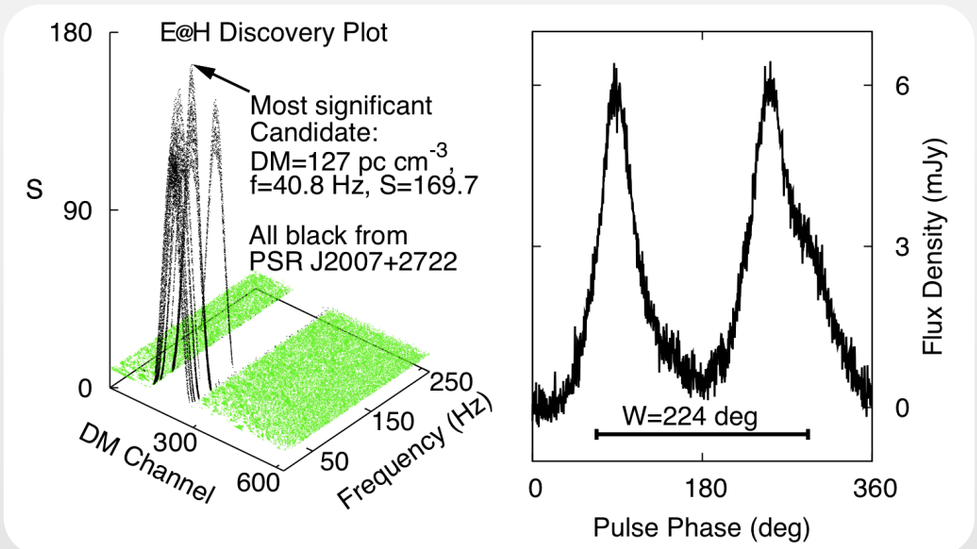
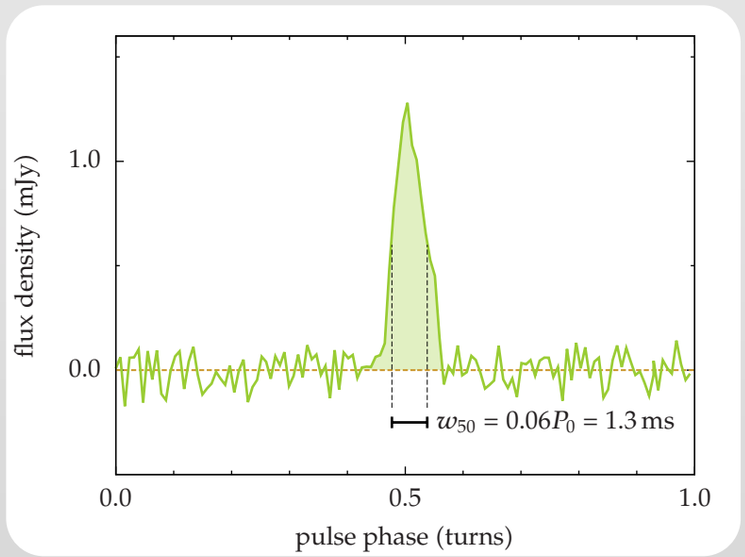
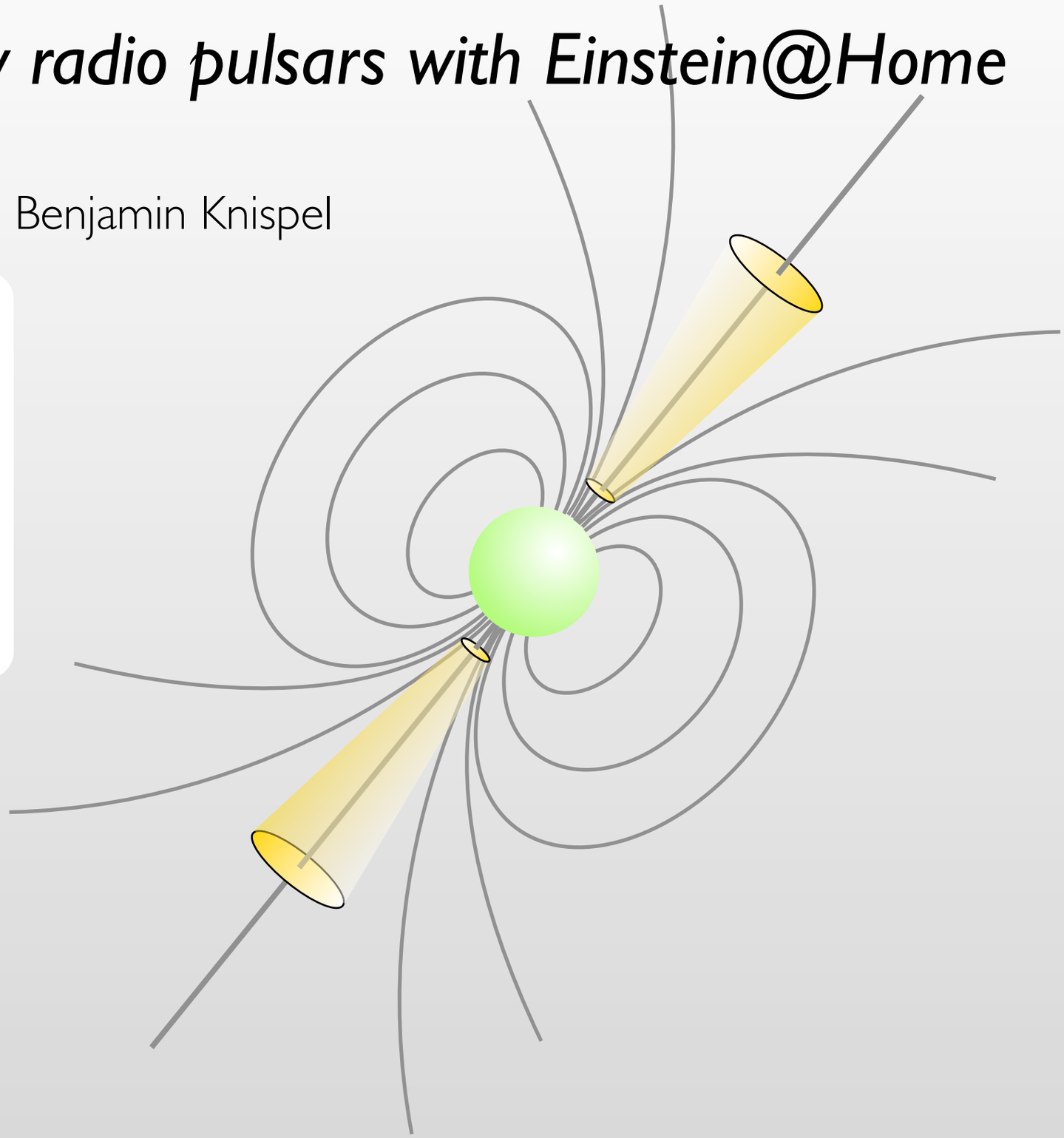
MAX-PLANCK-GESELLSCHAFT

