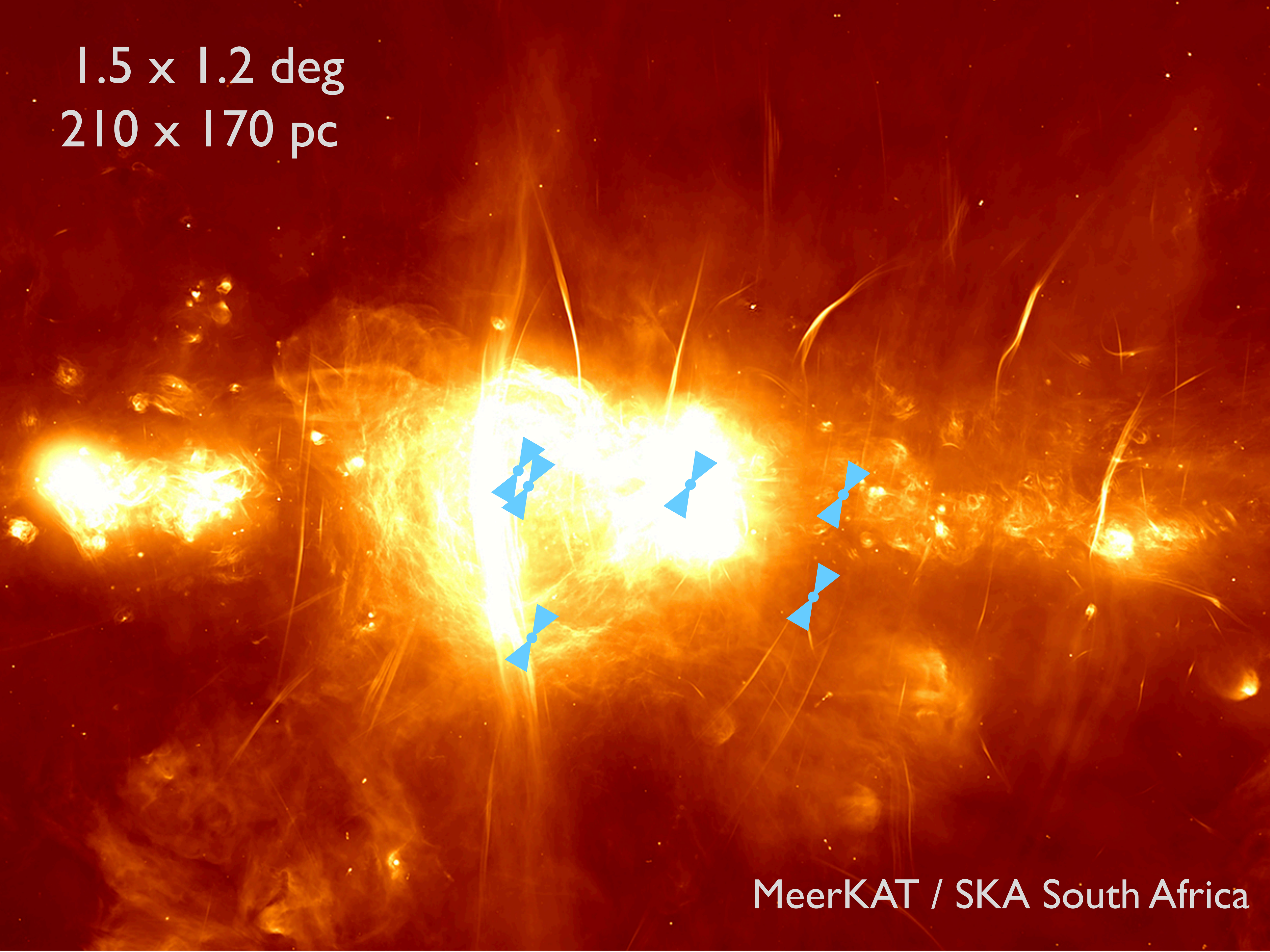
J1745-2900

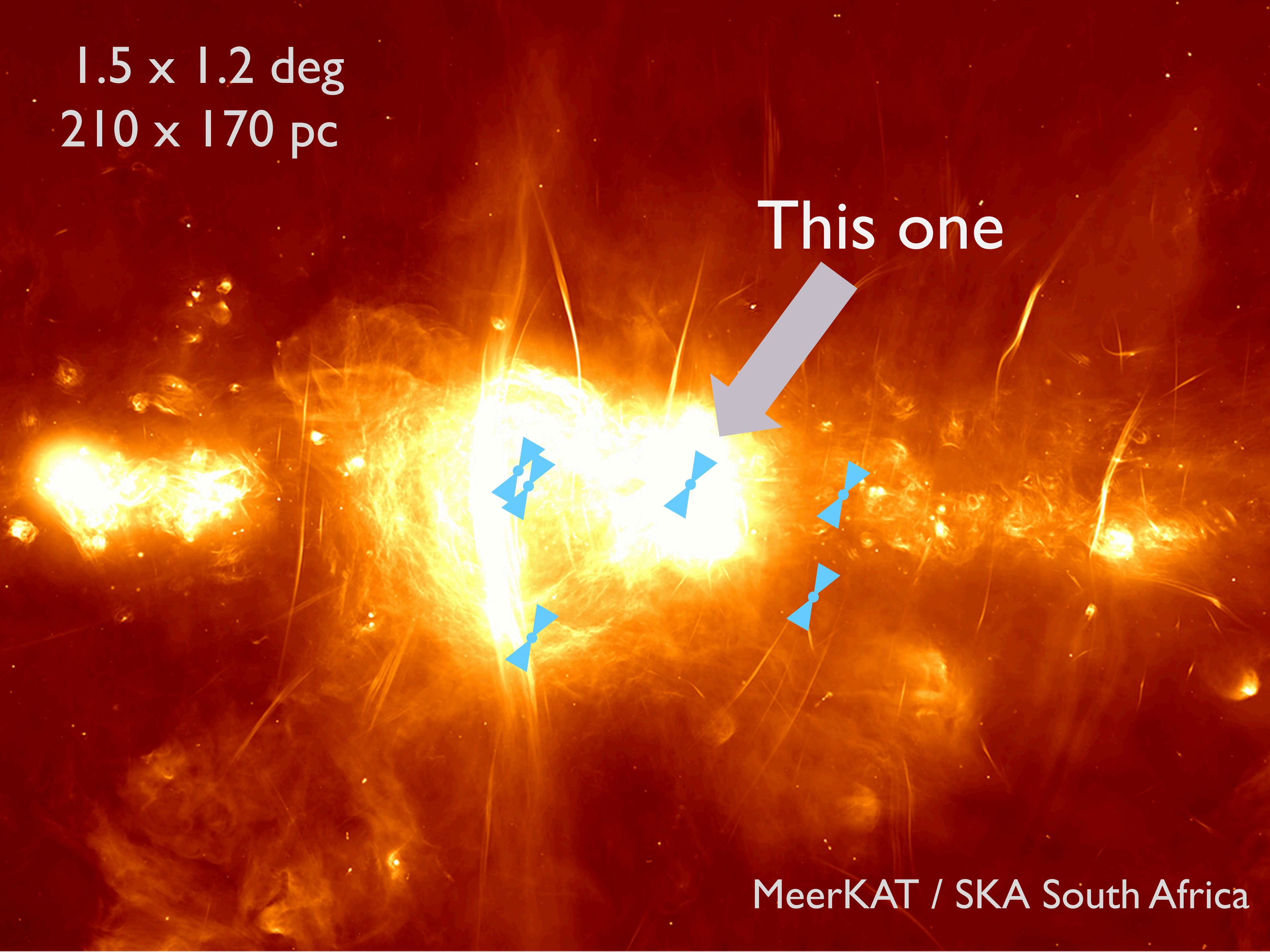
THE GALACTIC CENTER MAGNETAR

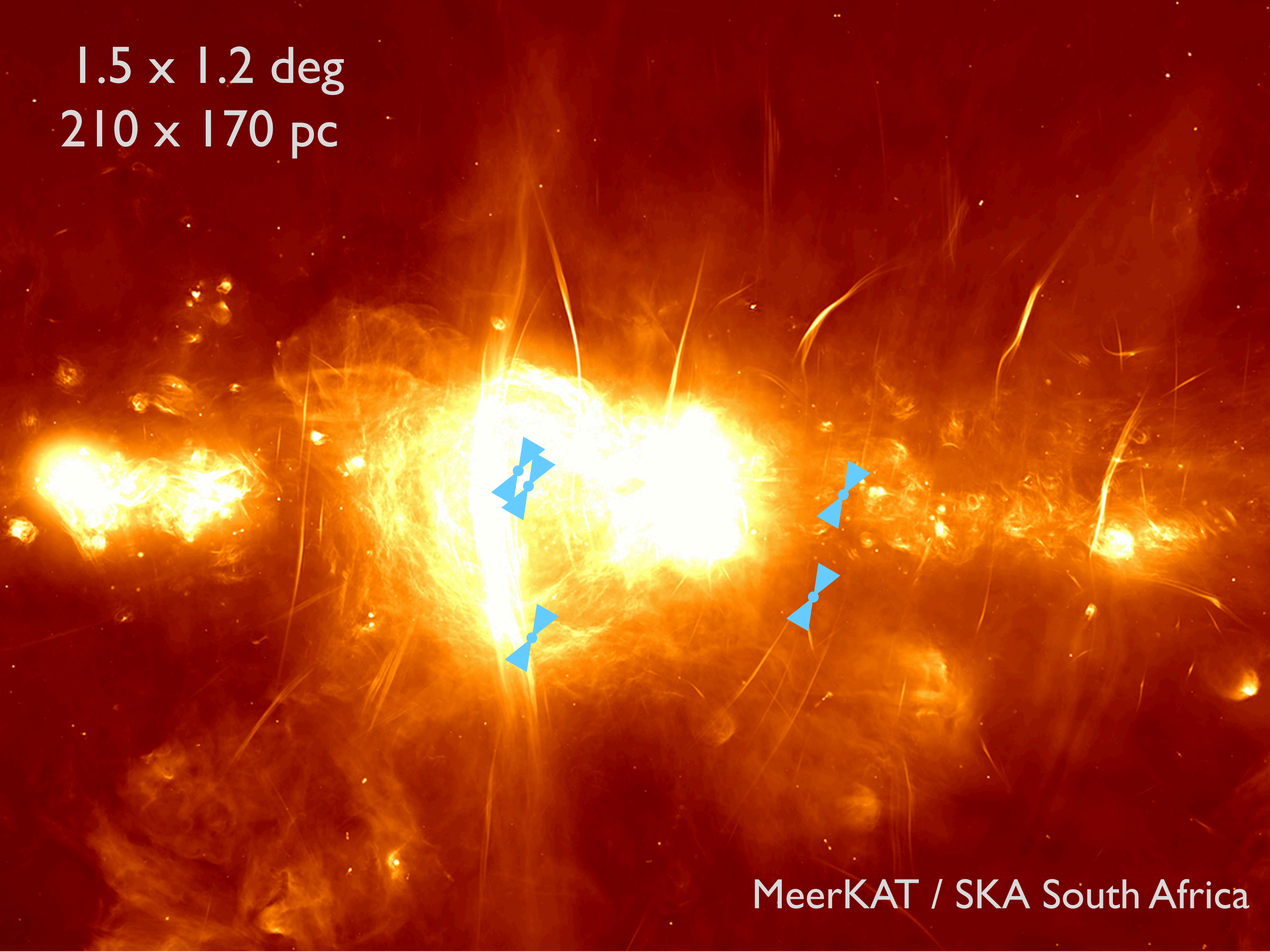
RS Wharton

Pulsar of the Week

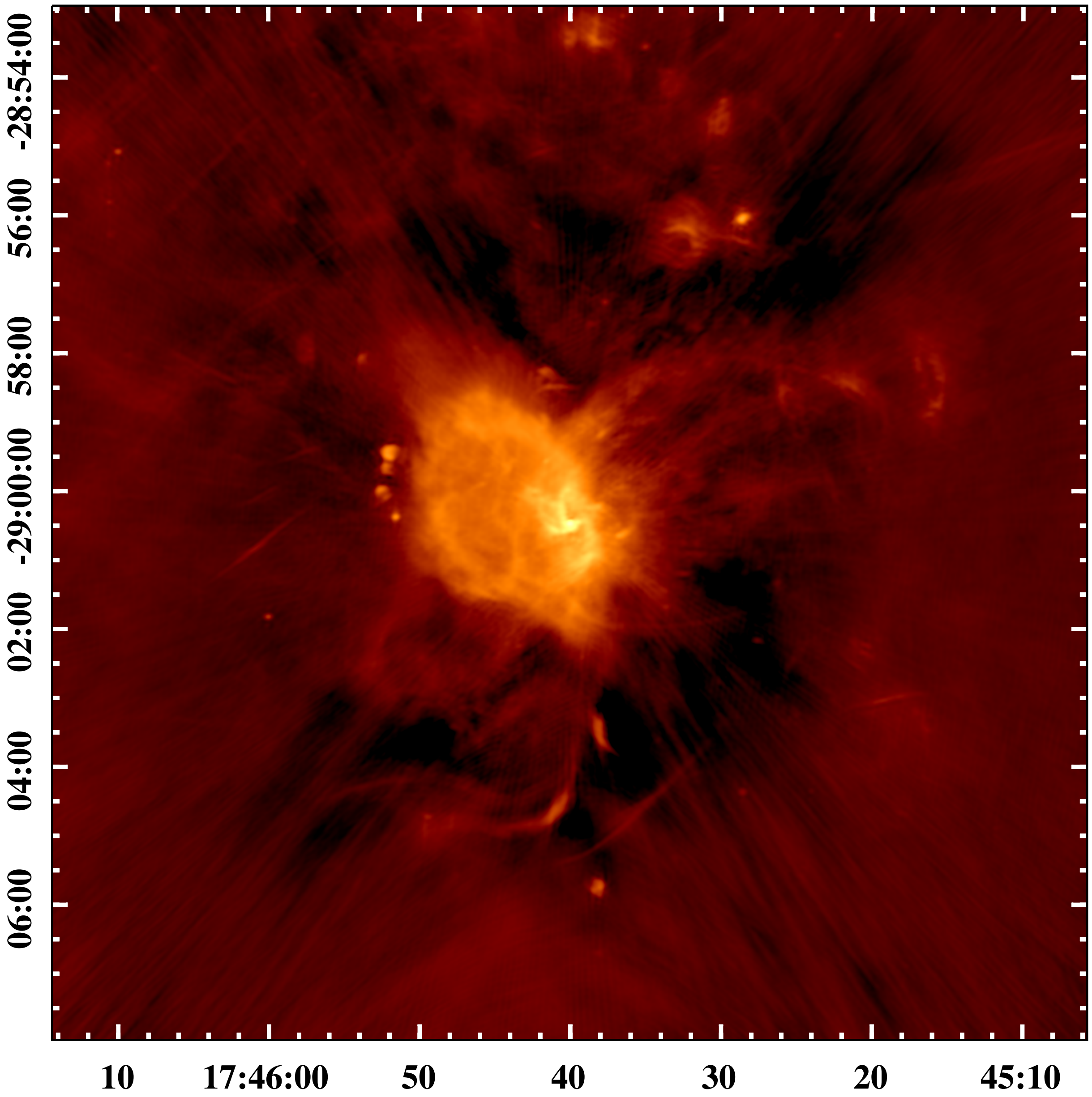
24 Oct 2018


1.5 x 1.2 deg
210 x 170 pc
MeerKAT / SKA South Africa


1.5 x 1.2 deg
210 x 170 pc
This one
MeerKAT / SKA South Africa


1.5 x 1.2 deg
210 x 170 pc
MeerKAT / SKA South Africa

Back to 2013…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56:00
58:00
-29:00:00
02:00
04:00
06:00
10
17:46:00
50
40
30
20
45:10

Back to 2013…

LETTER

doi:10.1038/nature10652

A gas cloud on its way towards the supermassive black hole at the Galactic Centre

S. Gillessen[1], R. Genzel[1,2], T. K. Fritz[1], E. Quataert[3], C. Alig[4], A. Burkert[4,1], J. Cuadra[5], F. Eisenhauer[1], O. Pfuhl[1], K. Dodds-Eden[1], C. F. Gammie[6] & T. Ott[1]

Table 1 | Orbit parameters of the infalling cloud

Parameters of Keplerian orbit around the $4.31 \times 10^6 M_\odot$ black hole at $R_0 = 8.33$ kpc	Best-fitting value
Semi-major axis, a	521 ± 28 mas
Eccentricity, e	0.9384 ± 0.0066
Inclination of ascending node, i	106.55 ± 0.88 deg
Position angle of ascending node, Ω	101.5 ± 1.1 deg
Longitude of pericentre, ω	[illegible]
Time of pericentre, t_{peri}	2013.51 ± 0.035
Pericentre distance from black hole, r_{peri}	$4.0 \pm 0.3 \times 10^{15}$ cm $= 3{,}140 R_S$

25 April 2013

Large Flare from Sgr A* Detected by Swift

ATel #5006; ***N. Degenaar, M. T. Reynolds, J. M. Miller (Michigan), J. A. Kennea (Penn State), R Wijnands (Amsterdam)***
on ***25 Apr 2013; 00:54 UT***
Credential Certification: Mark Reynolds (markrey@umich.edu)

Subjects: Radio, Infra-Red, X-ray, AGN, Black Hole, Transient

