

PULSAR OF THE WEEK:

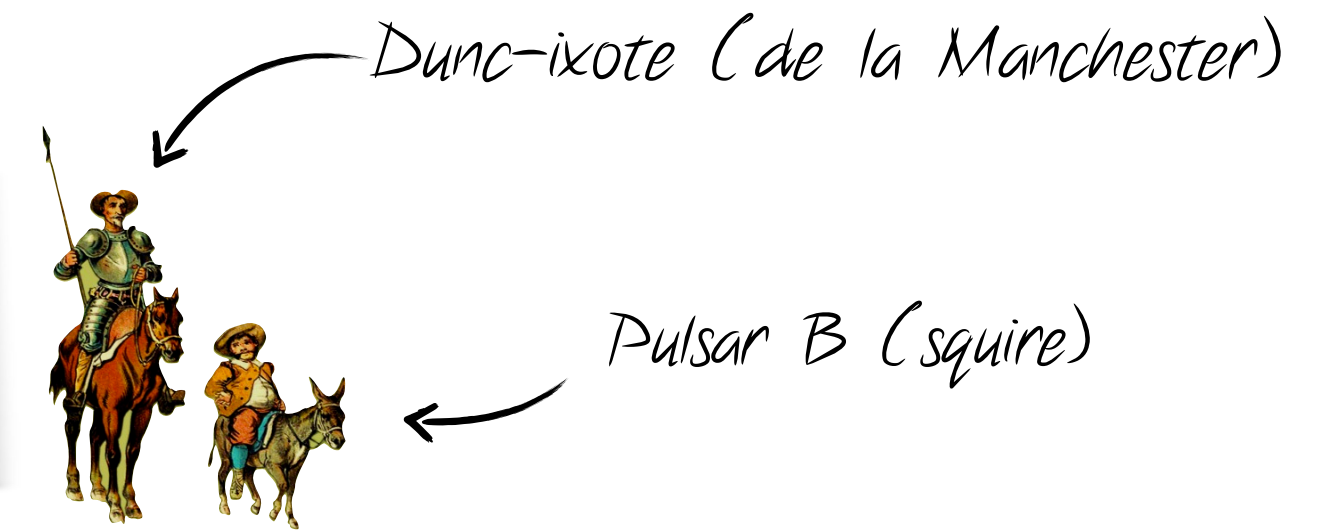
PSR J0737–3039B (aka Pulsar B)
or The Stories Michael Wouldn't Tell You

* Da-da-daaa!

Discovery & Tales of Chivalry

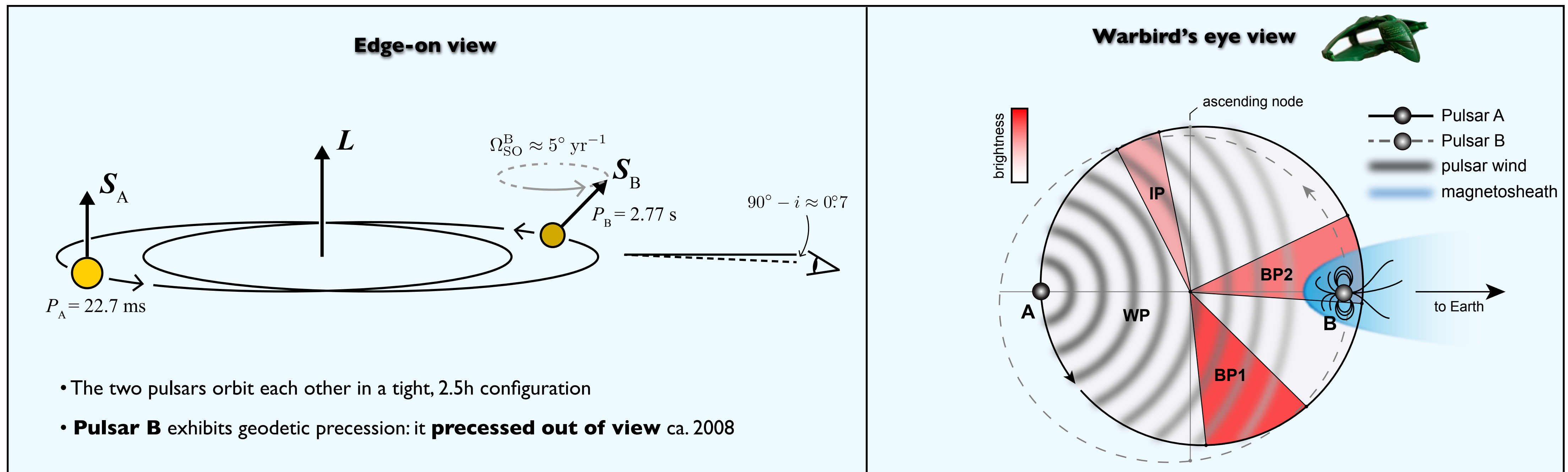
- **Pulsar B** is a **young**, 2.77s pulsar. Its companion, **Pulsar A**, is a mildly recycled 22.7 ms pulsar
- Pulsar B was discovered some months later after Pulsar A (see Lyne et al. 2004):

According to legend, Duncan Lorimer (Dunc) mistakenly used a minus sign ('-') before asini, while observing Pulsar A at Parkes, thus correcting for the orbit of the by-then-unknown Pulsar B, instead.

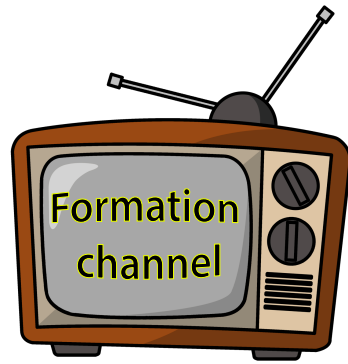


- Alas, it was not Dunc's project; he was just testing his code with the double PSR data. Hence, he could not claim discovery.
- The Lyne et al. (2004) is the reference paper describing the system's properties

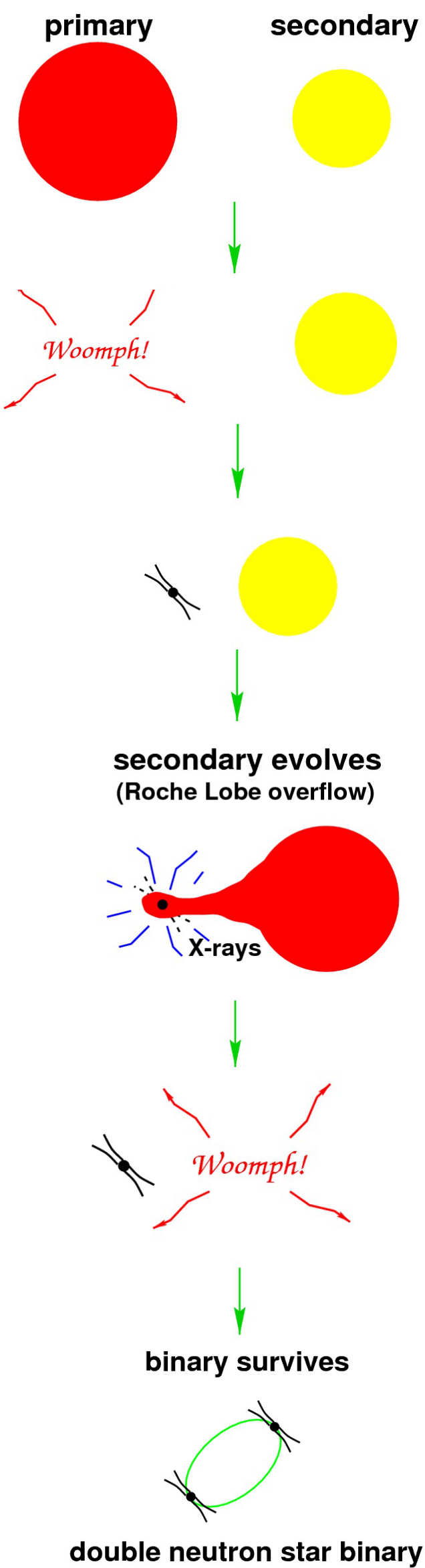
A. G. Lyne,^{1*} M. Burgay,² M. Kramer,¹ A. Possenti,^{3,4}
 R.N. Manchester,⁵ F. Camilo,⁶ M. A. McLaughlin,¹ D. R. Lorimer,¹
 N. D'Amico,^{3,7} B. C. Joshi,⁸ J. Reynolds,⁹ P. C. C. Freire¹⁰



- The two pulsars orbit each other in a tight, 2.5h configuration
- **Pulsar B** exhibits geodetic precession: it **precessed out of view** ca. 2008



Angular Discombobulation



A little background ...