One year of finding new radio pulsars with Einstein@Home

Benjamin Knispel







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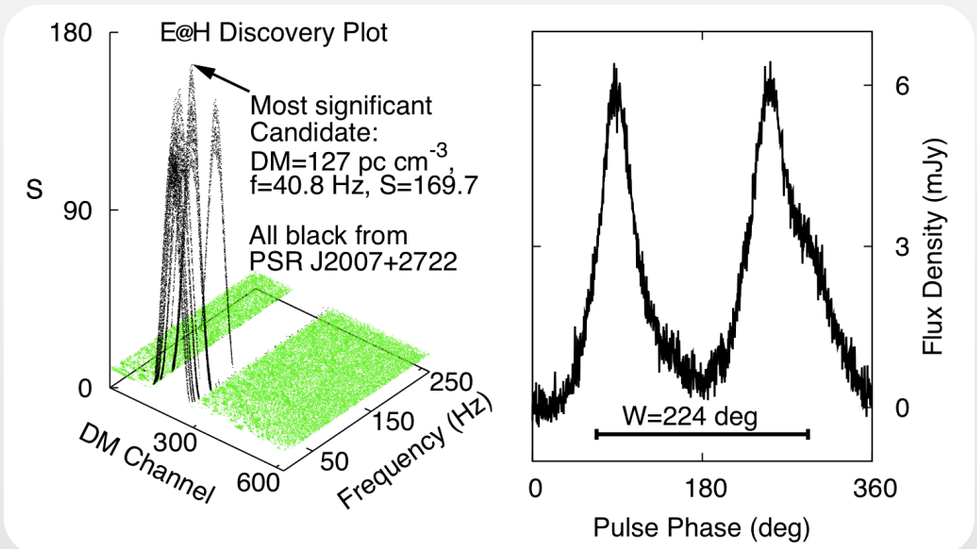
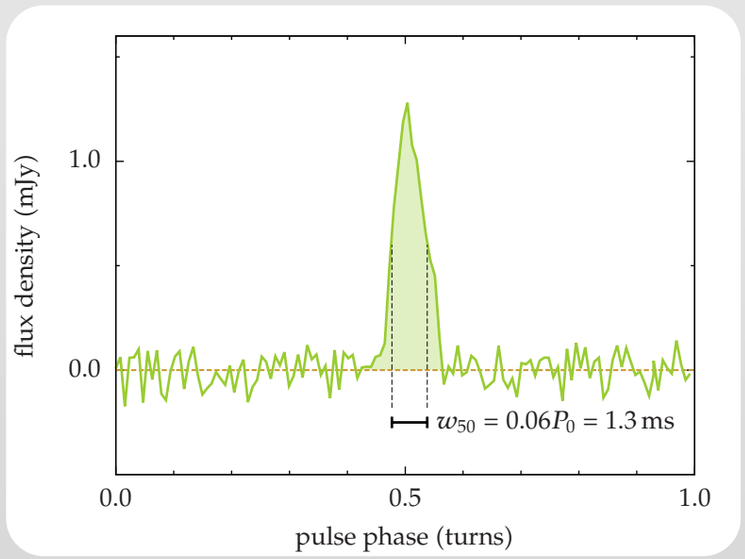
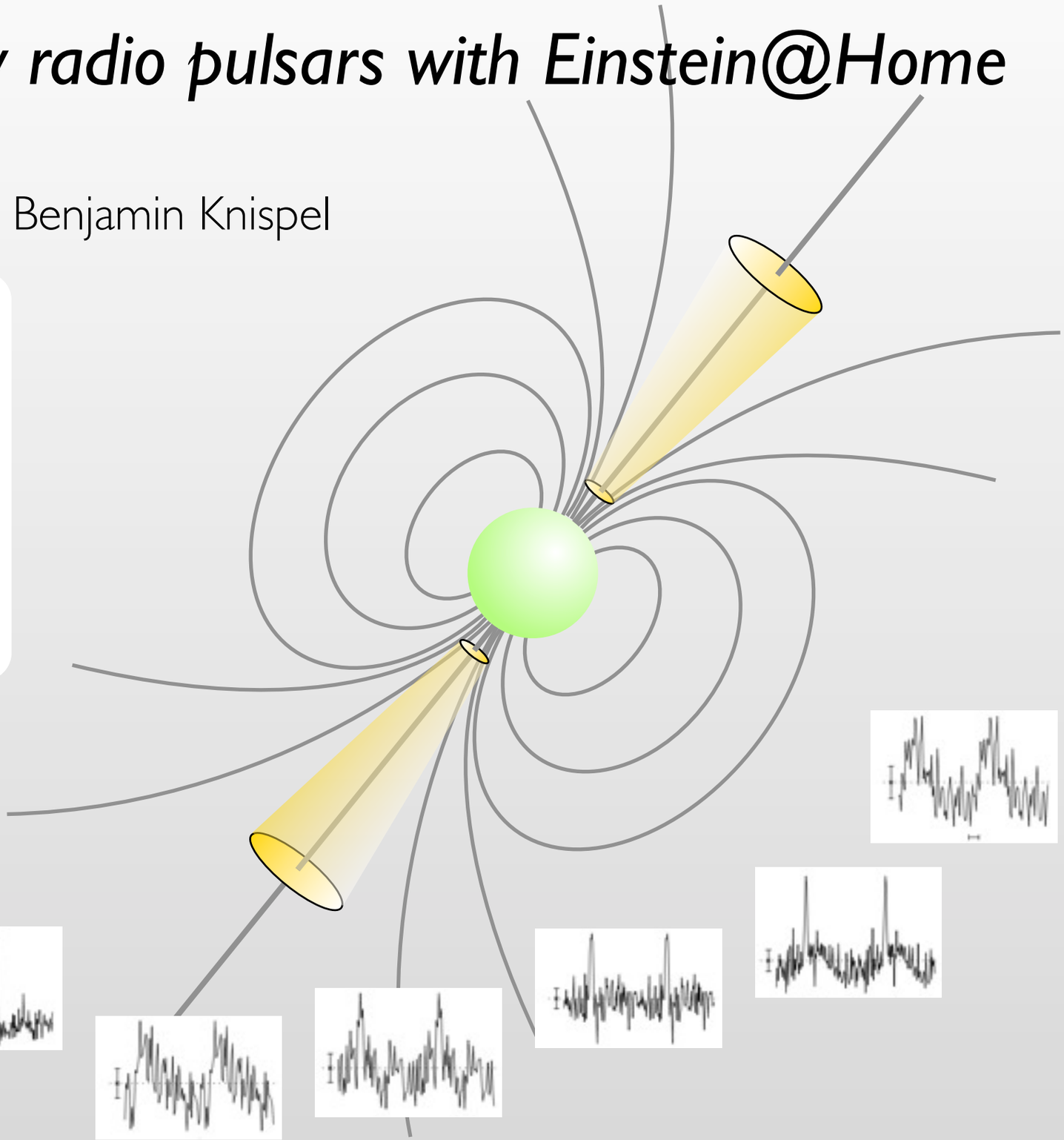
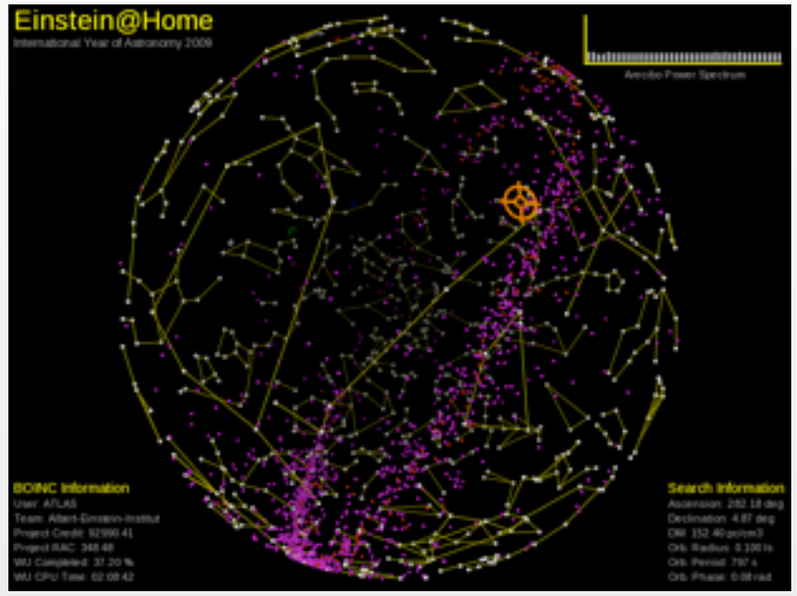