We report the detection of a large X-ray flare from a position consistent with Sgr A* during regular monitoring observations of the Galactic center with Swift.

In a 1ks observation on 2013-04-24 (17:34UT) a large flare is detected. Using an 10" radius extraction region centred on the known radio position, we measure a count rate of 0.11+/-0.1 ct/s. Comparing to the long term X-ray lightcurve of Sgr A* accumulated by Swift from 2006-2011 (Degenaar et al., 2013), the flare is consistent with the largest count rate detected from Sgr A* by Swift to date.

....

Swift is carrying out a daily monitoring campaign throughout 2013 to study the evolution of the X-ray properties of Sgr A* as it interacts with the G2 cloud (Gillessen et al., 2012, 2013). All observations are promptly analyzed and the resulting X-ray lightcurve will be made publicly available at the link below. Bright flares (Lx > 1e35 erg/s) will be reported to the community in further telegrams.

Swift/BAT detection of an SGR-like flare from near Sgr A*

ATel #5009; ***J. A. Kennea (PSU), H. Krimm, S. Barthelmy, N. Gehrels, C. Markwardt, J. Cummings, F. Marshall (GSFC), T. Sakamoto (AGU), N. Degenaar, M. T. Reynolds, J. M. Miller (Michigan), C. Kouveliotou (MSFC)***
*on **26 Apr 2013; 02:48 UT***
Credential Certification: Jamie A. Kennea (kennea@astro.psu.edu)

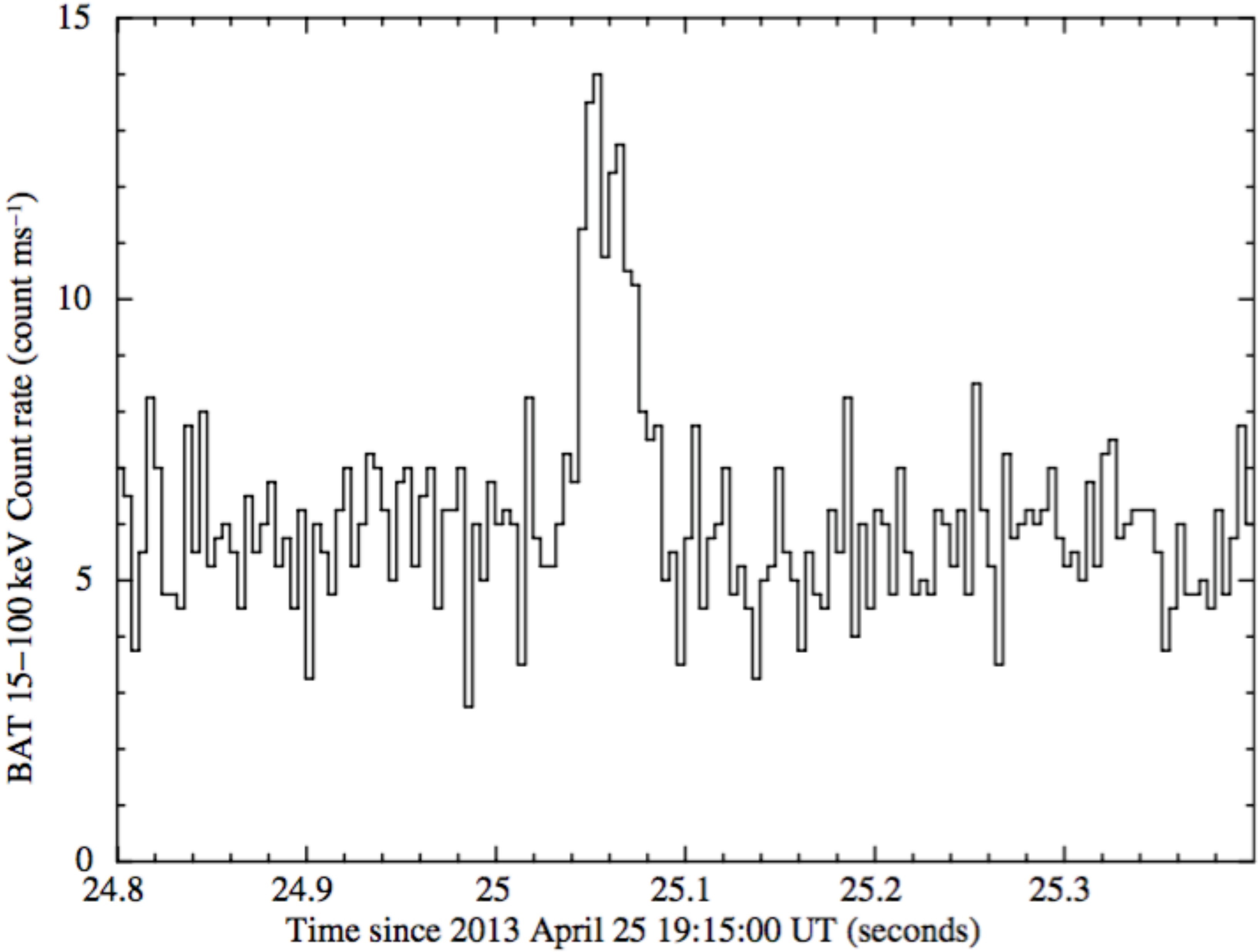
Subjects: X-ray, Black Hole, Soft Gamma-ray Repeater, Transient

Degenaar et al (ATEL #5006) recently reported elevated X-ray emission from Sgr A* detected in daily monitoring by Swift XRT, which has persisted for at least a day (Dwelly and Ponti, ATEL #5008). We report here on observations of Sgr A* triggered by the detection of a short flare by Swift BAT on April 25, 2013 at 19:15:25UT (Barthelmy et al., GCN #14443).

