Long-period radio transients

Natasha Hurley-Walker Senior Lecturer, ARC Future Fellow

Gemma Anderson, Arash Bahramian, Ewan Barr, **Ramesh Bhat**, Manisha Caleb, Tracy Clarke, Tim Galvin, Simona Giacintucci, **Paul Hancock**, Ian Heywood, *Csanad Horvath*, Scott Hyman, Emil Lenc, **Sam McSweeney**, **Bradley Meyers**, **John Morgan**, *Tyrone O'Doherty*, **Danny Price**, Kaustubh Rajwade, Nanda Rea, Ben Stappers, **Andrew Williams**, Francesco Coti Zelati, Xiang Zhang







2011



FT190100231 Dr Natasha Hurley-Walker

2019

2016

Curtin University eXtending the GLEAM view of the Universe \$857,533 31/12/2024

2013 HEDDPReth

GLEAM-X J162759.5-523504.3

Article

A radio transient with unusually slow periodic emission

https://doi.org/10.1038/s41586-021-04272-x	N. Hurley-Walker ¹⁵³ , X. Zhang ²³ , A. Bahn P. J. Hancock ¹ , J. S. Morgan ¹ , G. E. Ander The high-frequency radio sky is burs		
Received: 30 July 2021			
Accepted: 19 November 2021			
Published online: 26 January 2022			
Check for updates	been quiet beyond the Galactic pulsa		
	active galactic nuclei. The low-freque		

lurley-Walker[™], X. Zhang²³, A. Bahramian¹, S. J. McSweeney¹, T. N. O'Doherty¹, Hancock¹, J. S. Morgan¹, G. E. Anderson¹, G. H. Heald² & T. J. Galvin¹

The high-frequency radio sky is bursting with synchrotron transients from massive stellar explosions and accretion events, but the low-frequency radio sky has, so far, been quiet beyond the Galactic pulsar population and the long-term scintillation of active galactic nuclei. The low-frequency band, however, is sensitive to exotic coherent and polarized radio-emission processes, such as electron-cyclotron maser



- Hons student
 project: Tyrone
 O'Doherty
- Co-supervised by Paul Hancock
- A technique test: no expectations

- "On" for 30 60 s
- Repeats every **18.18 minutes**
- S ~ **20 50 Jy**
- 90% linearly polarised
- Active Jan Mar 2018 (and never again!)



Galactic Plane Monitoring (GPM; G0080)







10x 30-minute pointings

Revisit every 3 days

June to September 2022

Finding transients





Csanad Horvath (3rd year), Nick Swainston (ADACS), Tim Galvin, John Morgan

MWA Image Plane Transient Classifier Home page Survey status Candidate table Candidate rating Session Settings

nhurleywalker Manage Tokens Change Password Log Out

Candidate Rating ID:11325



Finding transients





Csanad Horvath (3rd year), Nick Swainston (ADACS), Tim Galvin, John Morgan

MWA Image Plane Transient Classifier Home page Survey status Candidate table Candidate rating Session Settings

nhurleywalker Manage Tokens Change Password Log Out

Candidate Rating ID:11325





Finding transients

Csanad Horvath (3rd year), Nick Swainston (ADACS), Tim Galvin, John Morgan





GPM J1839-10





5-min observation 4-s time steps

Another periodic transient!



P~1318s

Another periodic transient!



P~1318s

Compared to J1627:

- Intermittent
- Much wider pulses
 - (up to 400s)
- Variable pulse morphology



GLEAMX J162759.5-523504.3

P~1090s

Dispersion and distance



Dispersion and distance





Scattering timescale at 80 MHz ~ 60s!

Follow-up

MWA 72 – 231 MHz Tim Galvin Csanad Horvath Andrew Williams

MeerKAT 500 — 1000 MHz

Ewan Barr, Manisha Caleb, Ian Heywood, Yunpeng Men, Kaustubh Rashwade, Ben Stappers

UTMOST

805 — 860 MHz Chris Flynn

Matthew Bailes

ASKAP 0.5 — 1 GHz Emil Lenc Vanessa Moss

GHz Noss

Parkes 0.7 – 4 GHz Ramesh Bhat Danny Price ATCA 5 – 9 GHz Gemma Anderson Tim Galvin

Success!