Einstein@Home

- numbers
  - » 300,000 volunteers, 50,000 active computers
  - » ~200 TFlop/s sustained computing power
  - » servers in Milwaukee and Hannover



- science goals:
  - » **search for continuous gravitational waves (CPU)**
  - » search for tight binary radio pulsars (CPU+GPU)
  - » *search for gamma-ray pulsars (CPU)*

- science results so far:
  - » **upper limits** for continuous GWs (2 publications)
  - » **2 new pulsars** in Arecibo data (2 publications)
  - » **6 new pulsars** in Parkes data (stay tuned…)

PHYSICAL REVIEW D 79, 022001 (2009)

Einstein@Home search for periodic gravitational waves in LIGO S4 data

B. Abbott,[16] R. Abbott,[16] R. Adhikari,[16] P. Ajith,[2] B. Allen,[2,55] G. Allen,[32] R. Amin,[20] D. P. Anderson,[41] S. B. Anderson,[16] W. G. Anderson,[55] M. A. Arain,[42] M. Araya,[16] H. Armandula,[16] P. Armor,[55] Y. Aso,[10] S. Aston,[40] P. Aufmuth,[15]

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Sciencexpress — Brevia

Pulsar Discovery by Global Volunteer Computing

B. Knispel,*† B. Allen, J. M. Cordes, J. S. Deneva, D. Anderson, C. Aulbert, N. D. R. Bhat, O. Bock, S. Bogdanov, A. Brazier, F. Camilo, D. J. Champion, S. Chatterjee, F. Crawford, P. B. Demorest, H. Fehrmann, P. C. C. Freire, M. E. Gonzalez, D. Hammer, J. W. T. Hessels, F. A. Jenet, L. Kasian, V. M. Kaspi, M. Kramer, P. Lazarus, J. van Leeuwen, D. R. Lorimer, A. G. Lyne, B. Machenschalk, M. A. McLaughlin, C. Messenger, D. J. Nice, M. A. Papa, H. J. Pletsch, R. Prix, S. M. Ransom, X. Siemens, I. H. Stairs, B. W. Stappers, K. Stovall, A. Venkataraman

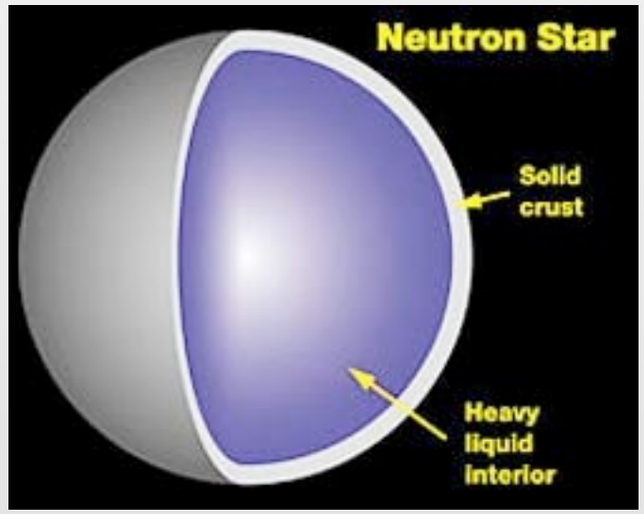
THE ASTROPHYSICAL JOURNAL LETTERS, 732:L1 (5pp), 2011 May 1 — doi:10.1088/2041-8205/732/1/L1

