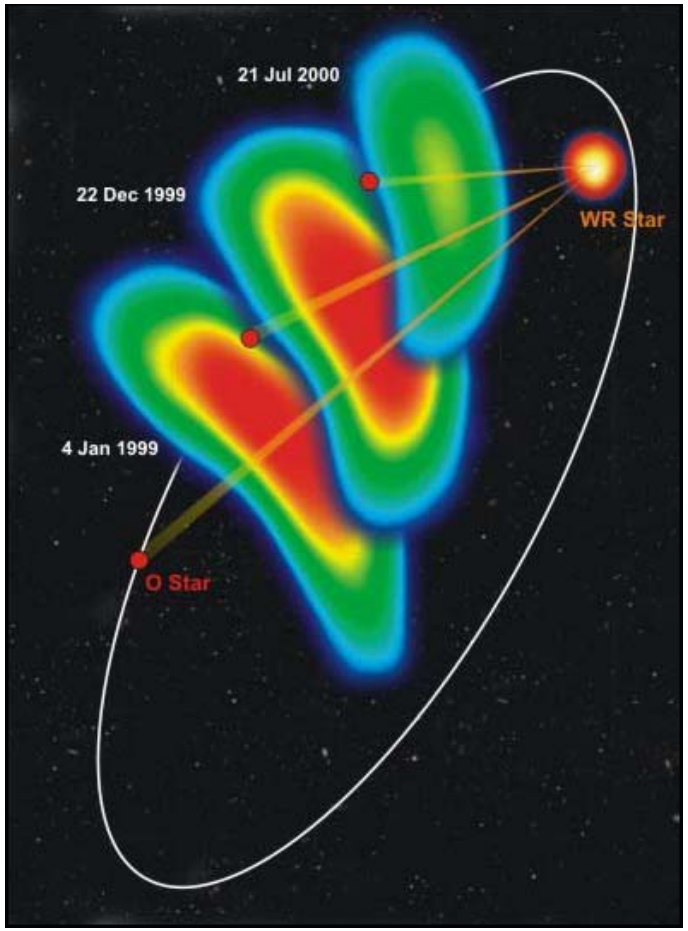
WR 140

The collision of supersonic winds in massive star binaries produces strong shocks where both e and p can be efficiently accelerated up to relativistic energies through first-order Fermi mechanism (Eichler& Usov 1993).

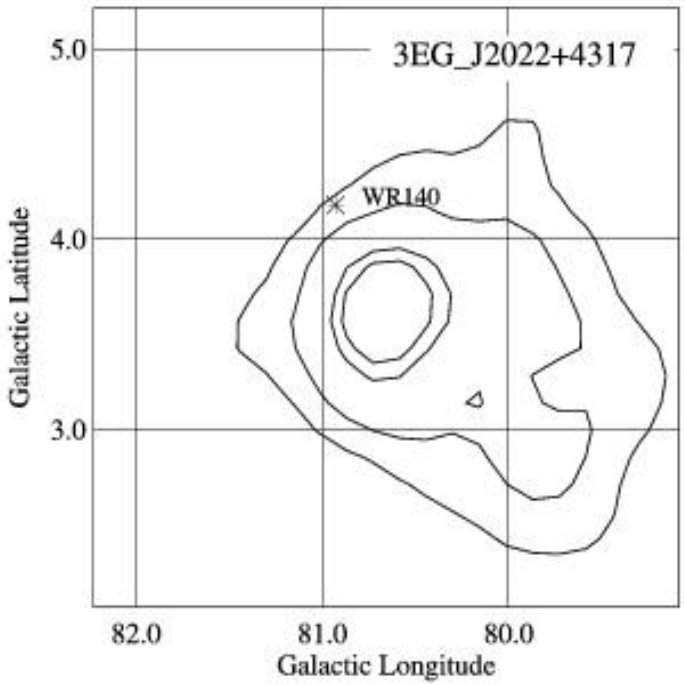
Strong synchrotron and IC losses are expected for relativistic e in this scenario (Eichler & Usov 1993, Benaglia et al. 2001).