Archival search





Detections over >33 years



Period = 1318.19576 s

202	2-08-06 13:38	-100	and the state of the second	and and	2022	-08-06	13:43
202	2-08-06 13:19	-		Aprepting	2022	-08-06	13:24
202	2-08-06 12:34	1	all and a stand				
202	2-08-03 15:19	-	annound a sound have		2022	-08-03	15:24
202	2-08-03 14:59		and the second s	1			
202	2-08-03 13:50	44		1	2022	-08-03	13:55
202	2-08-03 13:30	-	and the second s		2022	-08-03	13:35
202	2-08-03 13:11		Harrow Mary Mary Mary Mary				
202	2-08-02 13:44		Harden Mandan and and and	1			
202	2-08-02 13:20		- Manus	i.	2022	-08-02	13:24
202	2-08-02 13:00		much and and the the	1			
202	2-07-30 15:44		and the party in the second second		2022	-07-30	15:49
202	2-07-30 15:24	defailed.	and the second s	and and	2022	-07-30	15:29
202	2-07-30 15:04	-		Sec. 1	a series	5. 50	
202	2-07-30 13-31		and the standard and the standards	1	2022	-07-30	13:36
202	2-07-30 13-12	the second second	Ald	1	2022	-07-30	13.16
202	2-07-30 13:12	4.4.1.	all a second statements of	1	2022	-07-30	13.10
202	2-07-29 13:23	appender	and the second				
202	2-07-29 13:00		for the share				
202	2-07-25 13:26	Apparent marge	un and a state of the state of	1			
202	2-07-23 15:18	and and a second	man and the second seco	in	2022	-07-23	15:23
202	2-07-23 14:58		- Cal		2022	-07-23	15:03
202	2-07-22 15:12		Hand Marthan Marthan	1			
202	2-07-22 14:47		- Aman	1	2022	-07-22	14:52
202	2-07-22 14:27		A starter of a day of a start with	I THE REAL PROPERTY.			
202	2-07-20 19:12	_	mm				
202	2-07-17 12:53		1 ml mm				
202	2-07-17 12:28		1 miles	1	2022	-07-17	12:33
202	2-07-15 16-59	- Marchen and	Lan surger Market A.C.	1	2022	-07-15	16.58
202	2-07-15 16:33	and a second	as when the	and and an	2022	-07-15	16.38
202	2-07-15 10:55		A Block to a second	1 and the second	2022	07 15	15.00
202	2-07-15 15:04	-	I Provide the second second	The state	2022	-07-12	12:08
202	2-07-15 14:44				1		
202	2-07-15 14:25		forthe advant designation	-	\$		
202	2-07-14 14:56		under the manufacture and the second second	i i			
202	2-07-14 14:36		Antelinenenterinterinter		-		
202	2-06-30 16:17		matheman	frees	15		
202	2-06-30 15:52	-	An	1			
202	2-05-19 11:53		how	1			
202	2-05-18 08:03		\wedge	1			
202	2-05-06 08-59		mund	1			
202	2-04-19 13.09		whitew	1			
202	1-02-24 13.37		LA.				
201	8-06-12 16-11		~~~~~	1	2019	-06-12	16.13
201	0-00-12 10:11				2010	04 21	12.20
201	0-04-21 13:2/		AMA and	1	2018	-04-21	13:29
201	2-01-1/03:33			1			
201	5-01-03 09:41		in	1			
201	5-01-03 07:06			į.			
201	4-05-08 22:05			1			
201	3-08-27 13:26		m	1			
200	7-12-14 11:58		\wedge	1			
200	7-11-29 13:27		\sim	1			
200	7-11-29 13:06		\wedge	1			
200	7-11-17 12:54		\sim	1			
200	2-05-12 21.16		~~~				
200	2-05-12 19:05			1			
200	1-08-31 02.20		Time	1			
200	1.04.28 13.21			1			
200	1-04-20 15:21		~~~~	1			
200	1-04-28 11:31			1			
198	8-09-23 22:11			i i			
-				-		-	
	100	~					
.000	-400	-2	00 0 20	00	4	100	60
			Time o(c)				
			lime (s)				