.....

If this is a new SGR, the angular separation between it and Sgr A* would have to be relatively small (conservatively <4 arcsec). Alternatively the X-ray counterpart of the BAT flare could be below the level of XRT detectability.

We encourage follow-up of Sgr A* during this period of high X-ray emission. In particular we recommend observations by Chandra, to unambiguously determine if the enhanced emission is from Sgr A* or from an unresolved transient.

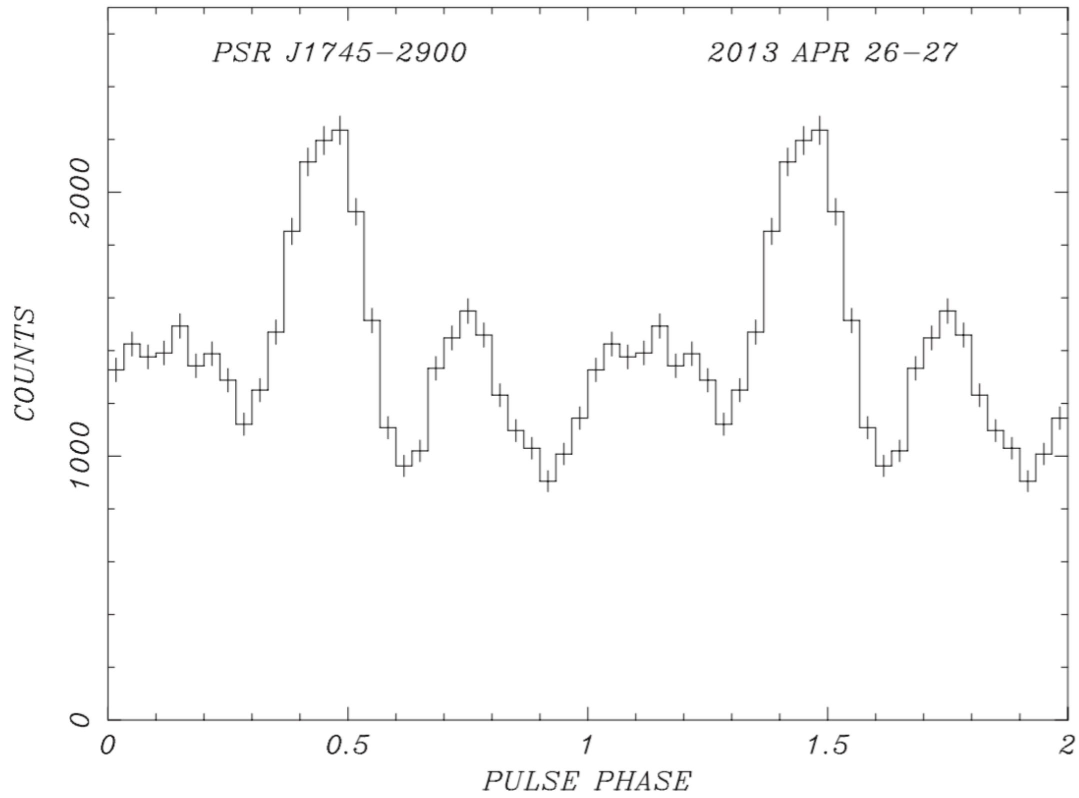


15
10
5
0
BAT 15–100 keV Count rate (count ms⁻¹)
24.8
24.9
25
25.1
25.2
25.3
Time since 2013 April 25 19:15:00 UT (seconds)

27 April 2013

NuSTAR discovery of a 3.76 second pulsar in the Sgr A* region

ATel #5020; **_Kaya Mori, Eric V. Gotthelf (Columbia University), Nicolas M. Barriere (UC Berkeley), Charles J. Hailey (Columbia Univerity) , Fiona A. Harrison (Caltech), Victoria M. Kaspi (McGill University), John A. Tomsick (UC Berkeley), Shuo Zhang (Columbia University)_**
*on **27 Apr 2013; 05:40 UT***
Credential Certification: Jules Halpern (jules@astro.columbia.edu)



30 April 2013

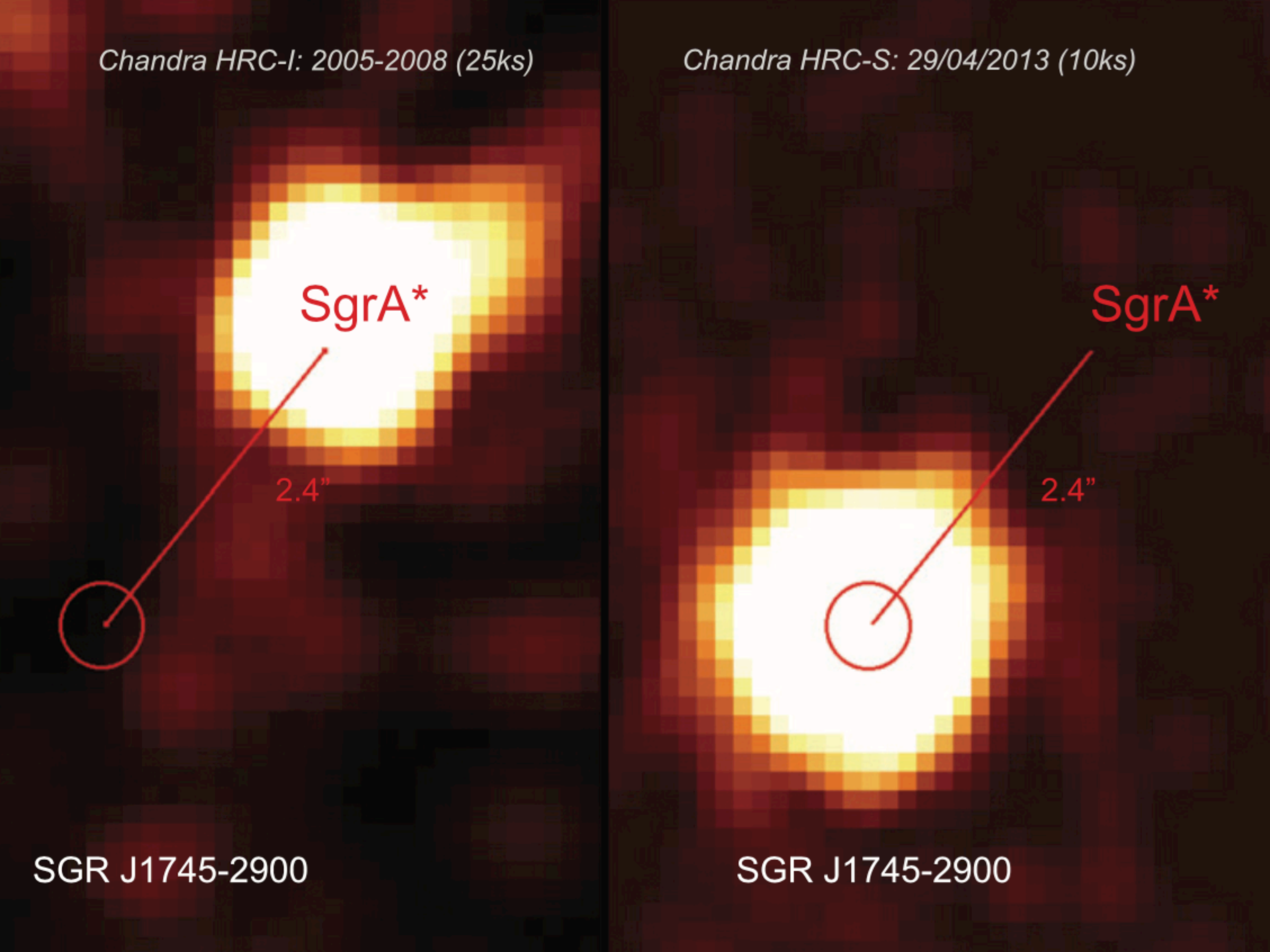
Chandra localization of the soft gamma repeater in the Galactic Center region

ATel #5032; ***N. Rea (CSIC-IEEC), P. Esposito, G. L. Israel (INAF), A. Papitto (CSIC-IEEC), A. Tiengo (IUSS/INAF), F. Baganoff (MIT), D. Haggard (Northwestern/CIERA), S. Mereghetti, M. Burgay, A. Possenti (INAF), S. Zane (MSSL), on behalf of a larger collaboration***

on ***30 Apr 2013; 21:53 UT***

Distributed as an Instant Email Notice Transients

Credential Certification: Nanda Rea (rea@ieec.uab.es)



Chandra HRC-I: 2005-2008 (25ks)
SgrA*
2.4"
SGR J1745-2900
Chandra HRC-S: 29/04/2013 (10ks)
SgrA*
2.4"
SGR J1745-2900

Searches for radio pulsations from the 3.76 second NuSTAR X-ray pulsar in the Galactic centre.