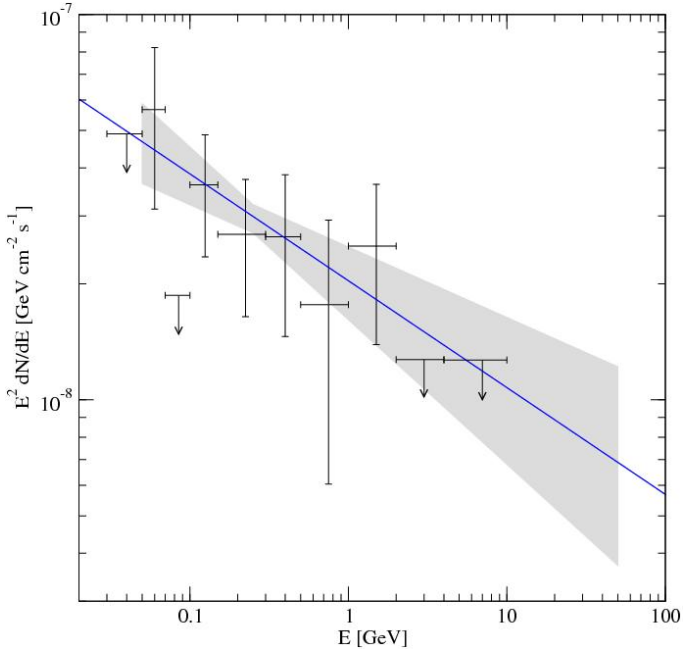
WR140 is the archetype colliding-wind binary system

WC 7 & O4-5 V
P= 2899±10 d
e= 0.881±0.005



Dougherty & Pittard 2006, Proceedings of Science





WR 140

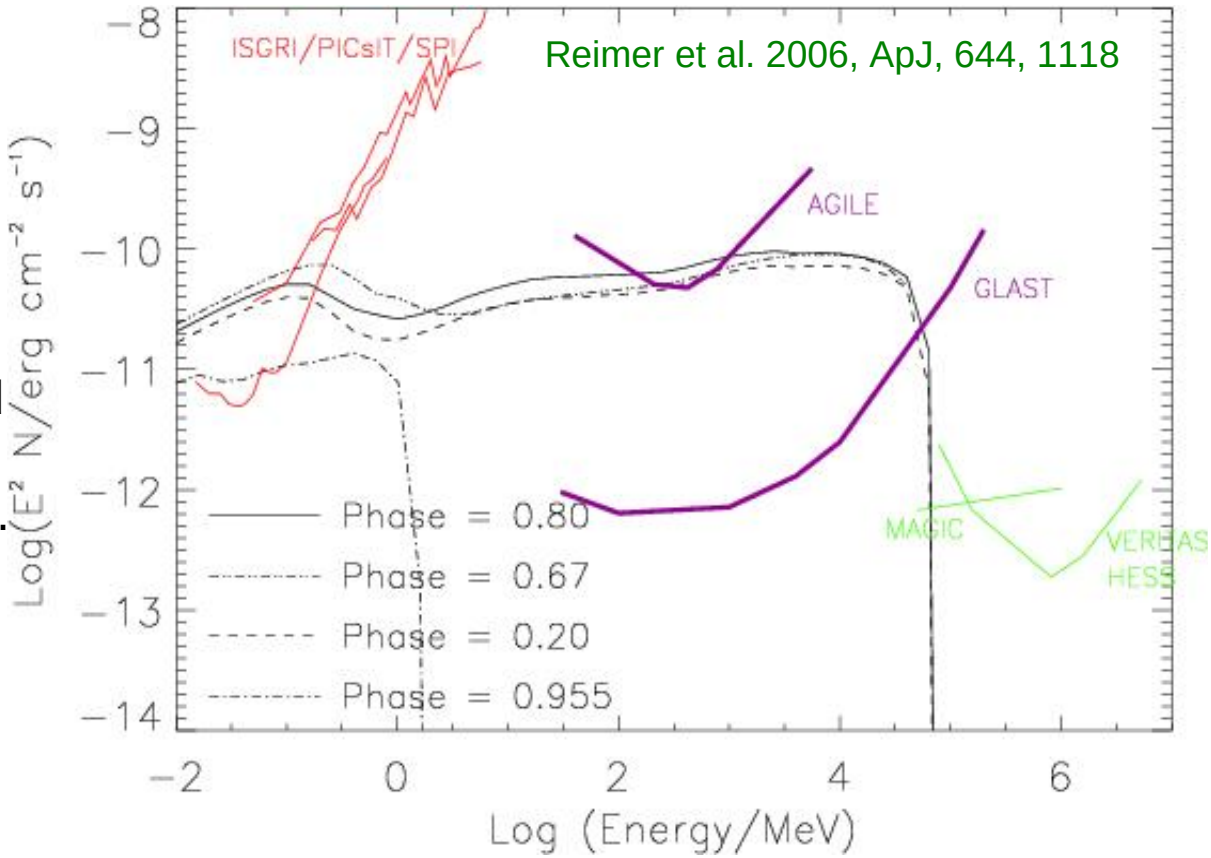
WR 140 is the only prominent non-thermal source inside the location error box of the EGRET gamma-ray source 3EG J2022+4317

(Romero et al. 1999, A&A, 348, 868).