Detections over >33 years





2022-08-06 13:38	2022-08-06 13:43
2022-08-06 13:19	2022-08-06 13:24
2022-08-06 12:34	And a second
2022-08-03 15:19	2022=08-03 15:24
2022-08-03 14:59	and the second
2022-08-03 13:50	2022-08-03 13:55
2022-08-03 13:30	2022-08-03 13:35
2022-08-03 13:11	And the second description of the second sec
2022-08-02 13:44	mundan sharen and all
2022-08-02 13:20	2022-08-02 13:24
2022-08-02 13:00	much water had Marthand
2022-07-30 15:44	2022-07-30 15:49
2022-07-30 15:24	2022-07-30 15:29
2022-07-30 15:04	and the second se
2022-07-30 13:31	2022-07-30 13:36
2022-07-30 13-12	ALL 2022-07-30 13:16
2022-07-20 13-25	allalad a laterative a manufactor and all the angle of the second s
2022 07 20 13:06	
2022-07-25 13.00	
2022-07-23 13:20	
2022-07-23 15:10	
2022-07-23 14:50	2022-07-23 15:03
2022-07-22 15:12	
2022-07-22 14:47	2022-07-22 14:52
2022-07-22 14:27	Lighting & advantages alles
2022-07-20 19:12	
2022-07-17 12:53	- marken
2022-07-17 12:28	2022-07-17 12:33
2022-07-15 16:53	2022-07-15 16:58
2022-07-15 16:33	2022-07-15 16:38
2022-07-15 15:04	2022+07-15 15:09
2022-07-15 14:44	
2022-07-15 14:25	In the Alexander and a second s
2022-07-14 14:56	and the first function of the second second second
2022-07-14 14:36	Antillingen have been been been been been been been be
2022-06-30 16:17	
2022-06-30 15:52	A
2022-05-19 11:53	1
2022-05-18 08:03	^
2022-05-10 00.03	
2022-03-00 00.35	- August
2022-04-19 13:09	AL MARK
2021-02-24 13:37	
2018-06-12 16:11	2018-06-12 16:13
2018-04-21 13:27	W 1 2018-04-21 13:29
2015-01-17 03:33	
2015-01-03 09:41	. M
2015-01-03 07:06	
2014-05-08 22:05	
2013-08-27 13:26	m
2007-12-14 11:58	\wedge
2007-11-29 13:27	~~
2007-11-29 13:06	\wedge
2007-11-17 12:54	\sim
2002-05-12 21-16	
2002-05-12 19:05	\sim
2001-08-31 02.20	min
2001-04-28 13-21	a Mari
2001-04-20 13:21	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
1000 00 22 22.11	
1 1 200-03-52 55:11	
H	
500 -400	_200 0 200 400 6
-400	-200 0 200 400 6
	Time (s)
	11116 (5)

Detections over >33 years

 $m \Rightarrow$ constraint on period derivative $\dot{P} < 4 imes 10^{-13} {
m s} \, {
m s}^{-1}$

And spin-down luminosity

$$L_{
m spin}=rac{4\pi^2 I\dot{P}}{P^3}$$
 $L_{
m spin}<10^{24}
m erg s^{-1}$

Period = 1318.19576 s

2022-08-06 13:38	an and the state of the state o	2022-08-06 13:43
2022-08-06 13:19	and the second s	2022-08-06 13:24
2022-08-06 12:34	Salaran Proping in the second second	
2022-08-03 15:19	aparameter and Manager	2022-08-03 15:24
2022-08-03 14:59	and the second s	
2022-08-03 13:50	the second secon	2022-08-03 13:55
2022-08-03 13:30	many many many many many many many many	2022-08-03 13:35
2022-08-03 13:11	Harrison Harrison Harrison Barrison Barrison	
2022-08-02 13:44	Heren Manager and and and	
2022-08-02 13:20		2022-08-02 13:24
2022-08-02 13:00	man man man man	
2022-07-30 15:44	show a find have been and and and and and and and and and an	2022-07-30 15:49
2022-07-30 15:24	Construction (The VIC) of the State of the State	2022-07-30 15:29
2022-07-30 15:04	and the second s	and the second state
2022-07-30 13:31	- handlike here and h	2022-07-30 13:36
2022-07-30 13:12	1 All	2022-07-30 13:16
2022-07-29 13:25	in the second of	2022 07 00 10110
2022-07-29 13:06	i mant a	
2022-07-25 13:26		~
2022-07-23 15:18	the second s	2022 07 23 15:23
2022-07-23 13.10	and the state of t	2022-07-23 15.23
2022-07-23 14:38		2022-07-23 15:05
2022-07-22 15:12	the second second second	2022 07 22 14:52
2022-07-22 14:47		2022-07-22 14:52
2022-07-22 14:27	A STATE OF THE OWNER	
2022-07-20 19:12	- www.	
2022-07-17 12:53	Andrea	
2022-07-17 12:28	- Coloring	2022-07-17 12:33
2022-07-15 16:53	the state of the s	2022-07-15 16:58
2022-07-15 16:33		2022-07-15 16:38
2022-07-15 15:04	and the second states a	2022-07-15 15:09
2022-07-15 14:44	- hill -	
2022-07-15 14:25	han New Manuscher	hitse
2022-07-14 14:56		
2022-07-14 14:36	Manual	and the second se
2022-06-30 16:17	and	
2022-06-30 15:52	- And -	
2022-05-19 11:53	lun	
2022-05-18 08:03	A	
2022-05-06 08:59		
2022 03 00 00.55	a history	
2022-04-19 13.09	LA VIE	
2021-02-24 13.37		2019 06 12 16:12
2018-06-12 10:11		2018-00-12 10:13
2018-04-21 13:27	ANN IN	2018-04-21 13:29
2015-01-17 03:33		
2015-01-03 09:41	M	
2015-01-03 07:06		
2014-05-08 22:05		
2013-08-27 13:26	m	
2007-12-14 11:58		
2007-11-29 13:27		
2007-11-29 13:06	\wedge	
2007-11-17 12:54	~	
2002-05-12 21:16		
2002-05-12 19:05	~	
2001-08-31 02:20	m	
2001-04-28 13:21	a Ma	
2001-04-28 11:31		
1988-09-23 22.11		
1300-09-23 22.11		
	i i i	
00 -400 -	200 0 200	400 60
400	200 0 200	400 00
	Time (s)	
	· · · · · · · · · · · · · · · · · · ·	