ATel #5027; ***Ralph Eatough (Max-Planck-Institut fuer Radioastronomie: MPIfR), Ramesh Karuppusamy (MPIfR), Michael Kramer (MPIfR), Alex Kraus (MPIfR), Bernd Klein (MPIfR), David Champion (MPIfR), Joris Verbiest (MPIfR), Patrick Lazarus (MPIfR), Paulo Freire (MPIfR), Andreas Brunthaler (MPIfR), Heino Falcke (ASTRON, Nijmegen)***
*on **29 Apr 2013; 16:54 UT***
Credential Certification: Andreas Brunthaler (brunthal@mpifr-bonn.mpg.de)

Following the recent discovery of 3.76 second pulsations in the Sgr A* region by the NuSTAR X-ray telescope (Atel #5020), we have conducted deep radio pulsar searches of the area. Observations have been performed with the Max-Planck-Institut fuer Radioastronomie (MPIfR) Effelsberg radio telescope at frequencies of 4.85 GHz (FWHM=146") and 14.6 GHz (FWHM=51"). High observing frequencies were chosen in order to mitigate the expected strong interstellar scattering in the Galactic centre region. Using cryogenically cooled receivers (system temperatures of 27 K at 4.85 GHz and 50 K at 14.6 GHz) we recorded summed polarisations for 128 spectral channels, across a bandwidth of 500 MHz, and with a data sampling interval of ~65 microseconds. Integration times of approximately one hour were performed at each frequency. No radio pulsations have been detected. For a 10 sigma pulse detection, and assuming a 10% pulse duty cycle, we derive upper limits on the flux density of pulsars of ~0.03 mJy and ~0.08 mJy at 4.85 GHz and 14.6 GHz respectively. We note the possibility of low-level terrestrial radio interference in our data. Sgr A* skims the horizon at the telescope site, making these observations susceptible to interference in the main beam of the telescope. As such we encourage further radio pulsar searches, at these frequencies and others.

Detection of radio pulsations from the direction of the Galactic center Soft Gamma-ray Repeater with Parkes and the GBT

ATel #5035; ***M. Burgay (INAF-Cagliari), R. Shannon (CASS-Marsfield), A. Possenti (INAF-Cagliari), M. Keith (CASS-Marsfield), J. Sarkissian (CASS-Parkes), G. Israel (INAF-O. A.Roma), S. Johnston (CASS-Marsfield), N. Rea (CSIC/IEEC-Barcelona), P. Esposito (INAF-IASF Milano), on behalf of a larger collaboration***
*on **1 May 2013; 13:09 UT***
Credential Certification: Marta Burgay (burgay@ca.astro.it)

For all the observations on-source a strong signal (visible in less than 1 minutes at 1369 MHz, 2000 MHz and 3094 MHz) with a large duty cycle (approaching 100%) was found, showing a rapidly changing period with values close to the 3.76 s detected in the NUSTAR (Atel #5020), and Chandra (Atel #5032) observations. The dispersion measure (DM) appears to be very low, ~< 50 cm-3 pc, although an accurate determination of DM is very hard because of the fact that the shape of the pulses is varying in time and possibly also in frequency.

Detection of radio pulsations from the direction of the NuSTAR 3.76 second X-ray pulsar at 8.35 GHz

ATel #5040; ***Ralph Eatough (Max-Planck-Institut fuer Radioastronomie: MPIfR), Ramesh Karuppusamy (MPIfR), Michael Kramer (MPIfR), Bernd Klein (MPIfR), David Champion (MPIfR), Alex Kraus (MPIfR), Evan Keane (Jodrell Bank Centre for Astrophysics: JBCA), Cees Bassa (JBCA), Andrew Lyne (JBCA), Patrick Lazarus (MPIfR), Joris Verbiest (MPIfR), Paulo Freire (MPIfR), Andreas Brunthaler (MPIfR), Heino Falcke (ASTRON, Nijmegen)***
*on **2 May 2013; 21:48 UT***
Credential Certification: Evan Keane (ekean@jb.man.ac.uk)

Further radio pulsations from the direction of the NuSTAR 3.76-second X-ray pulsar, and a dispersion measure estimate.

ATel #5043; ***Ralph Eatough (Max-Planck-Institut fuer Radioastronomie: MPIfR), Ramesh Karuppusamy (MPIfR), Michael Kramer (MPIfR), Bernd Klein (MPIfR), David Champion (MPIfR), Evan Keane (Jodrell Bank Centre for Astrophysics; JBCA), Alex Kraus (MPIfR), Cees Bassa (JBCA), Andrew Lyne (JBCA), Patrick Lazarus (MPIfR), Joris Verbiest (MPIfR), Paulo Freire (MPIfR), Andreas Brunthaler (MPIfR), Heino Falcke (ASTRON, Nijmegen), Laura Spitler (MPIfR), Ben Stappers (JBCA).***
*on **4 May 2013; 08:27 UT***
Credential Certification: Evan Keane (ekean@jb.man.ac.uk)

8 May 2013

On-going radio observations of PSR J1745-2900 at Effelsberg, Nancay, and Jodrell Bank: flux density estimates, polarisation properties, spin-down measurement, and the highest dispersion measure measured.

ATel #5058; ***Ralph Eatough (Max-Planck-Institut fuer Radioastronomie: MPIfR), Ramesh Karuppusamy (MPIfR), David Champion (MPIfR), Evan Keane (Jodrell Bank Centre for Astrophysics: JBCA), KJ Lee (MPIfR), Michael Kramer (MPIfR), Bernd Klein (MPIfR), Alex Kraus (MPIfR), Cees Bassa (JBCA), Andrew Lyne (JBCA), Ben Stappers (JBCA), Laura Spitler (MPIfR) , Paulo Freire (MPIfR), Ismael Cognard (CNRS-Orleans), Gregory Desvignes (MPIfR), Patrick Lazarus (MPIfR), Joris Verbiest (MPIfR), Andreas Brunthaler (MPIfR), Heino Falcke (ASTRON, Nijmegen)***

on ***8 May 2013; 21:29 UT***

Credential Certification: Evan Keane (ekean@jb.man.ac.uk)

Polarisation profiles and rotation measure of PSR J1745-2900 measured at Effelsberg

ATel #5064; *K. J.Lee (Max-Planck-Institut fuer Radioastronomie: MPIfR), Ralph Eatough (MPIfR), Ramesh Karuppusamy (MPIfR), David Champion (MPIfR), Evan Keane (Jodrell Bank Centre for Astrophysics: JBCA), Michael Kramer (MPIfR), Dominic Schnitzeler (MPIfR), Aris Noutsos (MPIfR), Bernd Klein (MPIfR), Alex Kraus (MPIfR), Cees Bassa (JBCA), Andrew Lyne (JBCA), Ben Stappers (JBCA), Laura Spitler (MPIfR) , Paulo Freire (MPIfR), Ismael Cognard (CNRS-Orleans), Gregory Desvignes (MPIfR), Patrick Lazarus (MPIfR), Joris Verbiest (MPIfR), Andreas Brunthaler (MPIfR), Heino Falcke (ASTRON, Nijmegen)*
on *13 May 2013; 20:01 UT*
Credential Certification: Evan Keane (ekean@jb.man.ac.uk)

We have measured full polarisation (Stokes IQUV) pulse profiles of PSR J1745-2900 at 4.8 and 8.3 GHz. The linear polarisation component is now detected following an increase in our frequency resolution. The degree of linear polarization is nearly 100%. The absence of linear polarisation in our previous measurements (ATel #5058) was due to the Faraday de-polarisation effect. Independent determination of the rotation measure (RM) using 4.8 and 8.3 GHz data suggest a consistent value, RM ~ 66,000 rad/m^2. Thus, as well as having the highest dispersion measure of any known pulsar (ATel #5058), PSR J1745-2900 also has the highest RM by more than an order of magnitude. After the RM correction, the intrinsic polarisation profile of the pulsar can be measured. The high degree of linear polarisation is in agreement with the observations of the other three magnetars seen at radio wavelengths. The polarisation position angle (PA) swing of this pulsar shows an S-shape as expected from a geometrical origin in the so-called rotating vector model. The swing rate is ~ 8 deg/deg (consistent between both frequencies), steeper than previously seen in the other radio magnetars. A detailed analysis will be published elsewhere.

Initial DM + RM

LETTER

doi:10.1038/nature12499

A strong magnetic field around the supermassive black hole at the centre of the Galaxy

R. P. Eatough[1], H. Falcke[1,2,3], R. Karuppusamy[1], K. J. Lee[1], D. J. Champion[1], E. F. Keane[4], G. Desvignes[1], D. H. F. M. Schnitzeler[1], L. G. Spitler[1], M. Kramer[1,4], B. Klein[1,5], C. Bassa[4], G. C. Bower[6], A. Brunthaler[1], I. Cognard[7,8], A. T. Deller[3], P. B. Demorest[9], P. C. C. Freire[1], A. Kraus[1], A. G. Lyne[4], A. Noutsos[1], B. Stappers[4] & N. Wex[1]

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY

MNRASL **435,** L29–L32 (2013) doi:10.1093/mnrasl/slt088
Advance Access publication 2013 August 14

Radio properties of the magnetar near Sagittarius A* from observations with the Australia Telescope Compact Array

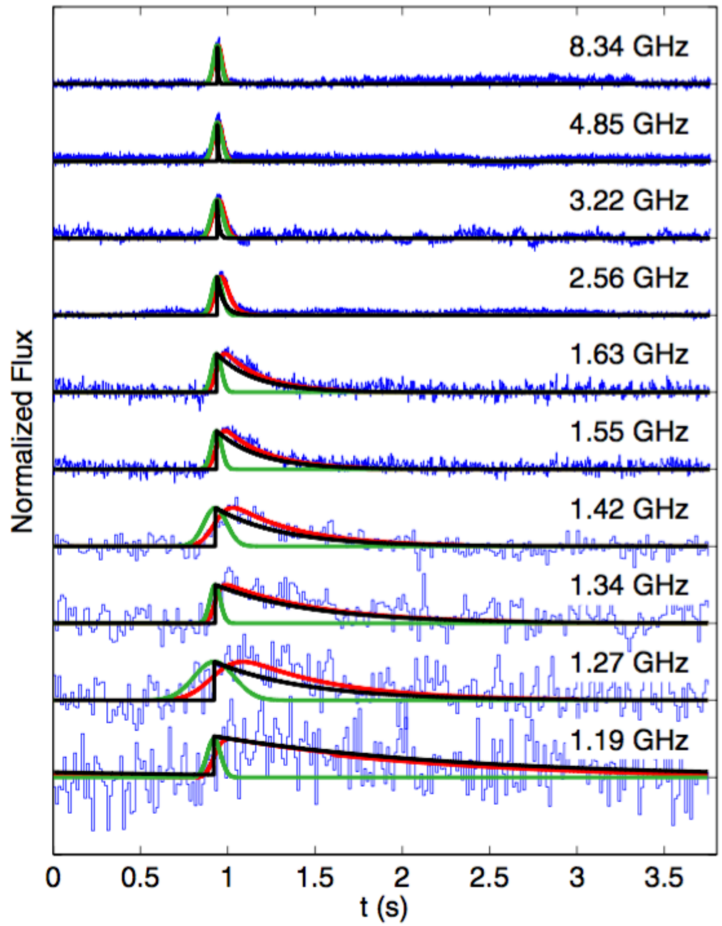
R. M. Shannon★ and S. Johnston
CSIRO Astronomy and Space Science, Australia Telescope National Facility, PO Box 76, Epping, NSW 1710, Australia