According to Damour & Taylor (1992) – i.e. the bible (pretty much):

$$\delta = (\mathbf{L} \wedge \mathbf{S})$$

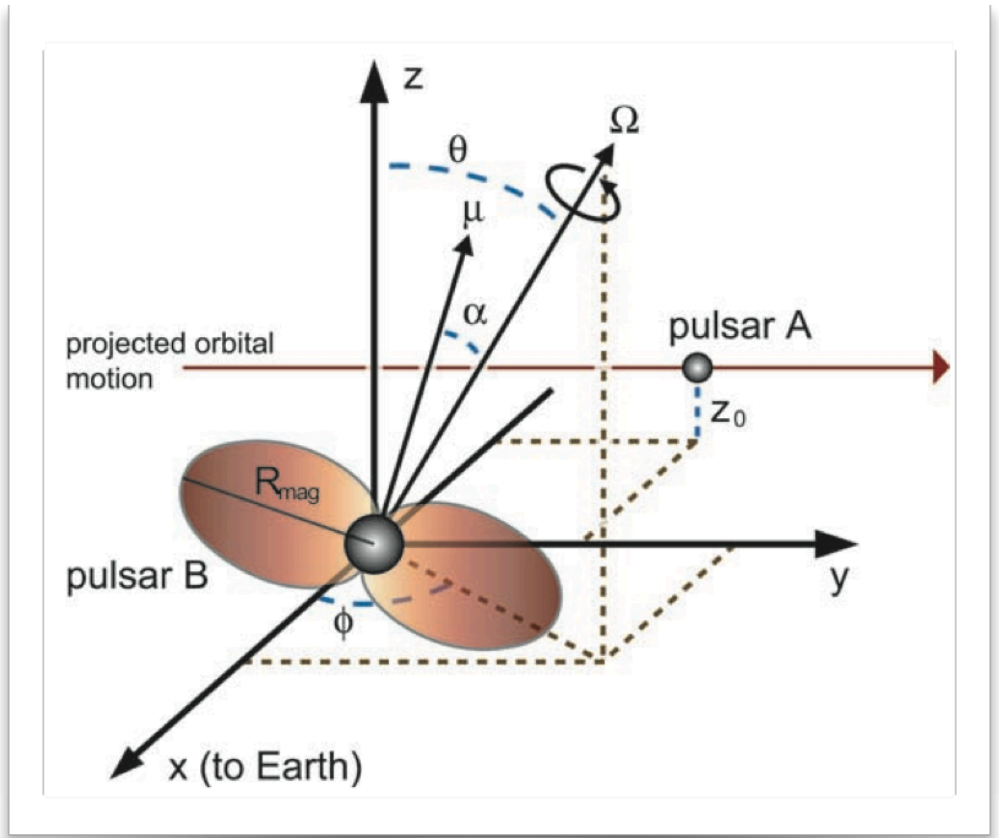
Degeneracy between supplementary spins

favoured by evolution

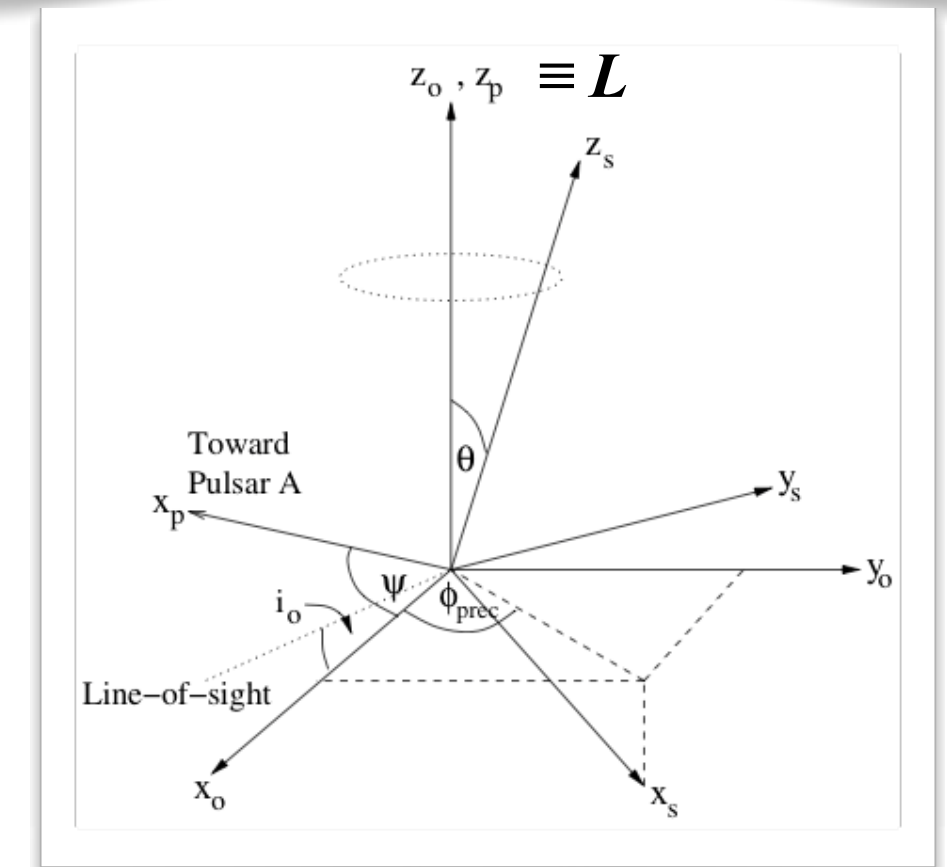
Breton et al. (2008) could not distinguish between the two

In Breton et al. (2008)
 $\theta = 130^\circ$

for the student:
 Where is \mathbf{L} ?