_

Detections over >33 years

ightarrow constraint on period derivative $\dot{P} < 4 imes 10^{-13} {
m s} \, {
m s}^{-1}$

And spin-down luminosity



Period = 1318.19576 s

2022-08-06 13:38	- and the state of the second	2022-08-06 13:43
2022-08-06 13:19 🌰	Harding and a second se	2022-08-06 13:24
2022-08-06 12:34	Hale contraction in the second second	
2022-08-03 15:19	man har	2022-08-03 15:24
2022-08-03 14:59	mathematic Participation of the second	
2022-08-03 13:50	The stand in the first faither	2022-08-03 13:55
2022-08-03 13:30		2022-08-03 13:35
2022-08-03 13:11		
2022-08-02 13:44	All and an and a second se	
2022 08 02 13.11	A 1.00	2022 08 02 12:24
2022-00-02 13.20		2022-00-02 1J.24
2022-08-02 13:00	strend providence day a state with	2022 07 20 15:40
2022-07-30 15:44	and a long to the house of the second to the	2022-07-30 15:49
2022-07-30 15:24	and the second state of the second state and a	2022-07-30 15:29
2022-07-30 15:04	put hat we have a second	and the second se
2022-07-30 13:31	month in here and	2022-07-30 13:36
2022-07-30 13:12		2022-07-30 13:16
2022-07-29 13:25	aline and a second and a second and a second as a s	
2022-07-29 13:06	monthe	and the second se
2022-07-25 13:26	and the second se	
2022-07-23 15:18	and and the state of the state	2022-07-23 15:23
2022-07-23 14:58	Martin Card	2022-07-23 15:03
2022 07 22 15:12	A A A	CUEZ-07-25 15.05
2022-07-22 13:12	the second second second	2022 07 22 14-52
2022-07-22 14:47		2022-07-22 14:52
2022-07-22 14:27	Antonio and a state of the stat	
2022-07-20 19:12	- mm	
2022-07-17 12:53	Andrea	
2022-07-17 12:28	- Call and a second	2022-07-17 12:33
2022-07-15 16:53	Anone was seen and the second second	2022-07-15 16:58
2022-07-15 16:33		2022-07-15 16:38
2022-07-15 15:04	Blacks sweet at all	2022-07-15 15:09
2022-07-15 14:44		Bart Merell are
2022-07-15 14:25	hand the second	his constant
2022-07-14 14:56	and the building of the second	and the second se
2022-07-14 14:36	And its	to be bell a
2022-06-30 16:17		
2022-00-30 10.17	A starting and a star	and and a second s
2022-00-30 13.32	Laplace and a property of the second se	
2022-05-19 11.55	1	
2022-05-18 08:03		
2022-05-06 08:59	man	
2022-04-19 13:09	when	
2021-02-24 13:37	N.	
2018-06-12 16:11	~~~~~	2018-06-12 16:13
2018-04-21 13:27	NW h	2018-04-21 13:29
2015-01-17 03:33	····	
2015-01-03 09:41	A	
2015-01-03 07:06	a Mamala	
2014-05-08 22:05		
2013-08-27 13-26	- m	
2013-00-27 13.20		
2007-12-14 11:58		
2007-11-29 13:27		
2007-11-29 13:06		
2007-11-17 12:54		
2002-05-12 21:16		
2002-05-12 19:05		
2001-08-31 02:20	m	
2001-04-28 13:21	m	
2001-04-28 11:31	~~~	
1988-09-23 22:11		
	16011080	
00 -400	-200 0 20	0 400 6
	$\operatorname{Time}_{\mathcal{A}}(z)$	
	lime (s)	

Crossing the death lines



Daily **Hail** AUSTRALIA

Home U.K. Rovals U.S. News World News Sport TV&Showbiz Femail AU Health Science Weather Video Travel

Login

Search

CP X

Latest Headlines | Facebook | YouTube | Google | eBay | Microsoft

Are aliens trying to contact Earth? Scientists discover a mysterious stellar object that emits a five-minute pulse every 22 minutes - and they have no idea what it is

• The magnetar is 15,000 light-years away from Earth in the Scutum constellation

Experts say this 'remarkable' stellar object is only the second of its kind detected

By SAM TONKIN FOR MAILONLINE UPDATED: 01:38 AEST, 20 July 2023



If aliens were to contact Earth, what would it sound like?