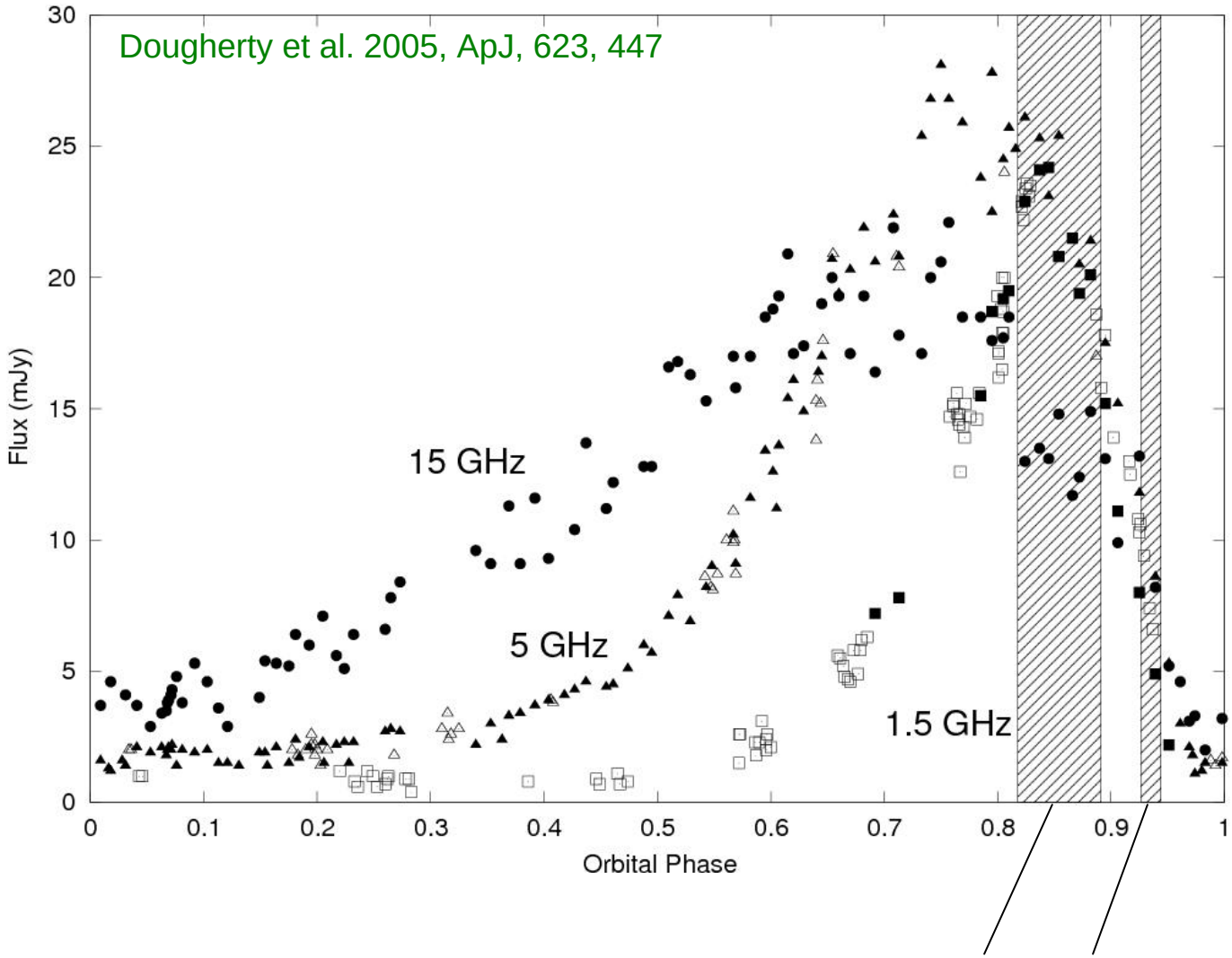
Calculations from several authors coincide on that the emission should be dominated by IC up-scattering of UV photons from the secondary star.