In Perera et al. (2012)
 $\theta = 138^\circ$

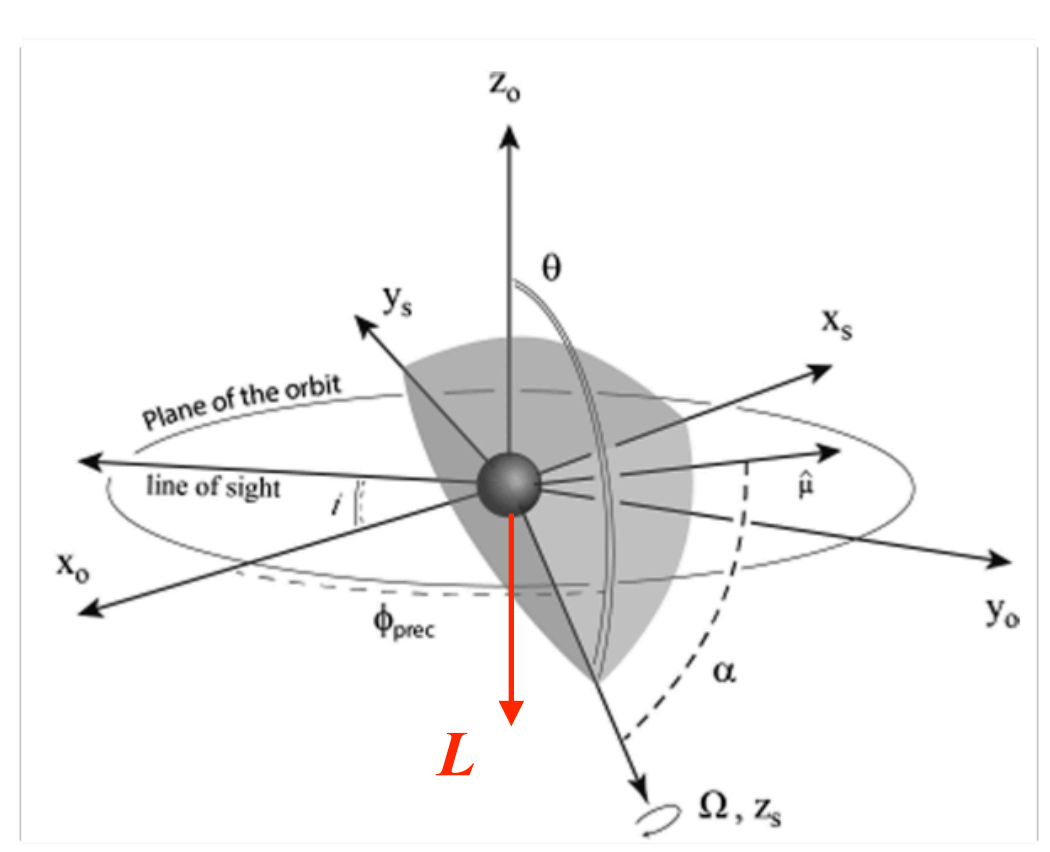


In Lomiashvili & Lyutikov (2014)
 $\theta = 122^\circ$

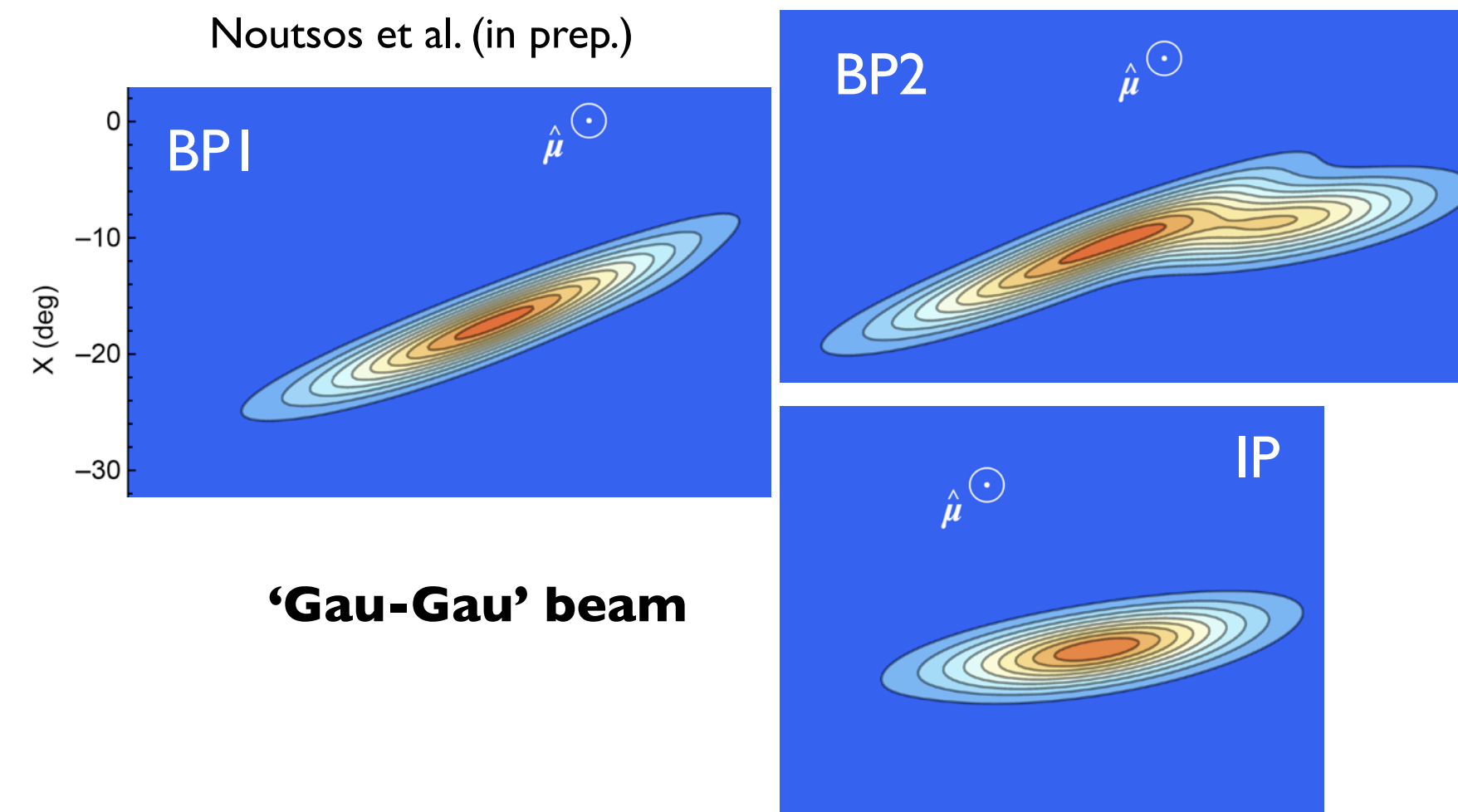