Such a scenario has been imagined countless times in science fiction but in reality we have no proof extraterrestrials even exist.

That hasn't dampened the excitement that an advanced civilisation might be out there, however, and the discovery of a mysterious stellar object which emits a fiveminute pulse every 22 minutes will only serve to intensify that.



iew comments

Home | U.K. | Royals | U.S. | News | World News

Latest Headlines | Facebook | YouTube | Google | eBay |

Are aliens trying to co Scientists discover a stellar object that em pulse every 22 minute have no idea what it is

- The magnetar is 15,000 light-years away fro
- Experts say this 'remarkable' stellar object i

By SAM TONKIN FOR MAILONLINE UPDATED: 01:38 AEST, 20 July 2023



If aliens were to contact Earth, what would it s

Such a scenario has been imagined countless we have no proof extraterrestrials even exist.

That hasn't dampened the excitement that an a image001.png there, however, and the discovery of a mysteria minute pulse every 22 minutes will only serve to intensify that.



< Back to Article List

A rare, mysterious radio source is stumping astronomers

This distant object has been flashing a signal for three decades. It might be a magnetar, a white dwarf — or something entirely new.

By Elizabeth Gamillo | Published: July 24, 2023

^



In 1988, radio telescopes picked up a transient signal from 15,000 light-years away within the constellation Scutum. E it remained unnoticed for three decades. Fast-forward to today: Astrophysicists have recently rediscovered the obje to find that its source may be a magnetar – a rare type of neutron star with a powerful magnetic field that sends ener into space as it spins. Named GPM J1839-10, this star displays behavior unlike any previously noted.

All other known magnetars have sneedy neriods ranging f



Elon Musk's Neuralink could be used as 'personality-altering' weapons -...

AUSTRALIA

Home | U.K. | Royals | U.S. | News | World News

Latest Headlines | Facebook | YouTube | Google | eBay |

Are aliens trying to cc Scientists discover a Stellar object that em pulse every 22 minute have no idea what it is By Elizabeth

- The magnetar is 15,000 light-years away fro
- Experts say this 'remarkable' stellar object i

By SAM TONKIN FOR MAILONLINE UPDATED: 01:38 AEST, 20 July 2023



If aliens were to contact Earth, what would it s

Such a scenario has been imagined countless we have no proof extraterrestrials even exist.

That hasn't dampened the excitement that an a image0 there, however, and the discovery of a mysteria minute pulse every 22 minutes will only serve to intensify that.

Astronomy

A Mysterious Object in Deep Space Has Blinked Every 22 Minutes for Over 30 Years

Isaac Schultz

Published 1 week ago: July 21, 2023 at 12:03 pm



ce Exploration 🗸

vhite dwarf - or something

Login/R

The Magaz





ENCLOSIVE. ON warns brain chips like Elon Musk's Neuralink could be used as 'personality-altering' weapons -... picked up a transient signal from vithin the constellation Scutum. If three decades. Fast-forward to ve recently rediscovered the obje y be a magnetar — a rare type of ful magnetic field that sends ene med GPM J1839-10, this star ny previously noted.

rs have sneedy neriods ranging fr

Home | U.K. | Royals | U.S. | News | World News

Latest Headlines | Facebook | YouTube | Google | eBay |

< Back to Ar Are aliens trying to co Scientists discover a A rar stellar object that em This dist pulse every 22 minute entirely n have no idea what it is By Elizabeth

- The magnetar is 15,000 light-years away fro
- Experts say this 'remarkable' stellar object i

By SAM TONKIN FOR MAILONLINE UPDATED: 01:38 AEST, 20 July 2023



If aliens were to contact Earth, what would it s

Such a scenario has been imagined countless we have no proof extraterrestrials even exist.

That hasn't dampened the excitement that an a image0 there, however, and the discovery of a mysteric minute pulse every 22 minutes will only serve to intensify that.

Astronomy

A Mysterious Object in Deep Space Has Blinked Every 22 Minutes for Over 30 Years

ars TECHNICA

SLOW BURN -







hing Something in space has been lighting up every 20 minutes since 1988

BIZ & IT

We have no explanations for this sort of slow repeat.