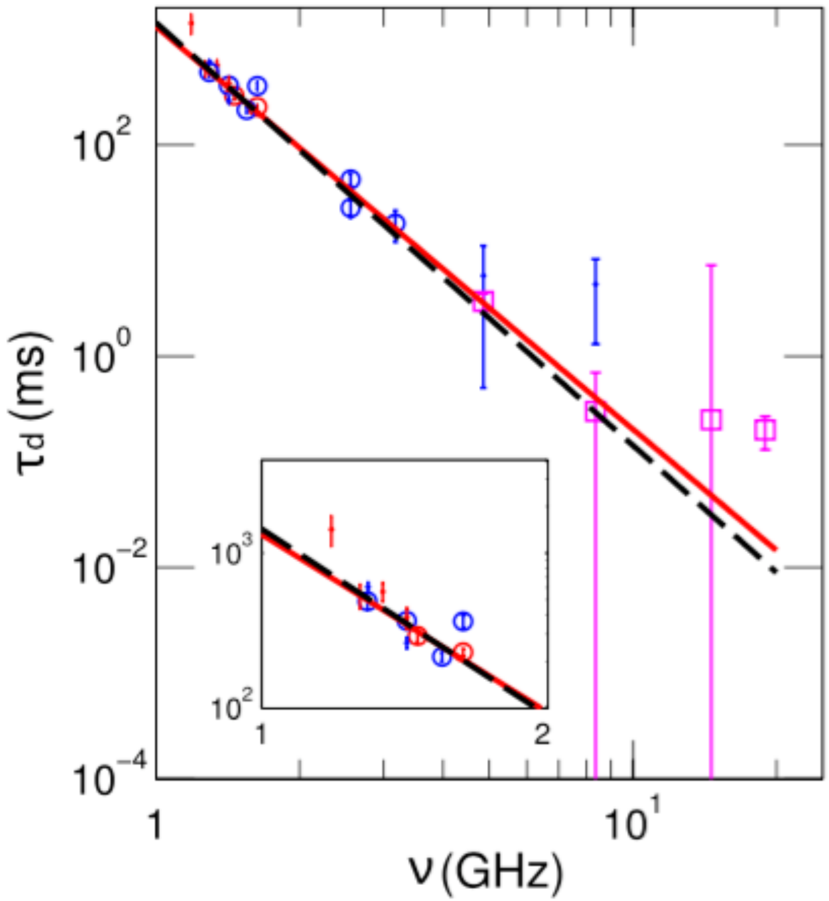
Scattering

The Astrophysical Journal Letters, 780:L3 (6pp), 2014 January 1
doi:10.1088/2041-8205/780/1/L3

PULSE BROADENING MEASUREMENTS FROM THE GALACTIC CENTER PULSAR J1745–2900

L. G. Spitler[1], K. J. Lee[1], R. P. Eatough[1], M. Kramer[1,2], R. Karuppusamy[1], C. G. Bassa[2], I. Cognard[3], G. Desvignes[1], A. G. Lyne[2], B. W. Stappers[2], G. C. Bower[4], J. M. Cordes[5], D. J. Champion[1], and H. Falcke[1,6,7]





Scattering

The Astrophysical Journal Letters, 780:L2 (6pp), 2014 January 1 doi:10.1088/2041-8205/780/1/L2

THE ANGULAR BROADENING OF THE GALACTIC CENTER PULSAR SGR J1745-29: A NEW CONSTRAINT ON THE SCATTERING MEDIUM

Geoffrey C. Bower[1], Adam Deller[2], Paul Demorest[3], Andreas Brunthaler[4], Ralph Eatough[4], Heino Falcke[2,4,5], Michael Kramer[4], K. J. Lee[4], and Laura Spitler[4]

$$\tau = 6.3\ \mathrm{s} \times \left(\frac{D}{8.5\ \mathrm{kpc}}\right)\left(\frac{\theta_1}{1.3\ \mathrm{arcsec}}\right)^2 \left(\frac{D}{\Delta} - 1\right)\nu^{-4},$$

$$\Delta = 5.8 \pm 0.3\ \mathrm{kpc}$$

Implications for GC Pulsar Population

THE ASTROPHYSICAL JOURNAL LETTERS, 783:L7 (5pp), 2014 March 1
doi:10.1088/2041-8205/783/1/L7

THE PECULIAR PULSAR POPULATION OF THE CENTRAL PARSEC

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Received 2013 October 24; accepted 2014 January 22; published 2014 February 13

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY
MNRASL **440,** L86–L90 (2014)
doi:10.1093/mnrasl/slu025
Advance Access publication 2014 February 27

The Galactic Centre pulsar population

Jayanth Chennamangalam[1]★ and D. R. Lorimer[1,2]★
[1]*Department of Physics and Astronomy, West Virginia University, PO Box 6315, Morgantown, WV 26506, USA*
[2]*National Radio Astronomy Observatory, PO Box 2, Green Bank, WV 24944, USA*

Spectrum out to >100 GHz

MNRAS 451, L50–L54 (2015) doi:10.1093/mnrasl/slv063

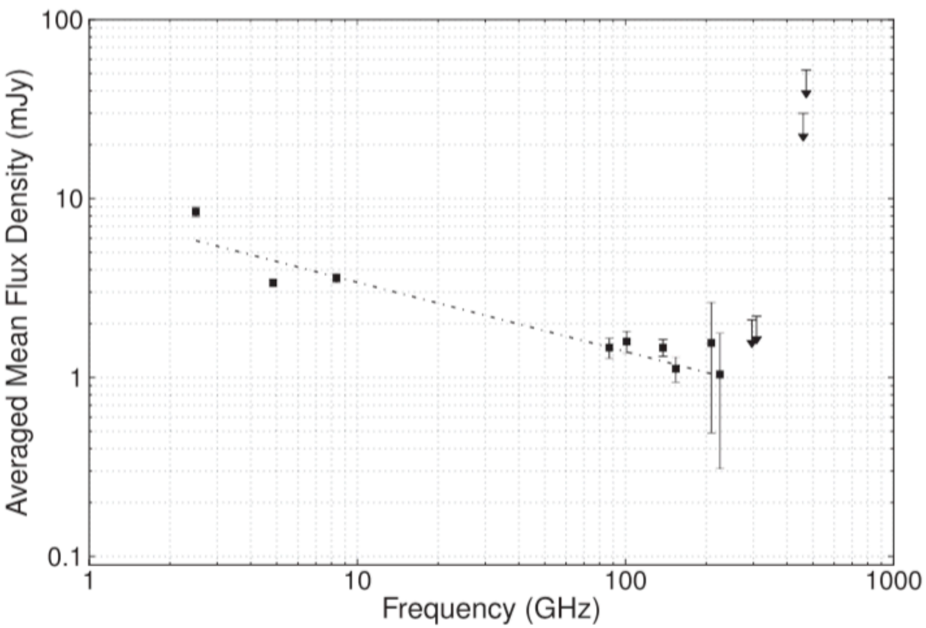
Simultaneous multifrequency radio observations of the Galactic Centre magnetar SGR J1745−2900

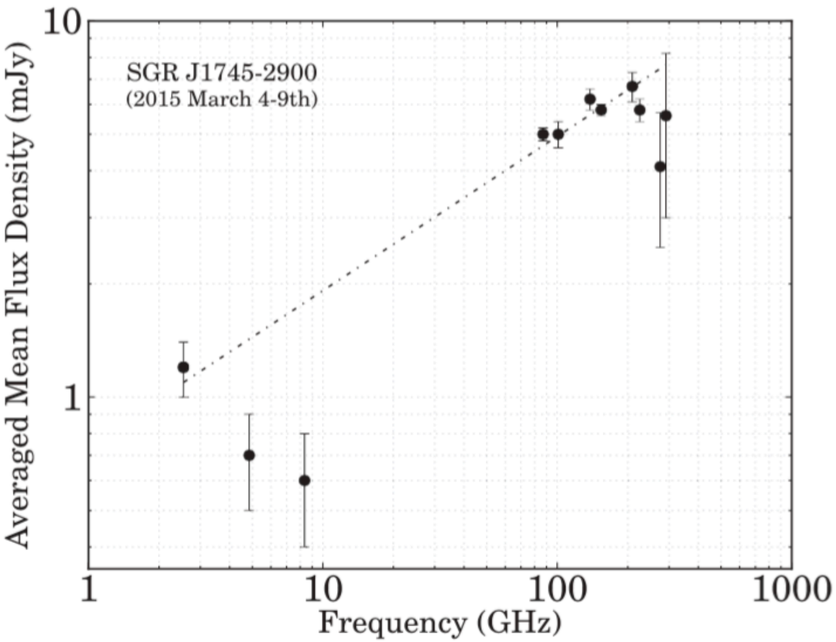
P. Torne,[1★] R. P. Eatough,[1] R. Karuppusamy,[1] M. Kramer,[1,2] G. Paubert,[3] B. Klein,[1,4] G. Desvignes,[1] D. J. Champion,[1] H. Wiesemeyer,[1] C. Kramer,[3] L. G. Spitler,[1] C. Thum,[3] R. Güsten,[1] K. F. Schuster[5] and I. Cognard[6,7]

MNRAS 465, 242–247 (2017) doi:10.1093/mnras/stw2757
Advance Access publication 2016 October 26