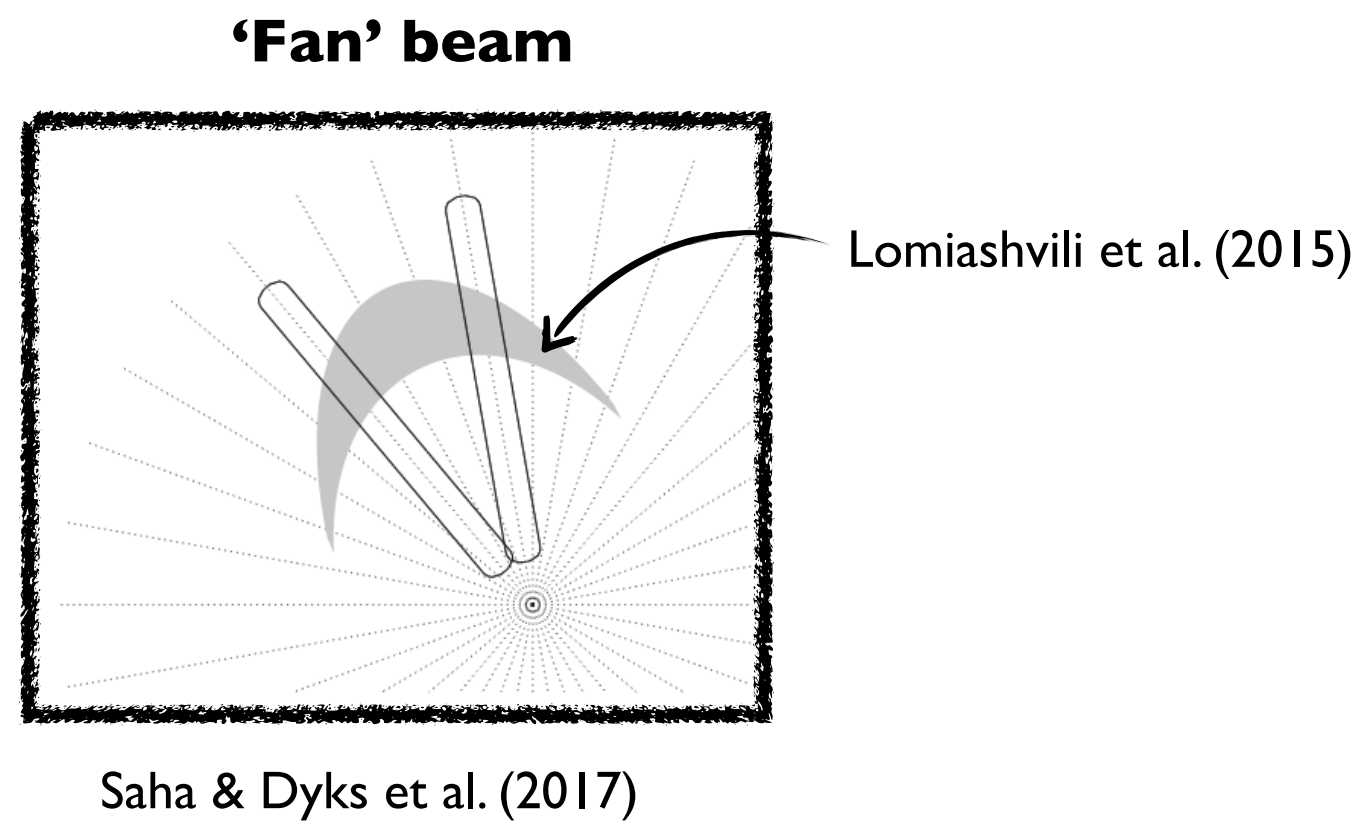
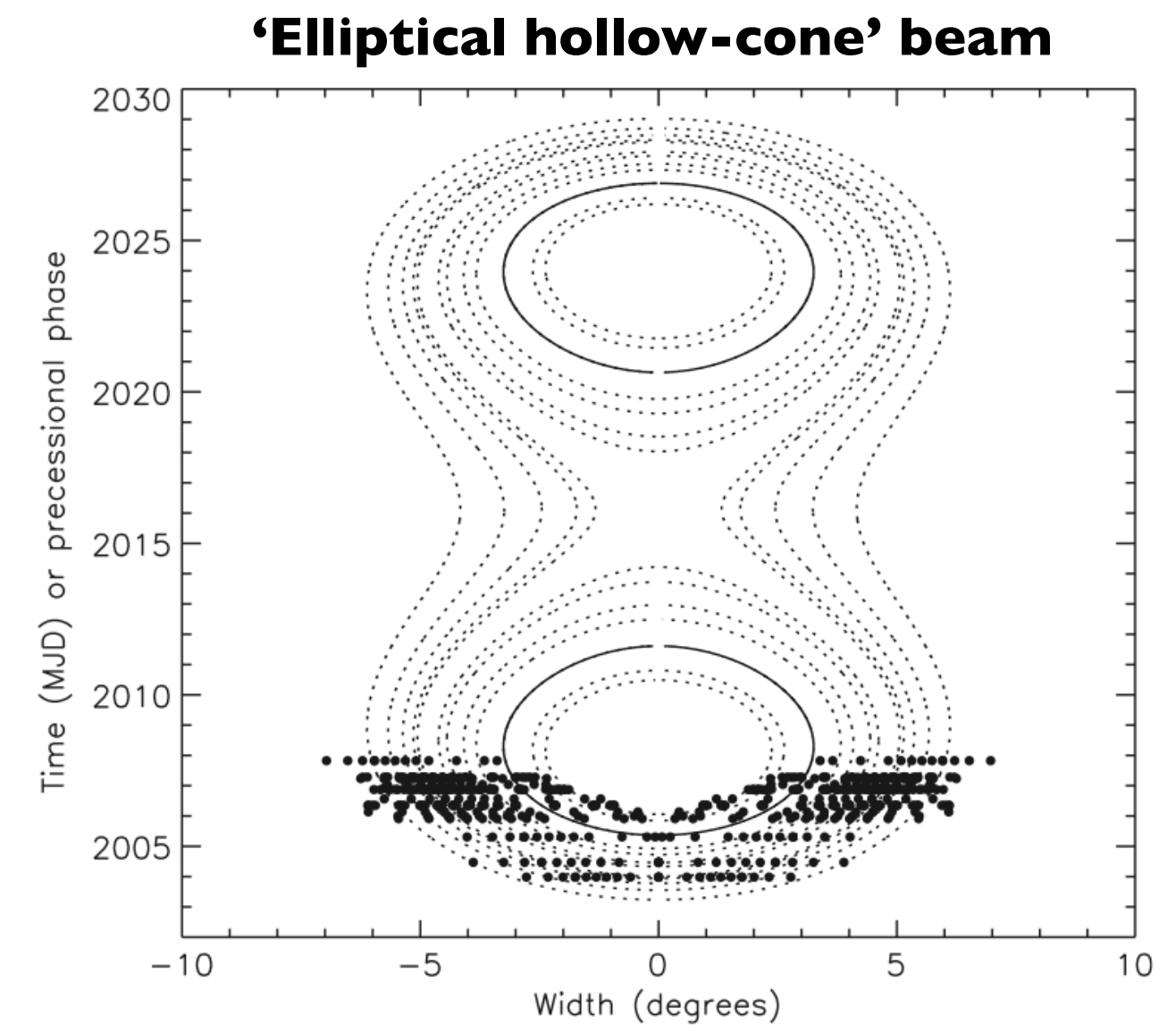
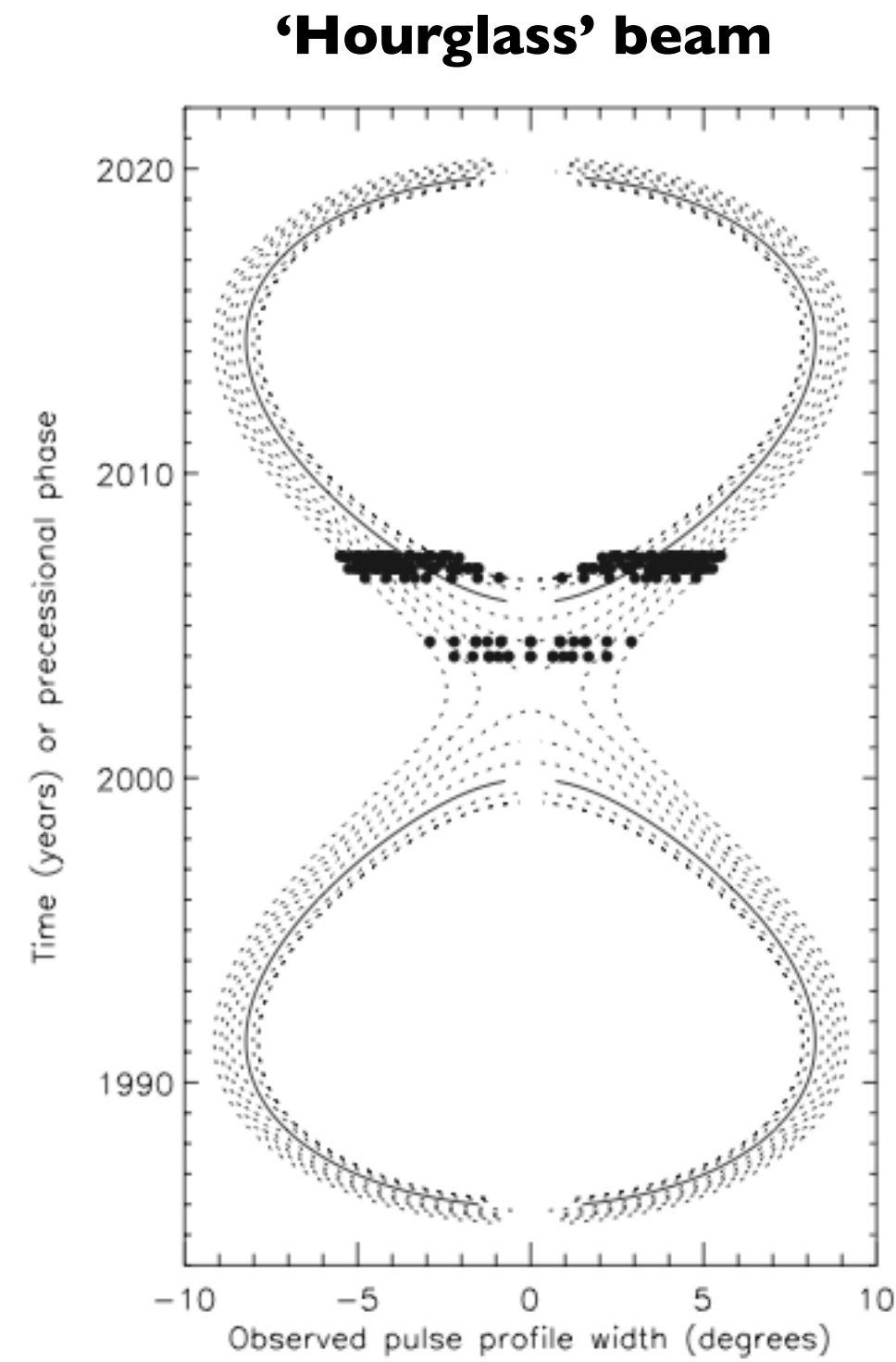
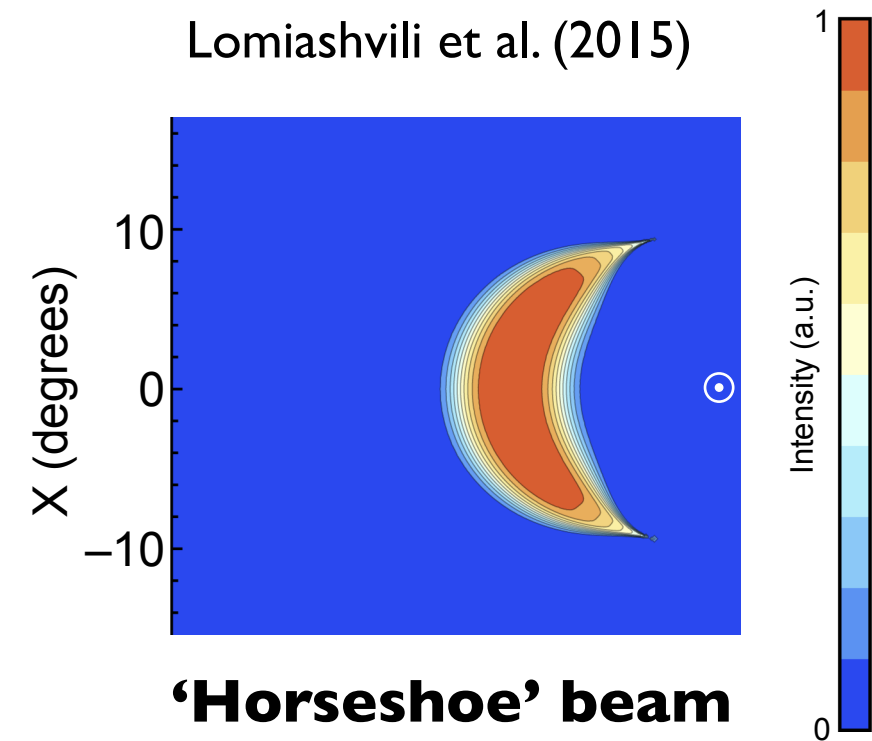
... but their model contradicts GR!