ARECIBO PALFA SURVEY AND EINSTEIN@HOME: BINARY PULSAR DISCOVERY BY VOLUNTEER COMPUTING

B. KNISPEL[1,2], P. LAZARUS[3], B. ALLEN[1,2,4], D. ANDERSON[5], C. AULBERT[1,2], N. D. R. BHAT[6], O. BOCK[1,2], S. BOGDANOV[7], A. BRAZIER[7,8], F. CAMILO[9], S. CHATTERJEE[7], J. M. CORDES[7], F. CRAWFORD[10], J. S. DENEVA[11], G. DESVIGNES[12], H. FEHRMANN[1,2], P. C. C. FREIRE[13], D. HAMMER[6], J. W. T. HESSELS[14,15], F. A. JENET[16], V. M. KASPI[3], M. KRAMER[13,17], J. VAN LEEUWEN[14,15], D. R. LORIMER[18,24], A. G. LYNE[17], B. MACHENSCHALK[1,2], M. A. MCLAUGHLIN[18,24], C. MESSENGER[1,2,19], D. J. NICE[20], M. A. PAPA[4,21], H. J. PLETSCH[1,2], R. PRIX[1,2], S. M. RANSOM[22], X. SIEMENS[4], I. H. STAIRS[23], B. W. STAPPERS[17], K. STOVALL[16], AND A. VENKATARAMAN[11]

Radio pulsars

- neutron stars = stellar remnants (supernova)
  - » high density: ~1.4 M_{sun} at 20 km diameter
  - » strong gravity: $R_{Schwarzschild} = 0.3\ R_{NS}$
  - » strong magnetic fields: 10^8 to 10^{14} G
- radio pulsars
  - » pulsed broadband radio emission ("lighthouse")
  - » serendipitously discovered in 1967
  - » today ~1900 known, 8% in binary systems
- searches
  - » unknown distance
  - » unknown spin frequency
  - » unknown binary parameters



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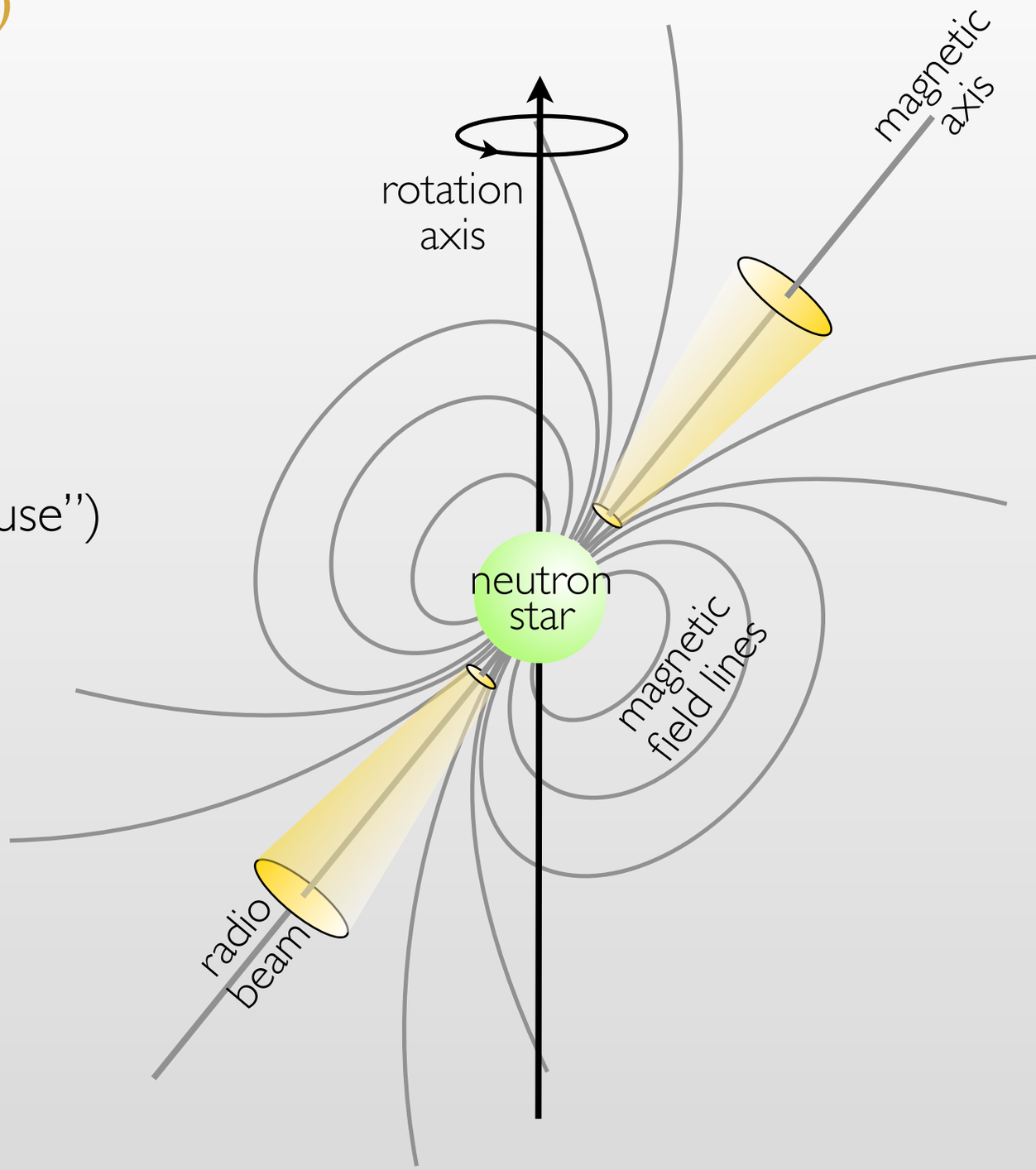