JOHN TIMMER - 7/20/2023, 3:09 AM



I from

Login/R

The Magaz

CARS GAMING 8

ce Exploration ~

tum. E ard to

ie obje

pe of

ds ene

aina fi

AUSTRALIA

Home | U.K. | Royals | U.S. | News | World News

Latest Headlines | Facebook | YouTube | Google | eBay |

Are aliens trying to cc ^{CBack to Ar} Scientists discover a **A rar** stellar object that **A rar** pulse every 22 min back to Ar

- The magnetar is 15,000 light-years a
- Experts say this 'remarkable' stellar

By SAM TONKIN FOR MAILONLINE UPDATED: 01:38 AEST, 20 July 2023



If aliens were to contact Earth, what we

Such a scenario has been imagined co we have no proof extraterrestrials even

That hasn't dampened the excitement t there, however, and the discovery of a minute pulse every 22 minutes will only

Astronomy

A Mysterious Object in Deep Space Has Blinked Every 22 Minutes for Over 30 Years

ars TECHNICA

SCIENCE

BIZ & IT

ce Exploration ~

Something in our galaxy is flashing every 20 minutes but what?

Login/R

The Magaz

CARS GAMING 8

Two newly spotted objects in space emitting regular pulses of radio wav anything astronomers have seen bed

Field-of-view

Performing the GPM would have taken

- ASKAP: 200 hours per night
- MeerKAT: 6,000 hours per night
- Parkes: 24,000 hours per night

Field-of-view

Performing the GPM would have taken

- ASKAP: 200 hours per night
- MeerKAT: 6,000 hours per night
- Parkes: 24,000 hours per night

Frequency coverage

- 200 MHz for detection (covers most of Milky Way, minimal scattering)
- 72 231 MHz for characterisation
- 100% fractional bandwidth = interesting physics!

Field-of-view

Performing the GPM would have taken

- ASKAP: 200 hours per night
- MeerKAT: 6,000 hours per night
- Parkes: 24,000 hours per night

Frequency coverage

- 200 MHz for detection (covers most of Milky Way, minimal scattering)
- 72 231 MHz for characterisation
- 100% fractional bandwidth = interesting physics!

(u,v)-coverage

- → extremely uniform noise
- → Very easy to detect real signals



Broad scientific expertise



Broad scientific expertise



Supercomputing culture







Toy modelling

Input parameter distributions

Table 2. Intrinsic population properties varied in the simulations, and reasonable options for ranges to probe.

Property	Options
Р	Log-uniform between 60 s – 10 ⁵ s
L _{radio}	Single value, 10 ²⁸ erg s ⁻¹ ;
	Log distribution with index –1
Spectrum	Identical to GPM J1839-10;
	Uniform within range $-3 < \alpha < -1$
Pulse occupancy	Identical $\eta = 5\%$ for all sources;
	Identical $W = 30$ s for all sources;
	A uniform distribution of η across 0.2–40 %;
	A uniform distribution of W across 20–400 s
Spatial distribution	Lorimer+2006
	Follow the number density of electrons, e.g. NE2001
Activity window	uniform between two months and ten years
	identical at 2 months for all sources
	identical at ten years for all sources
Duty cycle	uniform between 5 and 100 %
	identical at 5 % for all sources
	identical at 100 % for all sources

Surveys and archives



Predicted detection rates



Hurley-Walker et al. in prep: Detection Prospects for Long-Period Radio Transients

Toy modelling

Input parameter distributions

Surveys and archives

Predicted detection rates

 Table 2. Intrinsic population properties varied in the sin sonable options for ranges to probe.

Property	Options		
Р	Log-uniform between		
L _{radio}	Single value, 10 ²⁸		
	Log distribution with		
Spectrum	Identical to GPM J1	•	
	Uniform within range -		
Pulse occupancy	Identical η = 5 % for a		
	Identical $W = 30$ s for		
	A uniform distribution of η		
	A uniform distribution of ${\cal W}$		
Spatial distribution	Lorimer+200		
	Follow the number density of el		
Activity window	uniform between two mont		
	identical at 2 months fo		
	identical at ten years for all sour		
Duty cycle	uniform between 5 and 10	00 %	
	identical at 5 % for all sou	irces	
	identical at 100 % for all source		

Super preliminary predictions:

- MWA to find O(10) in the archive
- VAST to find O(10) per year
 - MeerKAT L-band Galactic Plane Survey equally productive for some luminosity distributions





Hurley-Walker et al. in prep: Detection Prospects for Long-Period Radio Transients

Thank you!

Questions?

What are they?



Magnetars typically go into outburst to produce radio emission...

Multiwavelength follow-up



Magnetars typically go into outburst to produce radio emission...



Multiwavelength follow-up



Magnetars typically go into outburst to produce radio emission...

 $L_{x} < 10^{33} \text{ erg/s}$

Orders of magnitude lower than expected from magnetar outbursts!



Credit: Emil Lenc



What are they?