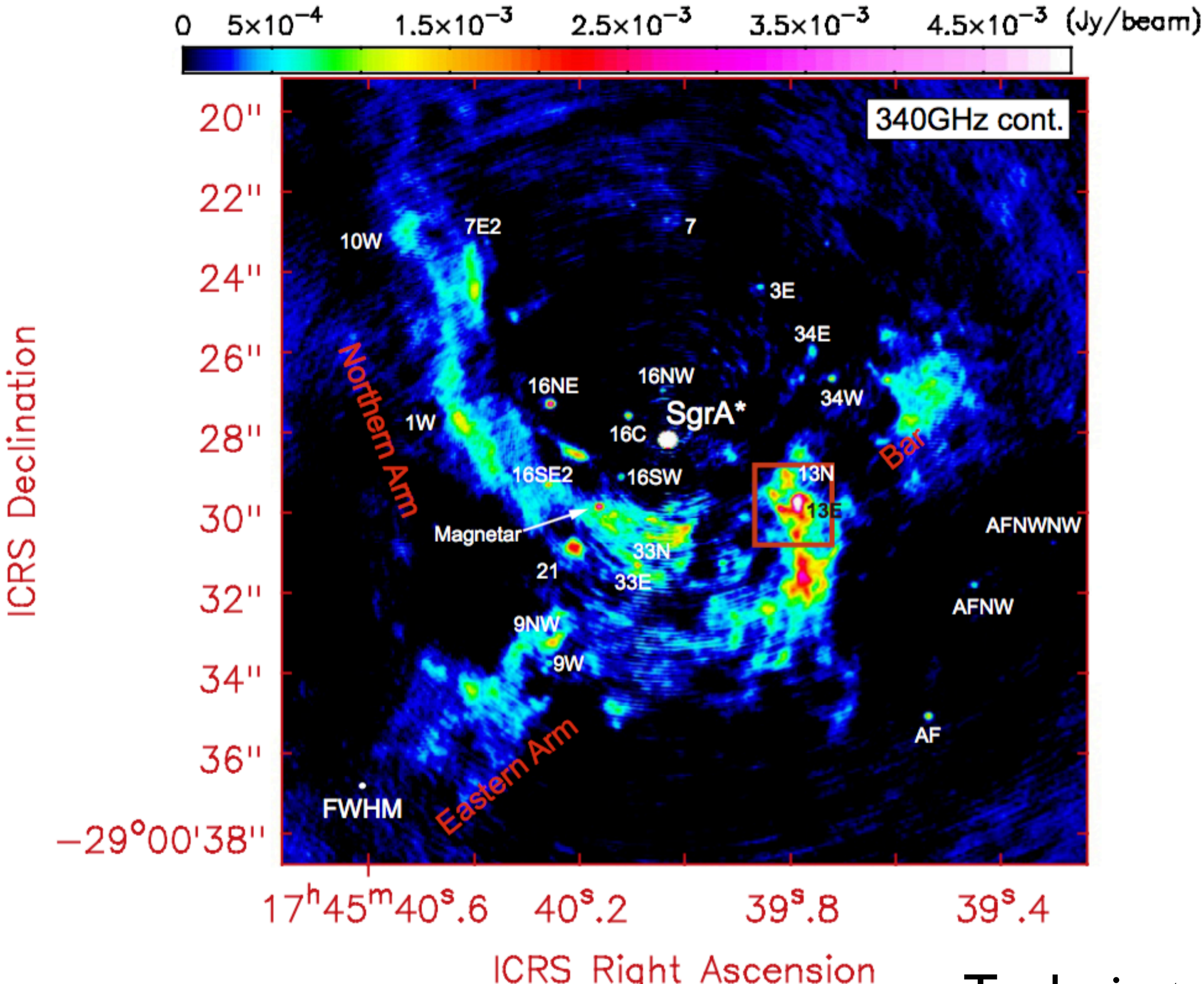
Detection of the magnetar SGR J1745−2900 up to 291 GHz with evidence of polarized millimetre emission

P. Torne,[1★] G. Desvignes,[1] R. P. Eatough,[1] R. Karuppusamy,[1] G. Paubert,[2] M. Kramer,[1,3] I. Cognard,[4,5] D. J. Champion[1] and L. G. Spitler[1]