from the paper:

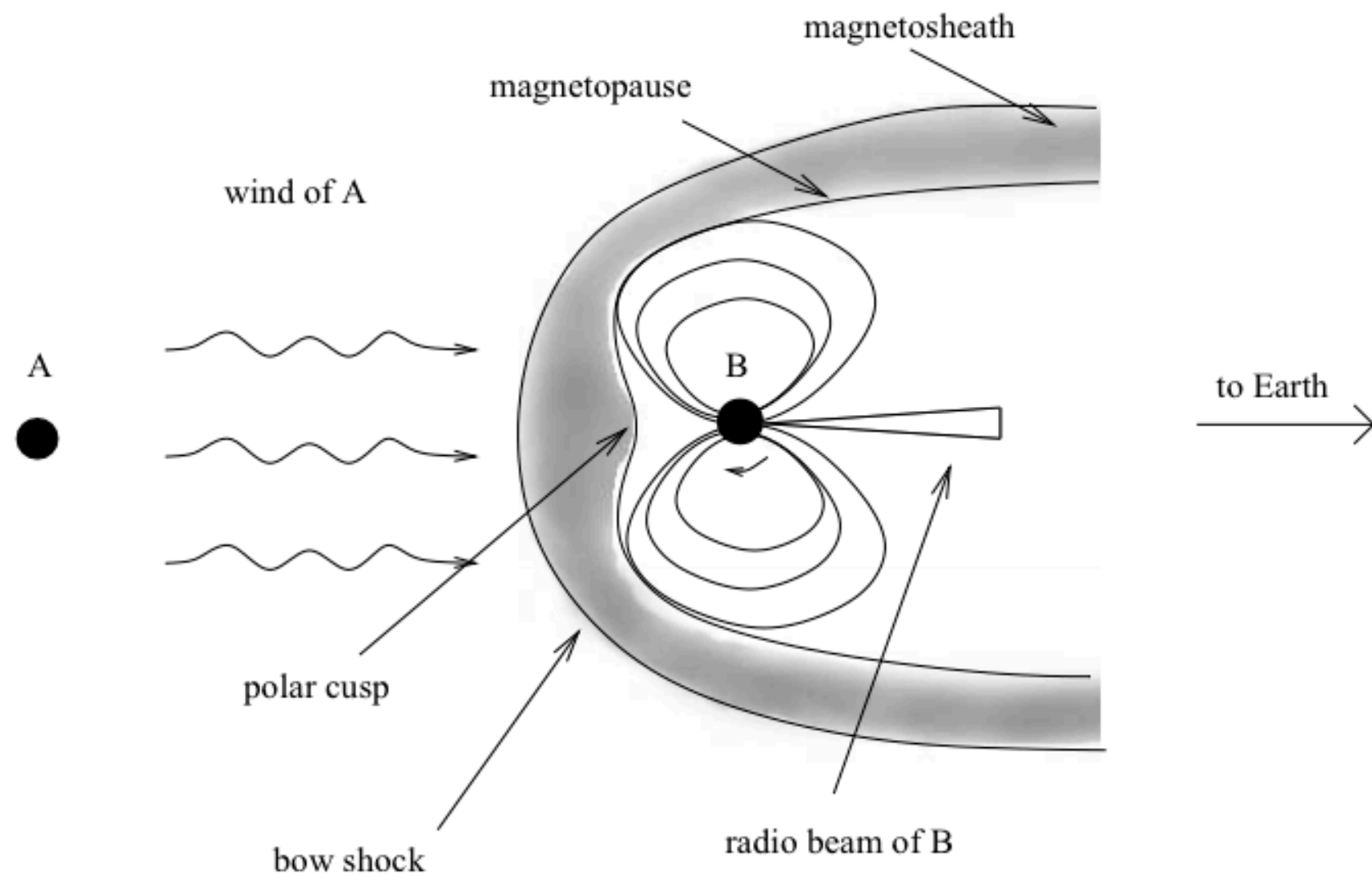
Simulation results implied that the direction of B's spin axis precession is the opposite of the direction of the orbital motion. One could argue that this is against theoretical predictions.



Beam Me Up, Scotty!