Predicted spectral energy distribution from WR 140 for different orbital phases, according to Reimer et al. (2006). Similar results are obtained by Benaglia & Romero (2003) and some models in Pittard & Dougherty (2006).

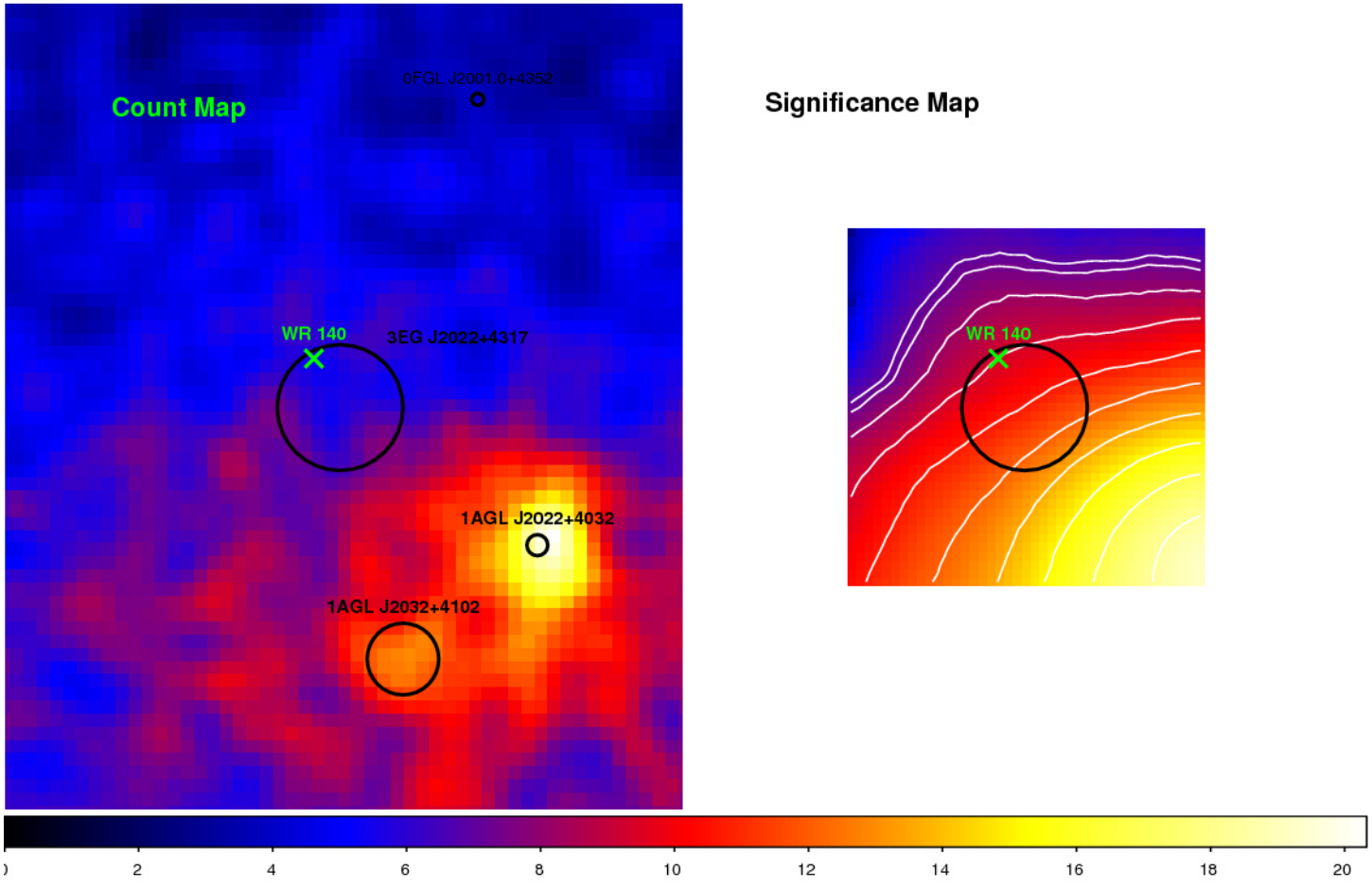
If absorption of gamma-ray photons in the stellar photon fields is considered, the maximum of the IC flux should occur around phase 0.85, before the periastron passage.



(Consequently, the maximum gamma-ray emission is expected around February 2008)



phase ranges corresponding to the scheduled AGILE pointing periods for which WR 140 is visible.



The significance map points towards a source at WR 140 ?