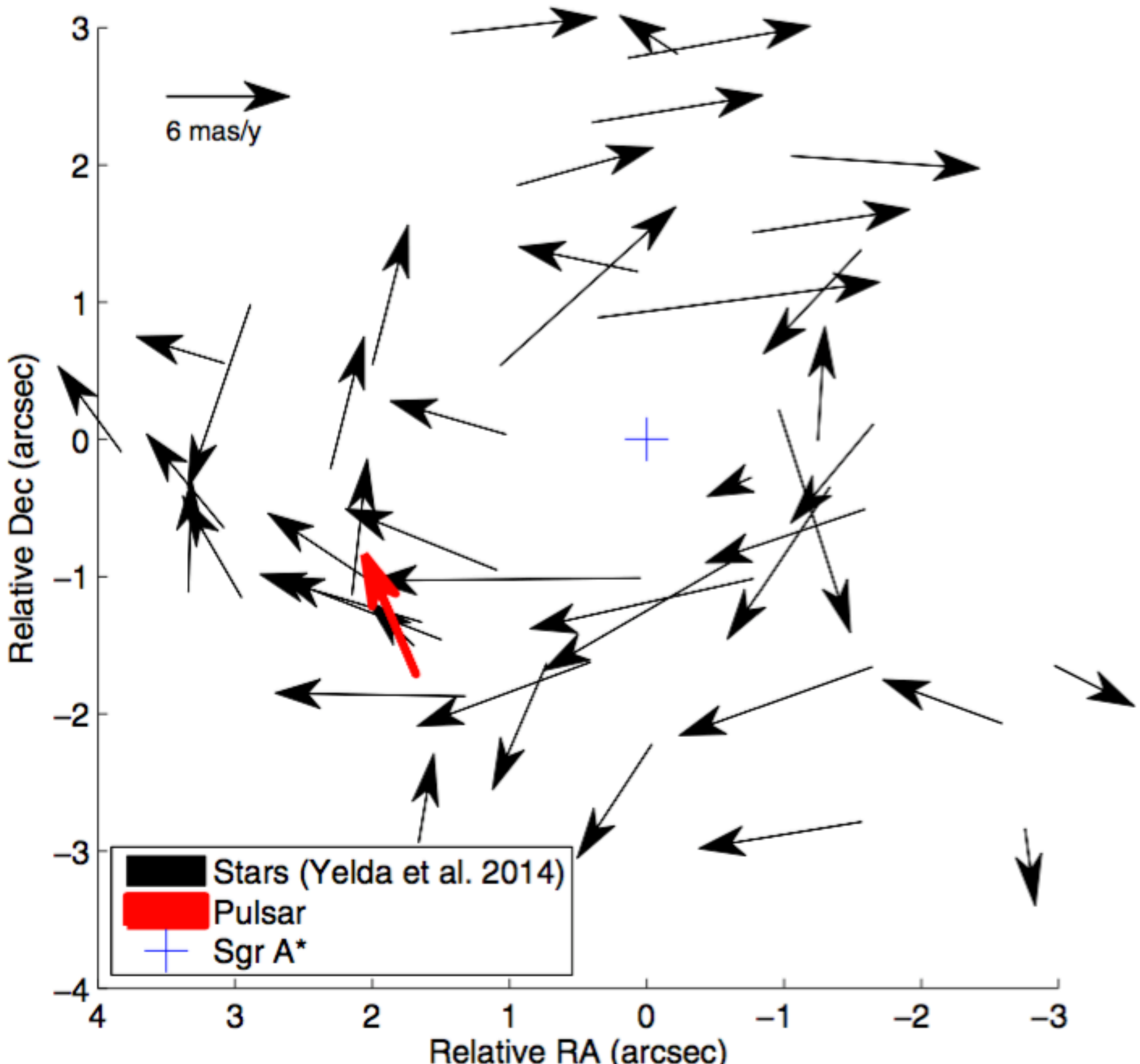


High Frequency Detections

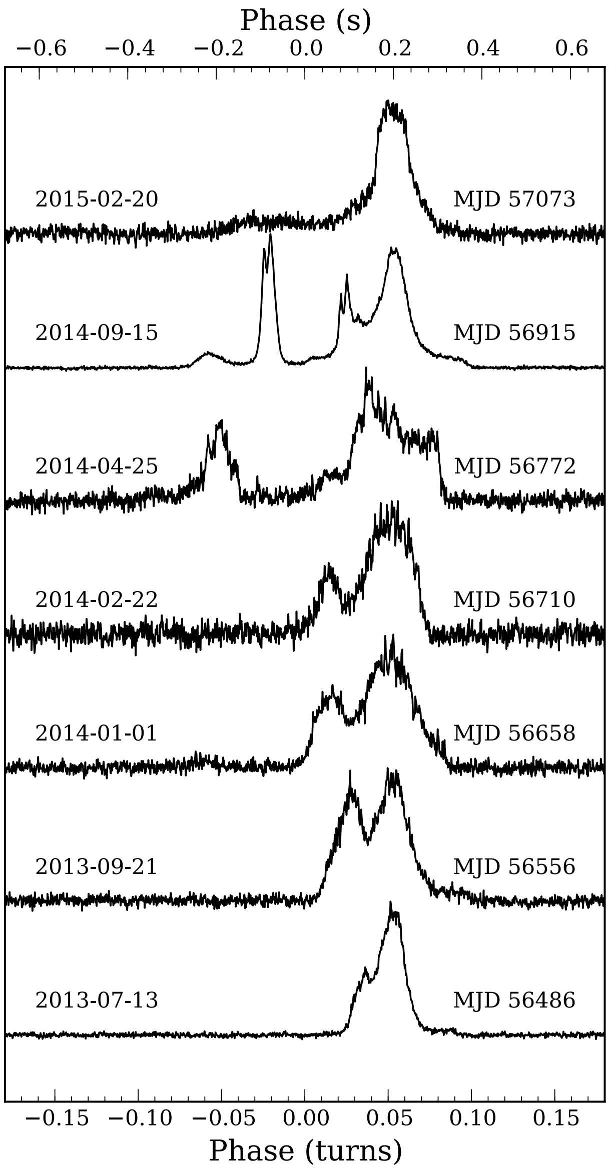


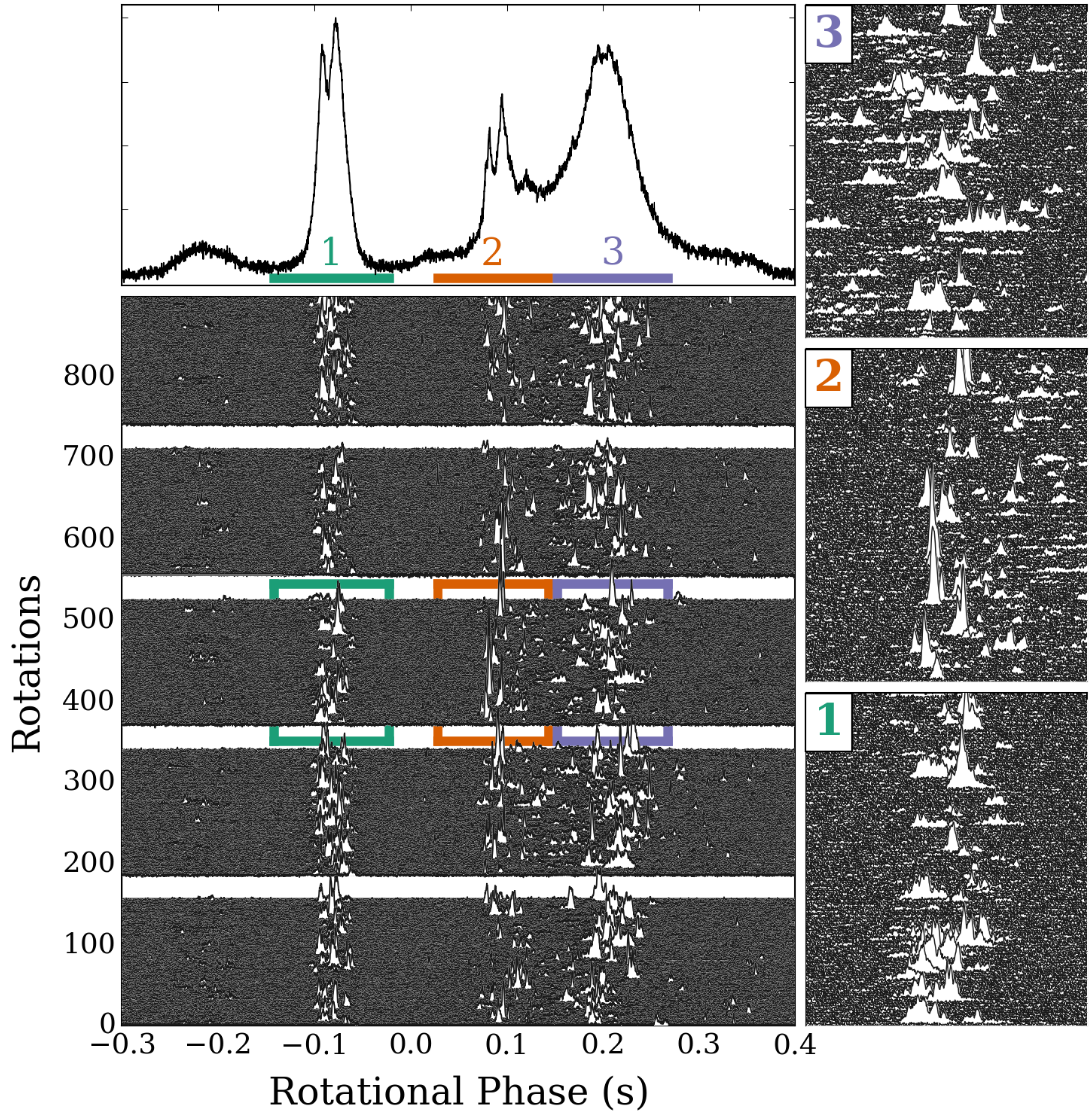
Tsuboi et al. (2018)

Proper Motion



Bower et al. (2018)


Phase (s)
−0.6 −0.4 −0.2 0.0 0.2 0.4 0.6
2015-02-20 MJD 57073
2014-09-15 MJD 56915
2014-04-25 MJD 56772
2014-02-22 MJD 56710
2014-01-01 MJD 56658
2013-09-21 MJD 56556
2013-07-13 MJD 56486
−0.15 −0.10 −0.05 0.00 0.05 0.10 0.15
Phase (turns)


1
2
3
Rotations
0 100 200 300 400 500 600 700 800
−0.3 −0.2 −0.1 0.0 0.1 0.2 0.3 0.4
Rotational Phase (s)
3
2
1

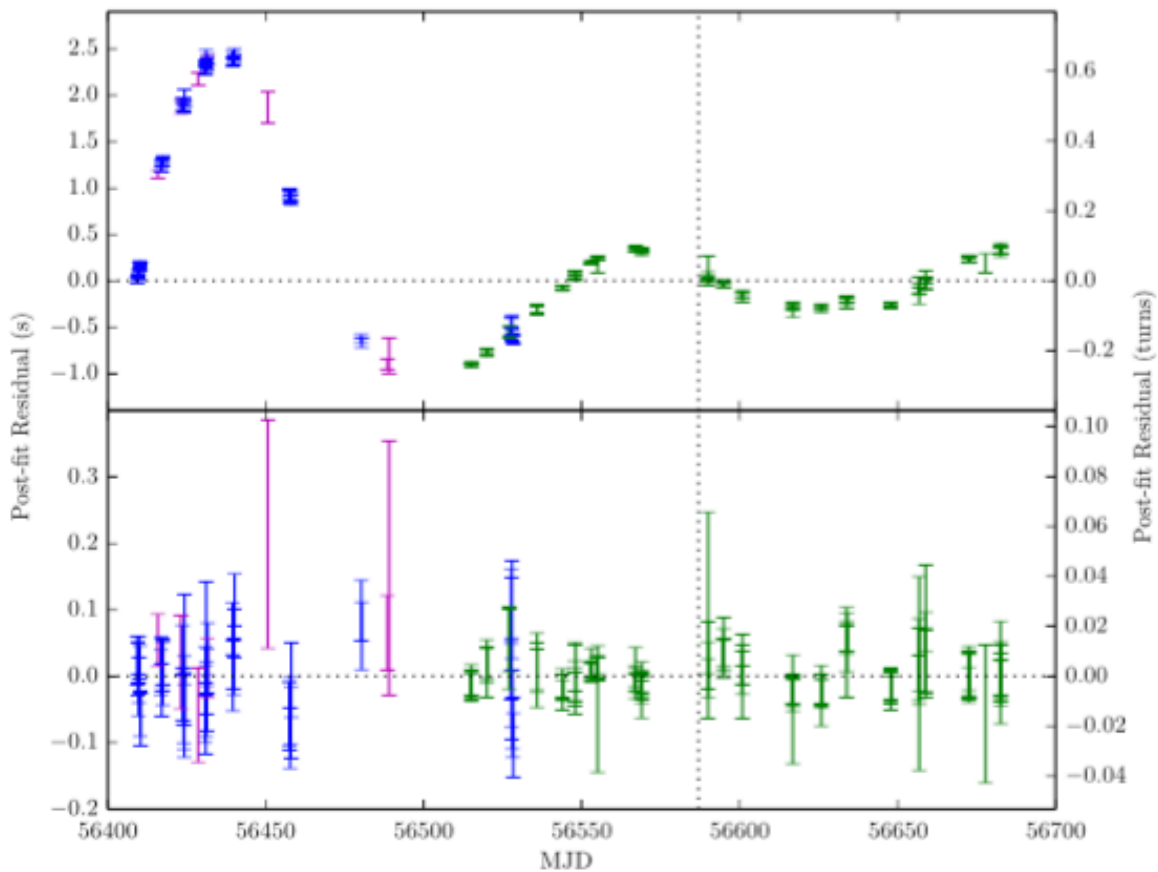
Timing

GREEN BANK TELESCOPE AND *SWIFT* X-RAY TELESCOPE OBSERVATIONS OF THE GALACTIC CENTER RADIO MAGNETAR SGR J1745–2900

RYAN S. LYNCH[1,2,3], ROBERT F. ARCHIBALD[1], VICTORIA M. KASPI[1], AND PAUL SCHOLZ[1]

Table 1
Timing Parameters of SGR J1745–2900

Data, Statistics, and Assumptions	
Data Span (MJD)	56409–56682
$N_{\rm TOA}$	165
Residual rms (ms)	25.6
Solar System Ephemeris	DE421
Clock Correction Procedure	TT(BIPM12)
Fixed Quantities	
R.A. (J2000)	$17^h45^m40\overset{s}{.}169$
Decl. (J2000)	$-29°00'29\overset{''}{.}84$
DM (pc cm^{-3})	1778
Reference Epoch (MJD)	56587.0
Measured Quantities	
f (Hz)	0.2656936554(12)
$\dot{f}$ (Hz s^{-1})	$-1.2399(15) \times 10^{-12}$
$\ddot{f}$ (Hz s^{-2})	$-1.047(13) \times 10^{-19}$
$f^{(3)}$ (Hz s^{-3})	$6.7(1.9) \times 10^{-27}$
$f^{(4)}$ (Hz s^{-4})	$3.74(18) \times 10^{-32}$
$f^{(5)}$ (Hz s^{-5})	$-7.1(2.0) \times 10^{-39}$
$f^{(6)}$ (Hz s^{-6})	$-3.90(26) \times 10^{-44}$
$f^{(7)}$ (Hz s^{-7})	$-5.0(1.4) \times 10^{-51}$
$f^{(8)}$ (Hz s^{-8})	$3.34(30) \times 10^{-56}$
$f^{(9)}$ (Hz s^{-9})	$1.83(11) \times 10^{-62}$
$f^{(10)}$ (Hz s^{-10})	$-1.37(17) \times 10^{-68}$
$f^{(11)}$ (Hz s^{-11})	$-1.71(15) \times 10^{-74}$
$f^{(12)}$ (Hz s^{-12})	$-5.05(43) \times 10^{-81}$
Derived Quantities	
B_s (G)	$2.6018(16) \times 10^{14}$
$\dot{E}$ (erg s^{-1})	$1.3005(16) \times 10^{34}$
τ_c (year)	3395.2(4.1)



DM + RM Variations

THE ASTROPHYSICAL JOURNAL LETTERS, 852:L12 (5pp), 2018 January 1
https://doi.org/10.3847/2041-8213/aaa2f8

CrossMark

Large Magneto-ionic Variations toward the Galactic Center Magnetar, PSR J1745-2900