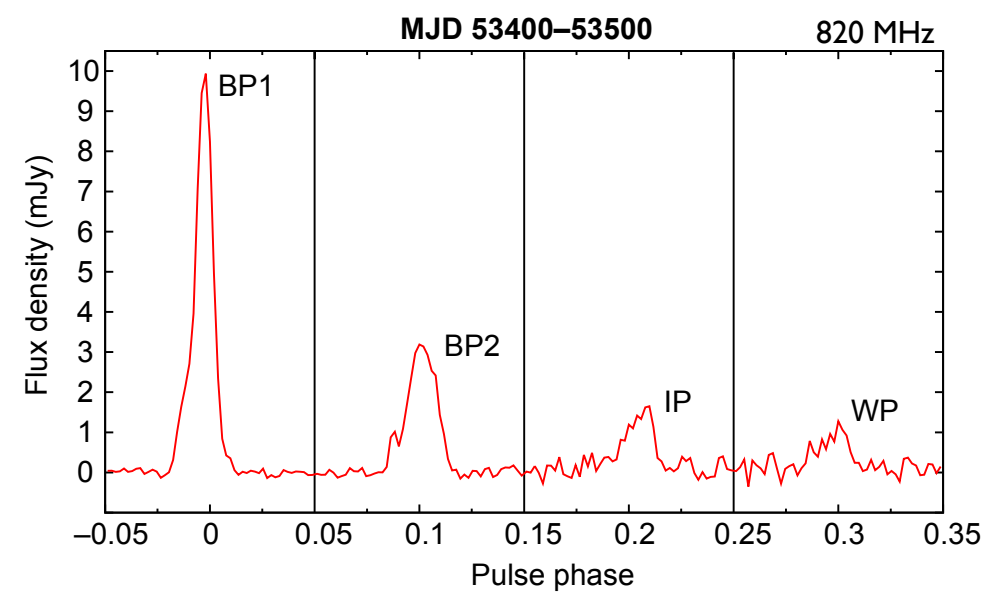
* First Contact



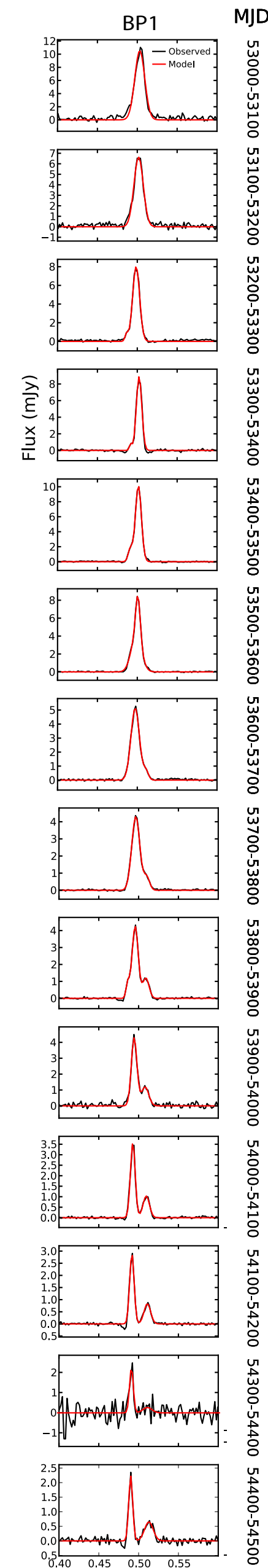
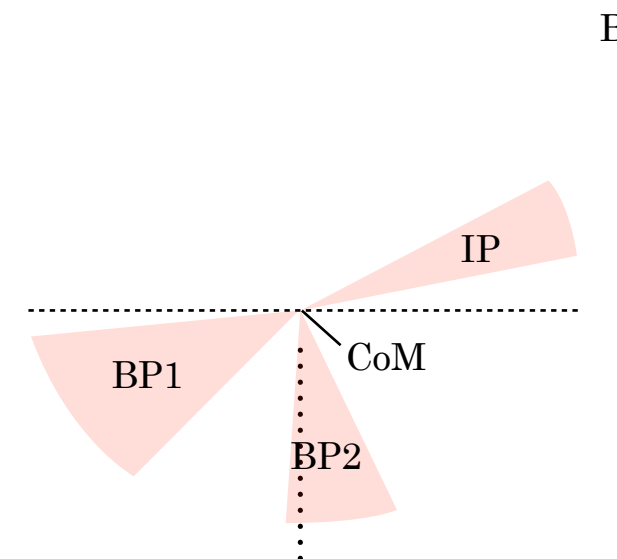
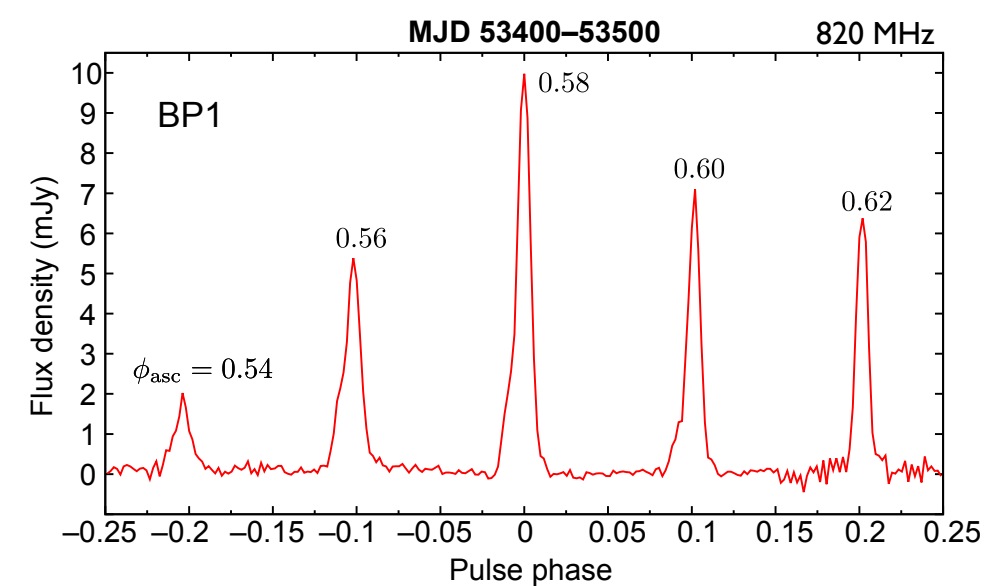
Orbital Profile Evolution (1% wind)

Pulsar A's spin-down power is $\sim 10^3$ x higher than Pulsar B's:
Its wind compresses and distorts the magnetosphere of Pulsar B, causing ...