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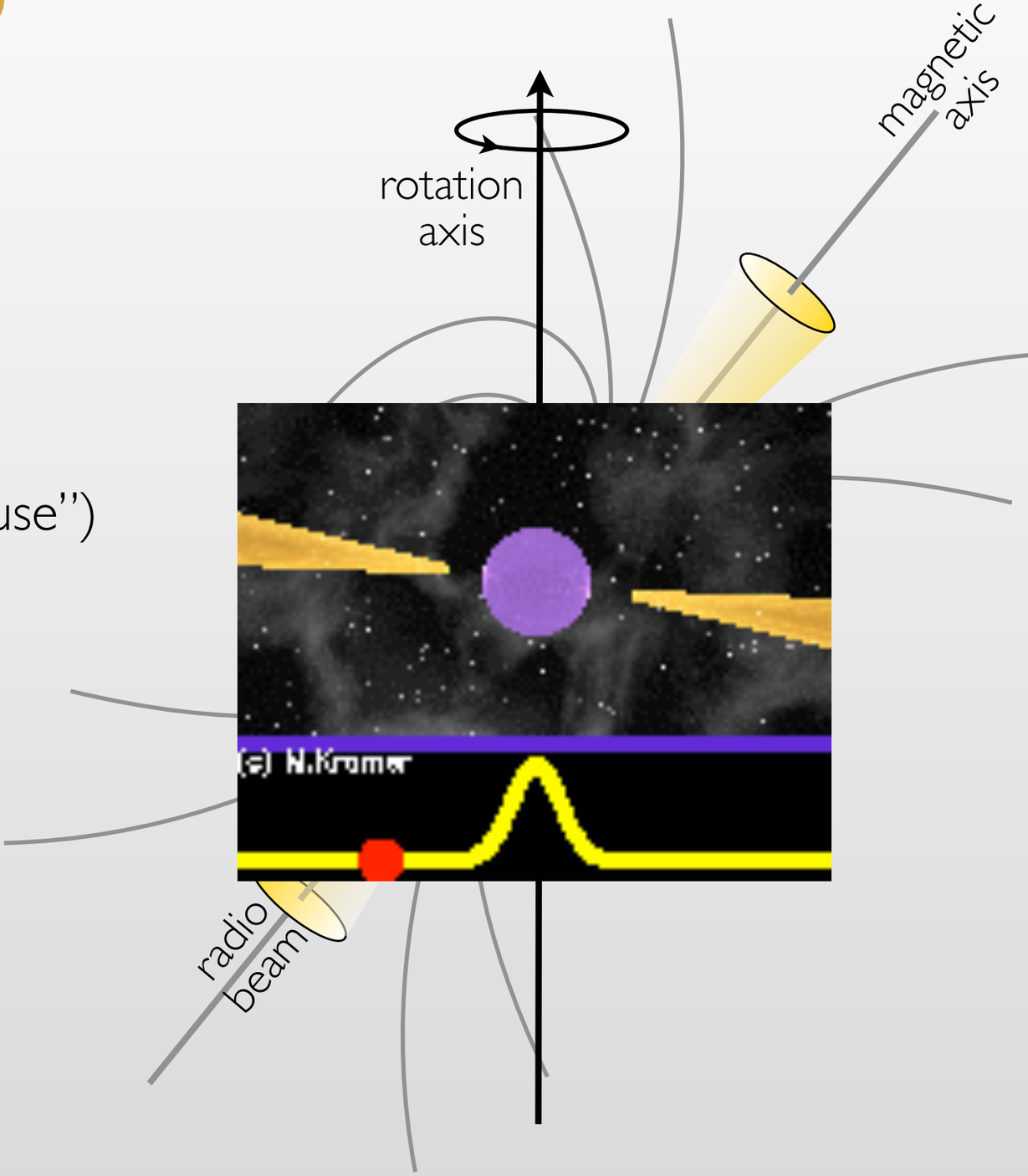

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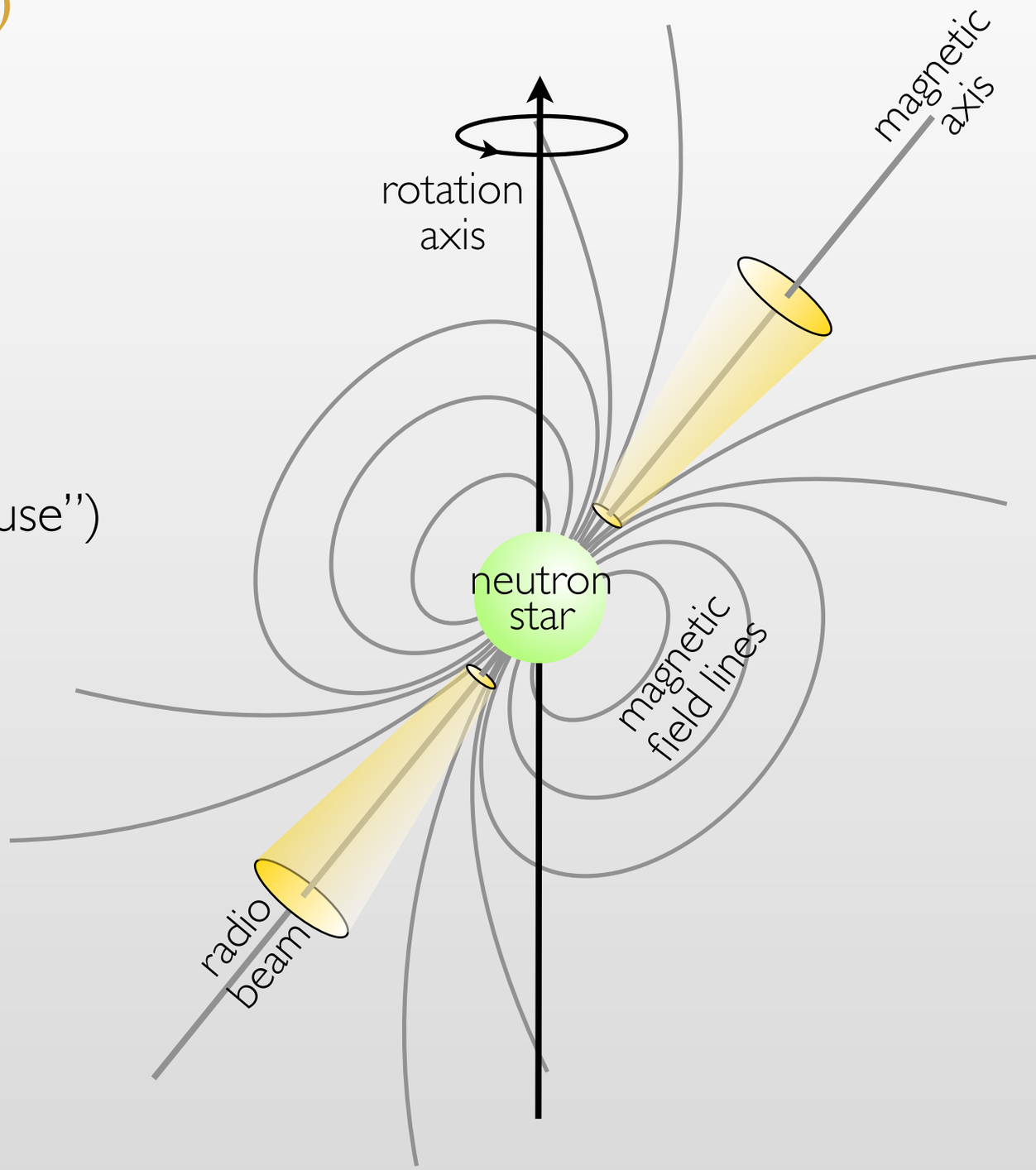