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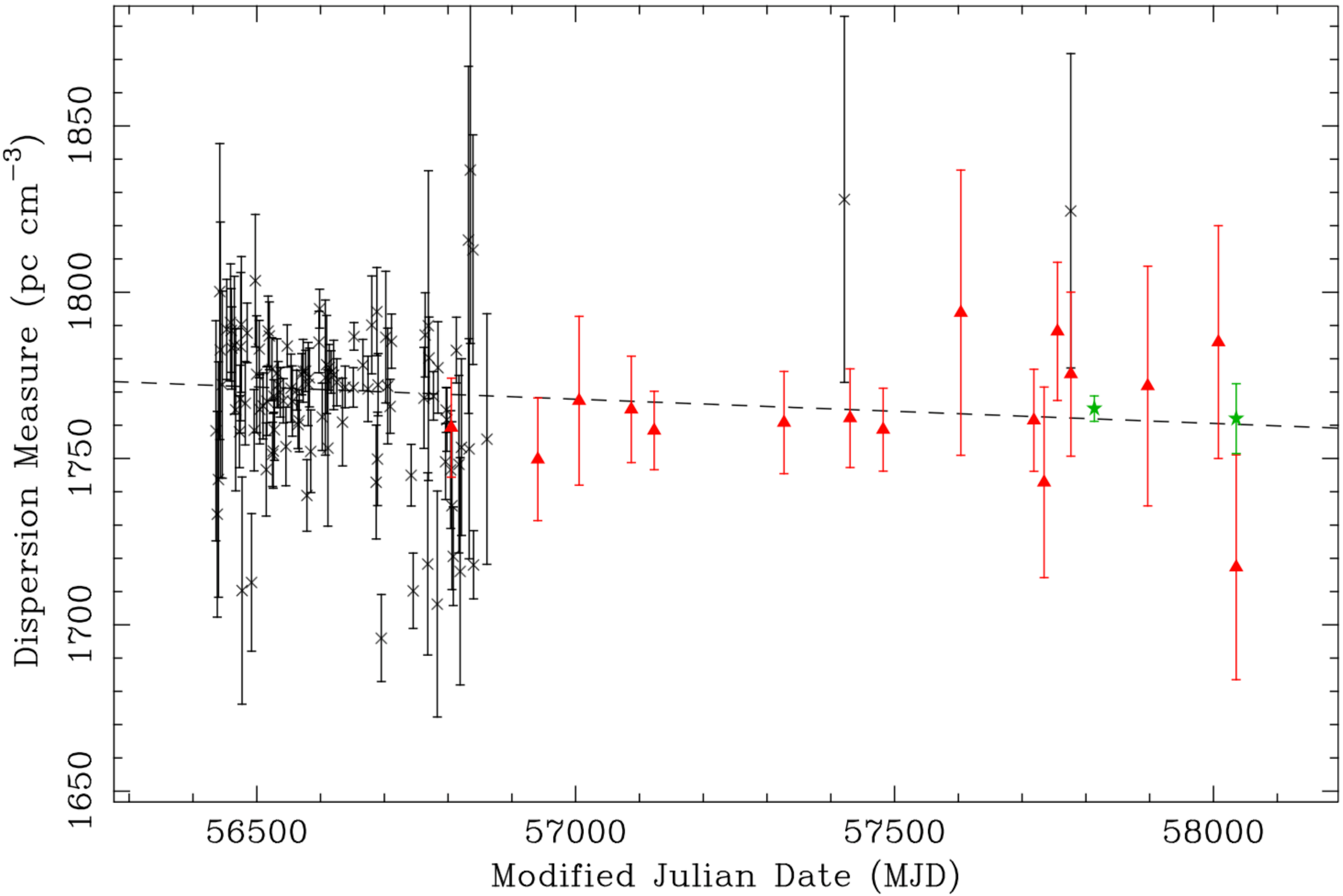
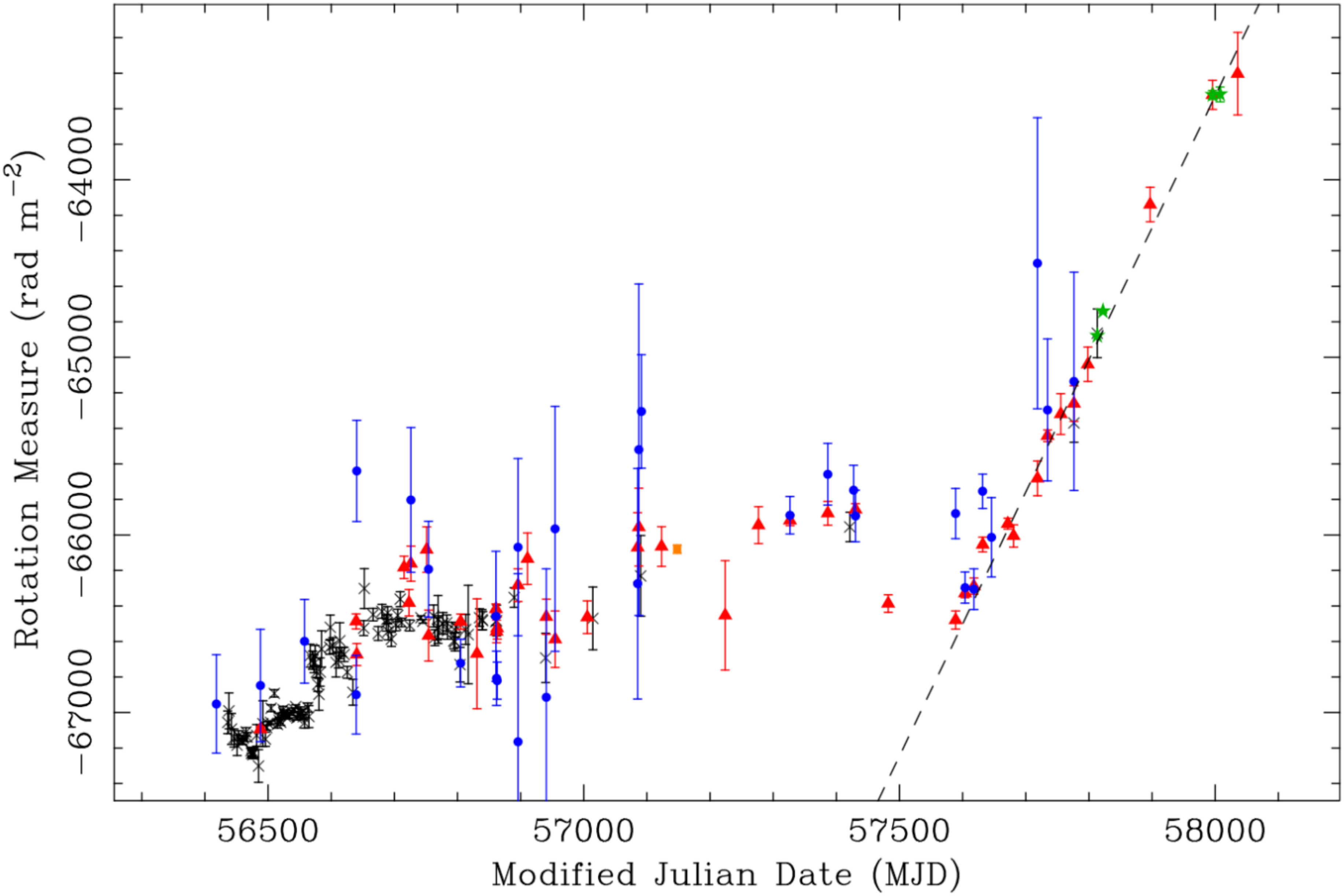
Abstract

Polarized radio emission from PSR J1745−2900 has already been used to investigate the strength of the magnetic field in the Galactic center (GC), close to Sagittarius A*. Here we report how persistent radio emission from this magnetar, for over four years since its discovery, has revealed large changes in the observed Faraday rotation measure (RM), by up to 3500 rad m^{-2} (a 5% fractional change). From simultaneous analysis of the dispersion measure, we determine that these fluctuations are dominated by variations in either the projected magnetic field or the free electron content within the GC, along the changing line of sight to the rapidly moving magnetar. From a structure function analysis of RM variations, and a recent epoch of rapid change of RM, we determine a minimum scale of magneto-ionic fluctuations of size ∼2 au at the GC distance, inferring PSR J1745−2900 is just ∼0.1 pc behind an additional scattering screen.

GC Magnetar J1745-2900

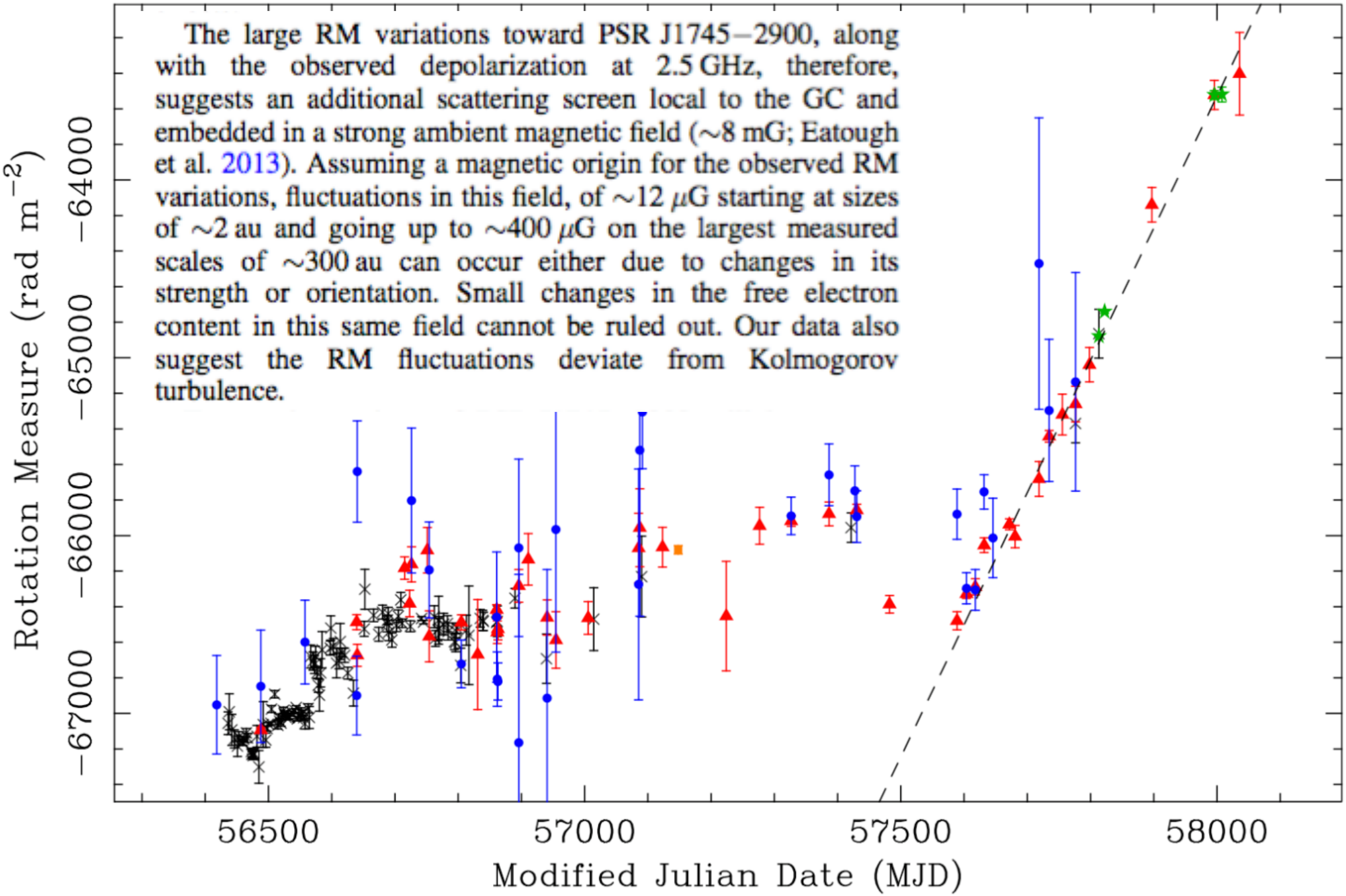


GC Magnetar J1745-2900



GC Magnetar J1745-2900

The large RM variations toward PSR J1745−2900, along with the observed depolarization at 2.5 GHz, therefore, suggests an additional scattering screen local to the GC and embedded in a strong ambient magnetic field (~8 mG; Eatough et al. 2013). Assuming a magnetic origin for the observed RM variations, fluctuations in this field, of ~12 μG starting at sizes of ~2 au and going up to ~400 μG on the largest measured scales of ~300 au can occur either due to changes in its strength or orientation. Small changes in the free electron content in this same field cannot be ruled out. Our data also suggest the RM fluctuations deviate from Kolmogorov turbulence.



Summary + Future