Strong profile evolution **across the orbit ...**

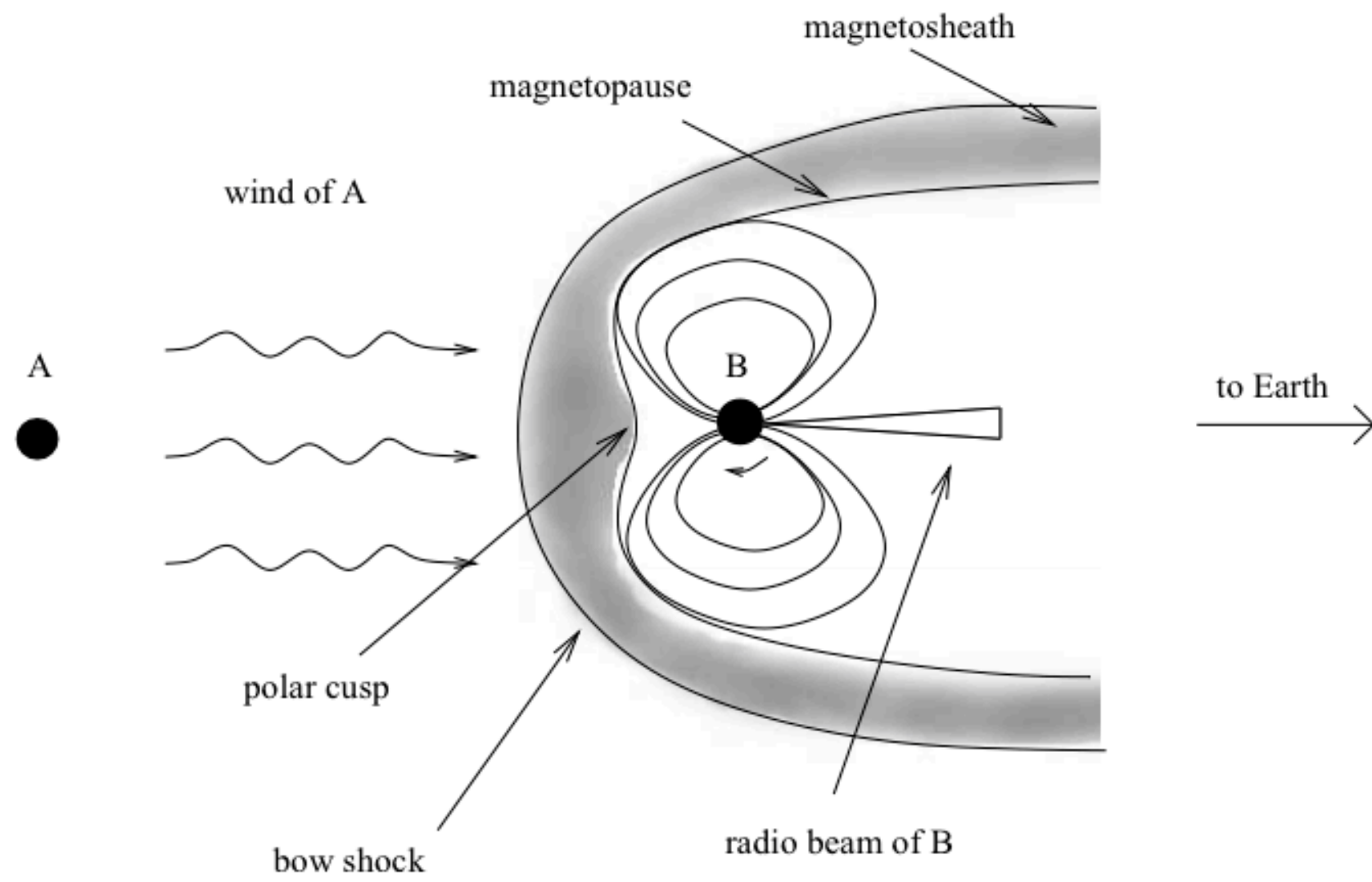


... and **across each bright phase**



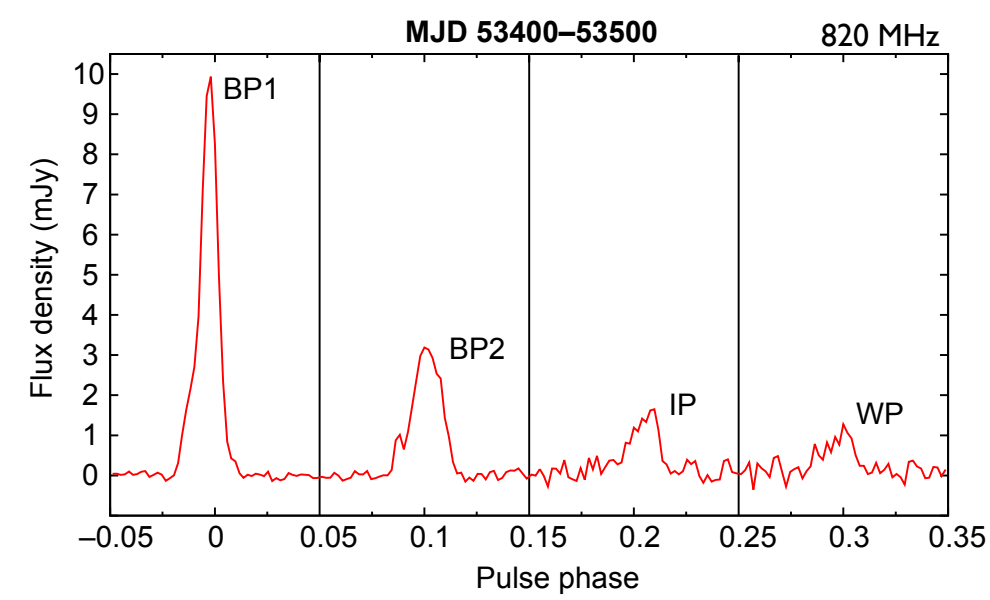
— 2003

— 2008

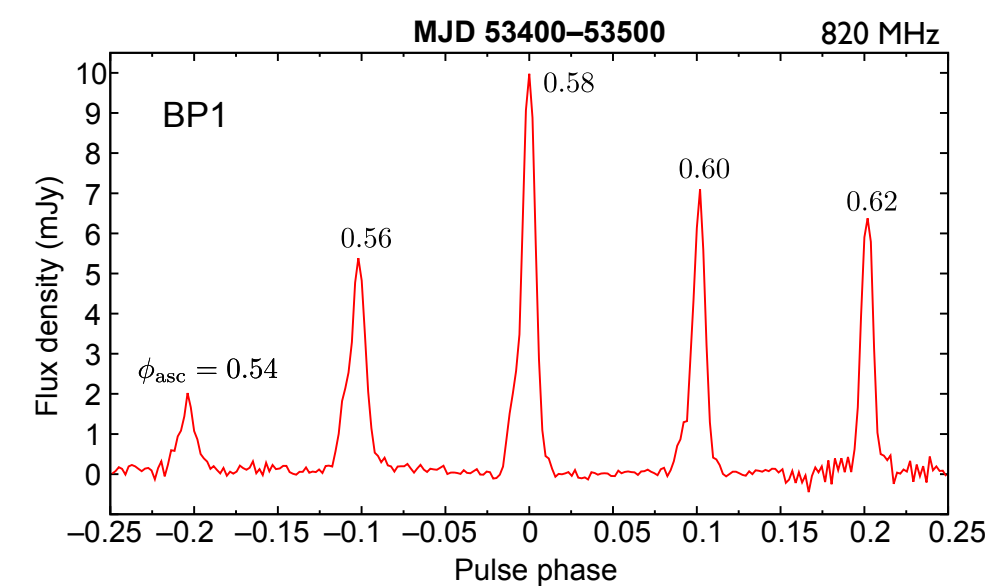


Pulsar A's spin-down power is $\sim 10^3$ x higher than Pulsar B's:
Its wind compresses and distorts the magnetosphere of Pulsar B, causing ...