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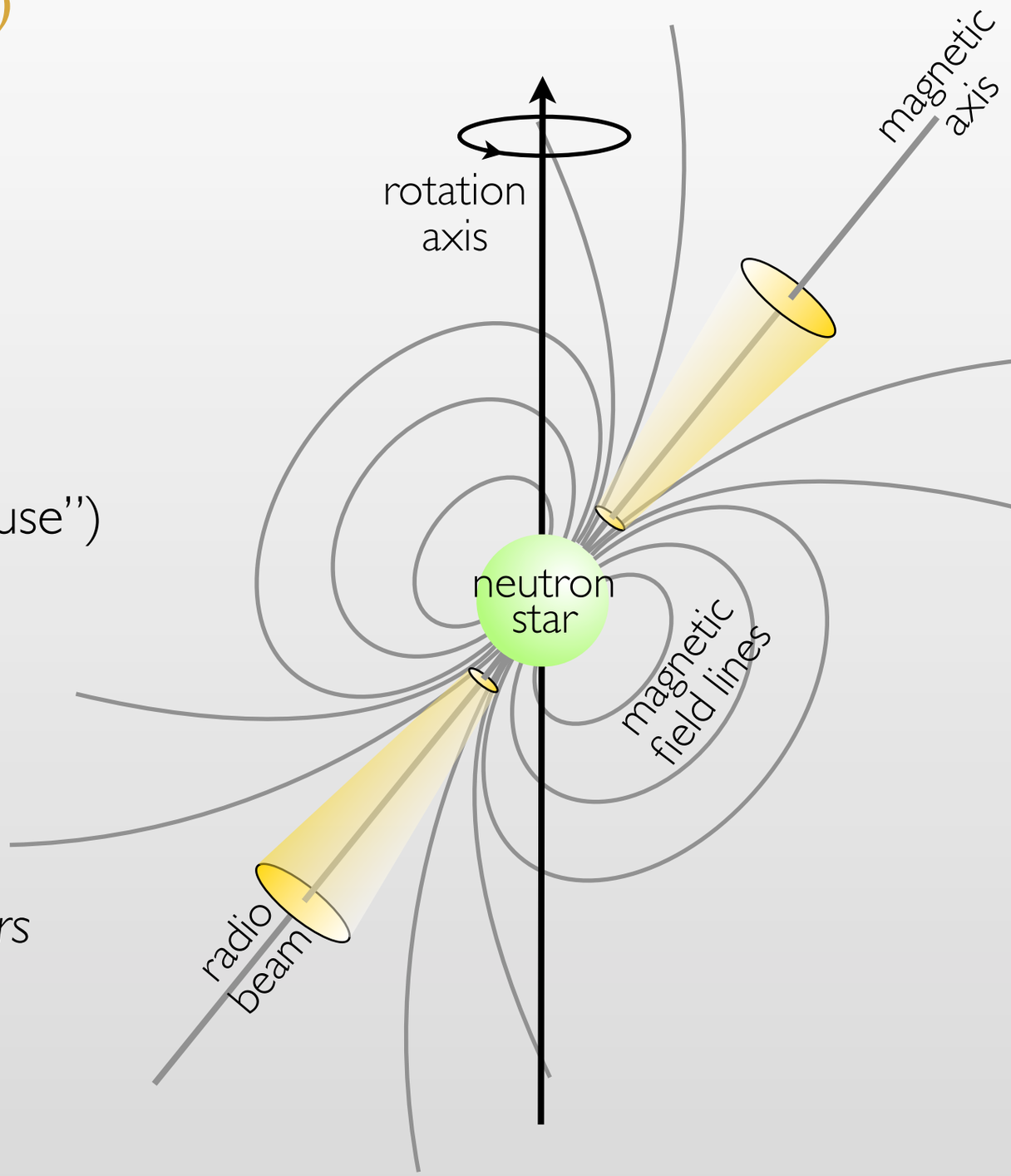
E@H servers