White dwarf high moment of inertia *I* could explain spin-down luminosity

 $L_{\rm spin} = \frac{4\pi^2 I\dot{P}}{P^3}$

A white dwarf pulsar?

A 5.3-minute-period pulsing white dwarf in a binary detected from radio to X-rays

Ingrid Pelisoli^{1*}, T. R. Marsh¹, David A. H. Buckley^{2,3,4}, I. Heywood^{5,6,7}, Stephen. B. Potter^{2,8}, Axel Schwope⁹, Jaco Brink^{2,3}, Annie Standke^{9,10}, P. A. Woudt³, S. G. Parsons¹¹, M. J. Green¹², S. O. Kepler¹³, James Munday^{1,14}, A. D. Romero¹³, E. Breedt¹⁵, A. J. Brown¹¹, V. S. Dhillon^{11,16}, M. J. Dyer¹¹, P. Kerry¹¹, S. P. Littlefair¹¹, D. I. Sahman¹¹, and J. F. Wild¹¹

¹Department of Physics, University of Warwick, Coventry, CV4 7AL, UK

²South African Astronomical Observatory, PO Box 9, Observatory, 7935, Cape Town, South Africa ³Department of Astronomy, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa ⁴Department of Physics, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa ⁵Astrophysics, Department of Physics, University of Oxford, Keble Road, Oxford, OX1 3RH, UK ⁶Department of Physics and Electronics, Rhodes University, PO Box 94, Makhanda 6140, South Africa ⁷South African Radio Astronomy Observatory, 2 Fir Street, Observatory 7925, South Africa ⁸Department of Physics, University of Johannesburg, PO Box 524, Auckland Park 2006, South Africa ⁹Leibniz-Institut für Astrophysik Potsdam (AIP), An der Sternwarte 16, 14482 Potsdam, Germany ¹⁰University of Potsdam. Institute for Physics and Astronomy, Karl-Liebknecht-Straße 24/25, 14476 Potsdam, Germany ¹¹Department of Physics and Astronomy, University of Sheffield, Sheffield, S3 7RH, United Kingdom 12 School of Physics and Astronomy, Tel-Aviv University, Tel-Aviv 6997801, Israel ¹³Instituto de Física, Universidade Federal do Rio Grande do Sul, 91501-970 Porto Alegre, RS, Brazil ¹⁴Isaac Newton Group of Telescopes, Apartado de Correos 368, E-38700 Santa Cruz de La Palma, Spain ¹⁵Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK ¹⁶Instituto de Astrofísica de Canarias, E-38205 La Laguna, Tenerife, Spain

White dwarf stars are the most common stellar fossils. When in binaries, they make up the dominant form of compact object binary within the Galaxy and can offer insight into different aspects of binary formation and evolution. One of the most remarkable white dwarf binary systems identified to date is AR Scorpii (henceforth AR Sco). AR Sco is composed of an M-dwarf star and a rapidly-spinning white dwarf in a 3.56-hour orbit. It shows pulsed emission with a period of 1.97 minutes over a broad range of wavelengths, which led to it being known as a white dwarf pulsar. Both the pulse mechanism and the evolutionary origin of AR Sco provide challenges to theoretical models. Here we report the discovery of the first sibling of AR Sco, J191213.72–441045.1 (henceforth J1912–4410), which harbours a white dwarf in a 4.03-hour orbit with an M-dwarf and exhibits pulsed emission with a period of 5.30 minutes. This discovery establishes binary white dwarf pulsars as a class and provides support for proposed formation models for white dwarf

- L-band peak flux density ~4mJy
- Spectral index ~ -3
- \rightarrow 154-MHz flux density ~ 3Jy
- Distance = 119 pc
- → Luminosity ~ 1000x lower than
 GPMJ1839-10 or GLEAM-XJ1627

pulsars.

*ingrid.pelisoli@warwick.ac.uk

A white dwarf pulsar?

A 5.3-minute-period pulsing white dwarf in a binary detected from radio to X-rays

Ingrid Pelisoli^{1*}, T. R. Marsh¹, David A. H. Buckley^{2,3,4}, I. Heywood^{5,6,7}, Stephen. B. Potter^{2,8}, Axel Schwope⁹, Jaco Brink^{2,3}, Annie Standke^{9,10}, P. A. Woudt³, S. G. Parsons¹¹, M. J. Green¹², S. O. Kepler¹³, James Munday^{1,14}, A. D. Romero¹³, E. Breedt¹⁵, A. J. Brown¹¹, V. S. Dhillon^{11,16}, M. J. Dyer¹¹, P. Kerry¹¹, S. P. Littlefair¹¹, D. I. Sahman¹¹, and J. F. Wild¹¹