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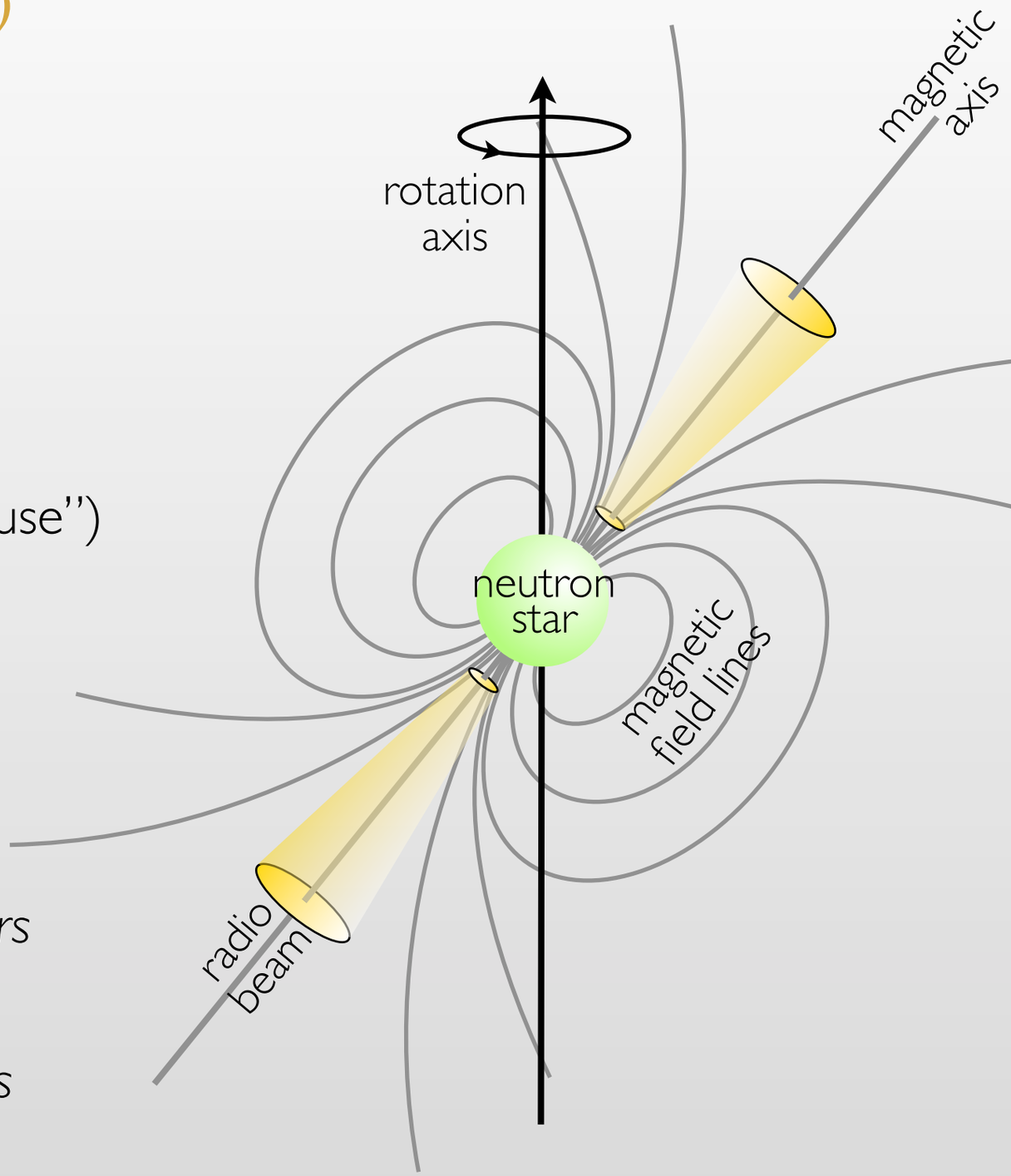
  - } *E@H hosts*

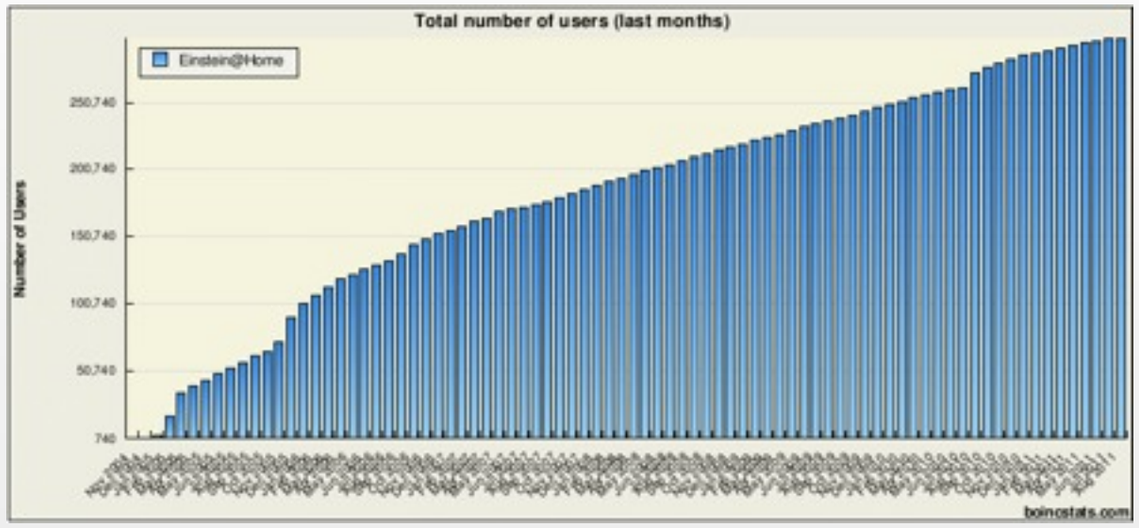


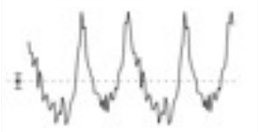
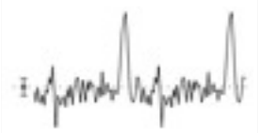
Radio pulsar runs

- Arecibo telescope, Puerto Rico (305 m)
  - » with PALFA collaboration
- Parkes telescope, Australia, NSW (64 m)
  - » data public, collaboration with MPIfR, Bonn
- *ABP1* (March 2009 - March 2010)
  - » first run using Arecibo data (*130 TB*, 2005 - 2009)
- *ABP2* (March 2010 - Dec 2010)
  - » improved run on Arecibo data (faster apps)
- *BRP3* (Dec 2010 - Jul 2011)
  - » re-analysis of PMPS (*4 TB* from 1997 - 2001)
- *BRP4* (started late Jul 2011)
  - » run on new, better Arecibo data (*44 TB* since 2009)