¹Department of Physics, University of Warwick, Coventry, CV4 7AL, UK

²South African Astronomical Observatory, PO Box 9, Observatory, 7935, Cape Town, South Africa ³Department of Astronomy, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa ⁴Department of Physics, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa ⁵Astrophysics, Department of Physics, University of Oxford, Keble Road, Oxford, OX1 3RH, UK ⁶Department of Physics and Electronics, Rhodes University, PO Box 94, Makhanda 6140, South Africa ⁷South African Radio Astronomy Observatory, 2 Fir Street, Observatory 7925, South Africa ⁹Department of Physics, University of Johannesburg, PO Box 524, Auckland Park 2006, South Africa ⁹Leibniz-Institut für Astrophysik Potsdam (AIP), An der Sternwarte 16, 14482 Potsdam, Germany ¹⁰University of Potsdam, Institute for Physics and Astronomy, Karl-Liebknecht-Straße 24/25, 14476 Potsdam, dermany ¹¹Department of Physics and Astronomy, University of Sheffield, Sheffield, S3 7RH, United Kingdom

¹²School of Physics and Astronomy, Tel-Aviv University, Tel-Aviv 6997801, Israel ¹³Instituto de Física, Universidade Federal do Rio Grande do Sul, 91501-970 Porto Alegre, RS, Brazil ¹⁴Isaac Newton Group of Telescopes, Apartado de Correos 368, E-38700 Santa Cruz de La Palma, Spain ¹⁵Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK ¹⁶Instituto de Astrofísica de Canarias, E-38205 La Laguna, Tenerife, Spain ^{*}ingrid.pelisoll@warwick.ac.uk

White dwarf stars are the most common stellar fossils. When in binaries, they make up the dominant form of compact object binary within the Galaxy and can offer insight into different aspects of binary formation and evolution. One of the most remarkable white dwarf binary systems identified to date is AR Scorpii (henceforth AR Sco). AR Sco is composed of an M-dwarf star and a rapidly-spinning white dwarf in a 3.56-hour orbit. It shows pulsed emission with a period of 1.97 minutes over a broad range of wavelengths, which led to it being known as a white dwarf pulsar. Both the pulse mechanism and the evolutionary origin of AR Sco provide challenges to theoretical models. Here we report the discovery of the first sibling of AR Sco, J191213.72–441045.1 (henceforth J1912–4410), which harbours a white dwarf in a 4.03-hour orbit with an M-dwarf and exhibits pulsed emission with a period of 5.30 minutes. This discovery establishes binary white dwarf pulsars as a tass and provides support for proposed formation models for white dwarf

- L-band peak flux density ~4mJy
- Spectral index ~ -3
- \rightarrow 154-MHz flux density ~ 3Jy
- Distance = 119 pc
- → Luminosity ~ 1000x smaller than
 GPMJ1839-10 or GLEAM-XJ1627
- Binarity required by current models



Binary WD&main sequence star excluded for GLEAM-X J1627 by deep optical IR observations

(Rea et al. 2022)

pulsars.

A white dwarf pulsar?

A 5.3-minute-period detected from radio

Ingrid Pelisoli1*, T. R. Marsh1, Da Potter^{2,8}, Axel Schwope⁹, Jaco B M. J. Green¹², S. O. Kepler¹³, Jam V. S. Dhillon^{11,16}, M. J. Dyer¹¹, P. K

¹Department of Physics, University of War ²South African Astronomical Observatory, ³Department of Astronomy, University of C ⁴Department of Physics, University of the 5Astrophysics, Department of Physics, Un ⁶Department of Physics and Electronics, F ⁷South African Radio Astronomy Observation ⁸Department of Physics, University of Joha ⁹Leibniz-Institut für Astrophysik Potsdam 10 University of Potsdam, Institute for Physi Germany ¹¹Department of Physics and Astronomy, 12 School of Physics and Astronomy, Tel-Av ¹³Instituto de Física, Universidade Federal 14 Isaac Newton Group of Telescopes, Apa ¹⁵Institute of Astronomy, University of Cam ¹⁶Instituto de Astrofísica de Canarias, E-36 *ingrid.pelisoli@warwick.ac.uk White dwarf stars are the most common stel

object binary within the Galaxy and can of of the most remarkable white dwarf binary composed of an M-dwarf star and a rapidly period of 1.97 minutes over a broad range e

the pulse mechanism and the evolutionary (

the discovery of the first sibling of AR Sco. J191213.72-441045.1 (henceforth J1912-4410), which harbours a white

dwarf in a 4.03-hour orbit with an M-dwarf and exhibits pulsed emission with a period of 5.30 minutes. This discovery

establishes binary white dwarf pulsars as a dass and provides support for proposed formation models for white dwarf



pulsars.