First discoveries in 2010

- Found two new pulsars within two weeks
  - » J2007+2722 on July 11, 2010
  - » J1952+2630 on July 26, 2010
- J2007+2722
  - » pulsar that should have (had) a companion
  - » companion likely ejected by its supernova, 13th system of this class
- J1952+2630
  - » massive white dwarf companion, 6th system of this class ever found



pulsar	P_0 (ms)	d (kpc)	volunteers	notes	profile
J2007+2722	24.497389	5.3	The Colvins / Powermandg Robert C. Tautz / Myat	DRP	
J1952+2630	20.732360	9.4	Vit-MIPT / staceman	IMBP	

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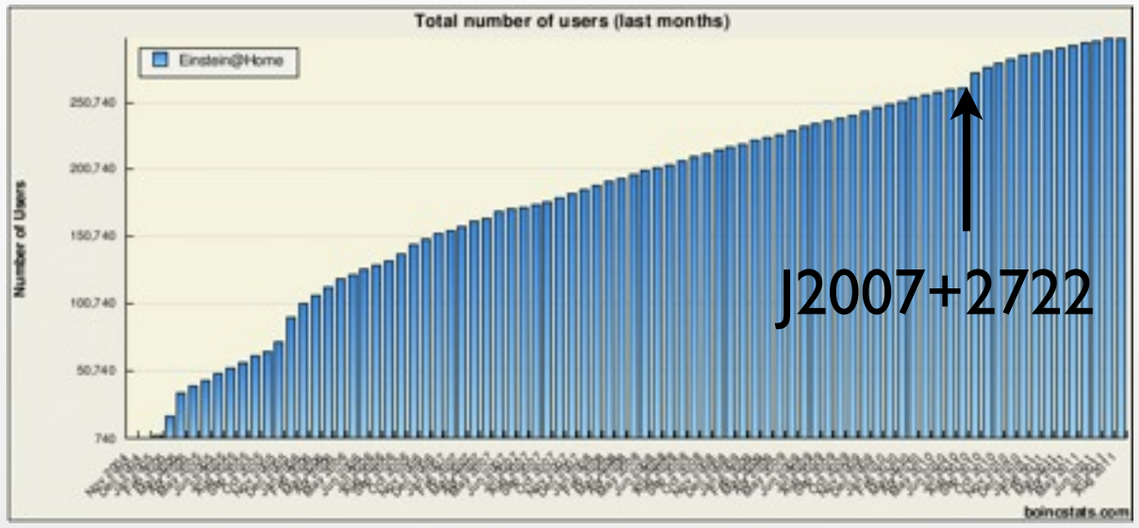

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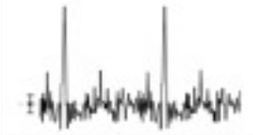
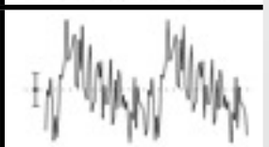
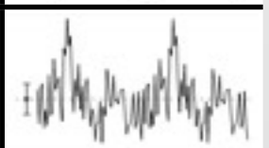
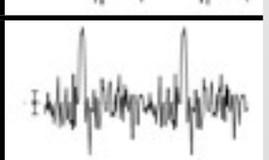
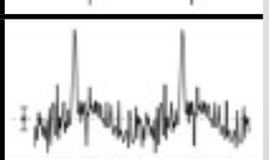
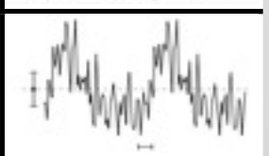
More discoveries in 2011

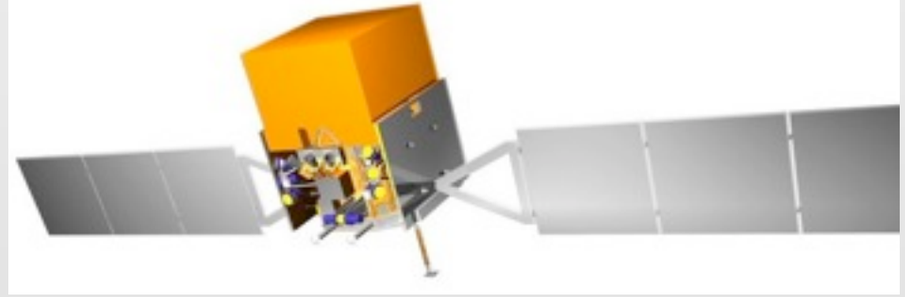
- Re-analysis of the Parkes Multibeam Pulsar Survey
  - » 3rd re-analysis, first fully coherent binary search (T_{obs}=35 min)
  - » 6 new pulsars confirmed + more good candidates

http://bit.ly/pIdEoG

pulsar	P_0 (ms)	d (kpc)	volunteers	notes	profile
J1322-6322	1044.8511	13	Vadim Gusev / David	intermittent	
J1455-5922	176.19117	7.0	Arax / UW-Madison CAE	–	
J1644-4409	173.91055	6.4	Jesse Charles Wagner II [USA] / Ras	–	
J1755-3331	959.4568	5.2	Omega Sector - Game Systems / Dwaine revoluzzer / Jacek Richter	in 3 beams	
J1817-1937	2046.916	7.7	Jaska / Family cjsturgess / Companion_Cube	intermittent	
J1840-0644	35.578184	6.6	terrydudley / nemo Trey / nemo	binary pulsar	

Present and future

- Run on new Arecibo data
  - » already new pulsars found in these data (not E@H)
  - » more discoveries likely (also E@H?)
- Search for radio-quite gamma-ray pulsars in NASA's Fermi LAT data
  - » exciting new field of astronomy
  - » already gamma-ray pulsars found in these data
  - » more discoveries likely
  - » first radio-quite MSP yet to be found (E@H?)
  - » running now on E@H (currently CPU only)
- Current surveys with Parkes / Effelsberg telescope
  - » analyse data on Einstein@Home in the future



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…to more Einstein@Home pulsar discoveries!