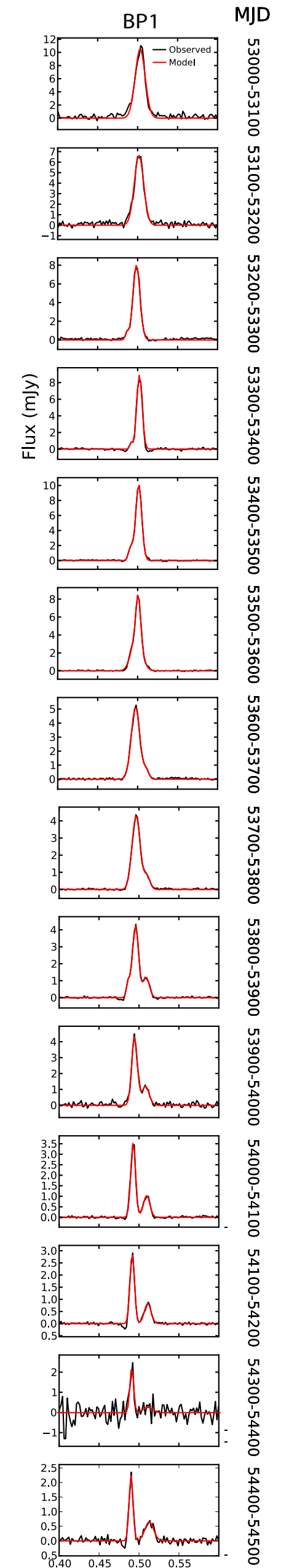
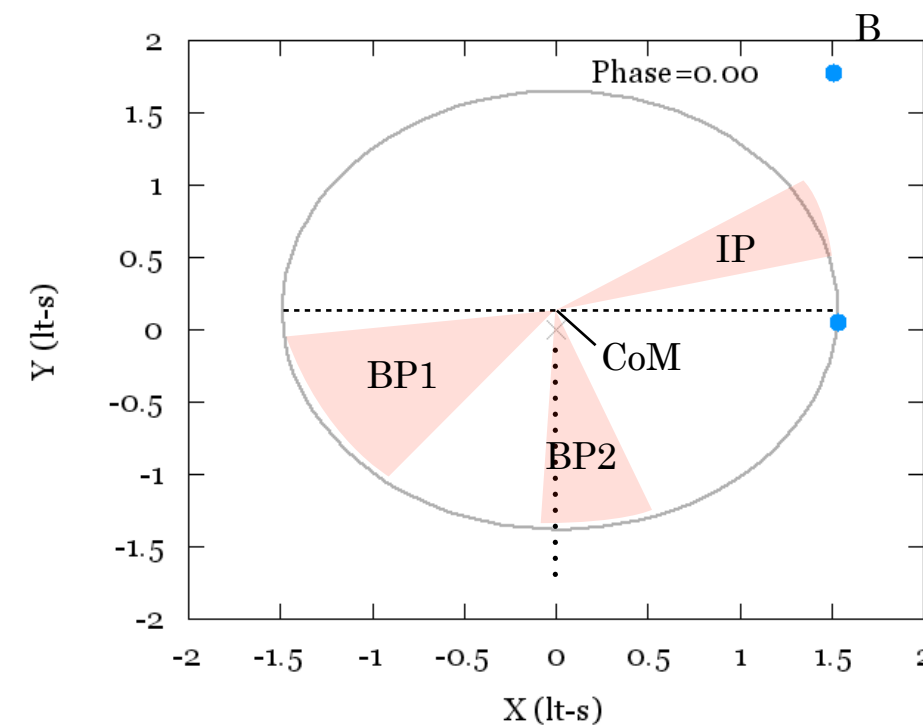
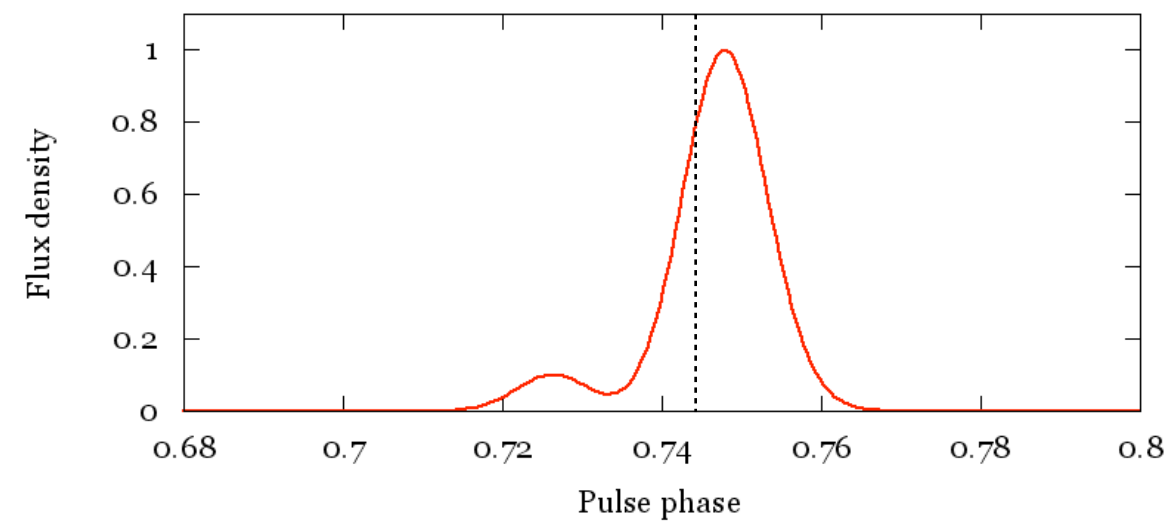
Strong profile evolution **across the orbit ...**



... and **across each bright phase**



Orbital Profile Evolution (1% wind)



— 2003

— 2008



... and many more. Subscribe now to Pulsar B Live



The fan-beam model for the pulse evolution of PSR J0737-3039B

L. Saha* and J. Dyks*

Relativistic Spin Precession in the Double Pulsar

Rene P. Breton,^{2*} Victoria M. Kaspi,¹ Michael Kramer,² Maura A. McLaughlin,^{3,4} Maxim Lyutikov,² Scott M. Ransom,⁶ Ingrid H. Stairs,⁷ Robert D. Ferdman,^{7,8} Fernando Camilo,⁹ Andrea Possenti¹⁰

A new technique for timing the double pulsar system

P. C. C. Freire,^{1,2*} N. Wex,³ M. Kramer,^{3,4} D. R. Lorimer,² M. A. McLaughlin,² I. H. Stairs,^{5,6} R. Rosen⁷ and A. G. Lyne⁴

Tests of General Relativity from Timing the Double Pulsar

M. Kramer,^{1*} I. H. Stairs,² R. N. Manchester,³ M. A. McLaughlin,^{1,4} A. G. Lyne,¹ R. D. Ferdman,² M. Burgay,⁵ D. R. Lorimer,^{1,4} A. Possenti,⁵ N. D'Amico,^{5,6} J. M. Sarkissian,³ G. B. Hobbs,³ J. E. Reynolds,³ P. C. C. Freire,⁷ F. Camilo⁸

THE EVOLUTION OF PSR J0737-3039B AND A MODEL FOR RELATIVISTIC SPIN PRECESSION

B. B. P. PERERA¹, M. A. McLAUGHLIN^{1,11,12}, M. KRAMER², I. H. STAIRS³, R. D. FERDMAN⁴, R. P. BRETON^{7,8}, R. N. MANCHESTER⁵, M. BURGAY⁶, A. G. LYNE², AND F. CAMILO¹⁰

A Double-Pulsar System: A Rare Laboratory for Relativistic Gravity and Plasma Physics

A. G. Lyne,^{1*} M. Burgay,² M. Kramer,¹ A. Possenti,^{3,4} R.N. Manchester,⁵ F. Camilo,⁶ M. A. McLaughlin,¹ D. R. Lorimer,¹ N. D'Amico,^{3,7} B. C. Joshi,⁸ J. Reynolds,⁹ P. C. C. Freire¹⁰

Orbital modulation of emission of the binary pulsar J0737-3039B

Maxim Lyutikov*

University of British Columbia, 6224 Agricultural Road, Vancouver, BC, V6T 1Z1, Canada

Radio emission region exposed: courtesy of the double pulsar

David Lomiashvili* and Maxim Lyutikov
Department of Physics, Purdue University, West Lafayette, IN 47905, USA

GBT Exploratory Time Observations of the Double-Pulsar System PSR J0737-3039

S. Ransom
Dept. of Physics, McGill University, 3600 University St., Montreal, QC H3A 2T8, Canada

P. Demorest
Dept. of Astronomy and Radio Astronomy Laboratory, University of California at Berkeley, 601 Campbell Hall 3411, Berkeley, CA 94720

V. Kaspi
Dept. of Physics, McGill University, 3600 University St., Montreal, QC H3A 2T8, Canada

R. Ramachandran, D. Backer
Dept. of Astronomy and Radio Astronomy Laboratory, University of California at Berkeley, 601 Campbell Hall 3411, Berkeley, CA 94720

THE DOUBLE PULSAR SYSTEM J0737-3039: MODULATION OF THE RADIO EMISSION FROM B BY RADIATION FROM A

M. A. McLAUGHLIN,¹ M. KRAMER,¹ A. G. LYNE,¹ D. R. LORIMER,¹ I. H. STAIRS,² A. POSSENTI,³ R. N. MANCHESTER,⁴ P. C. C. FREIRE,⁵ B. C. JOSHI,⁶ M. BURGAY,³ F. CAMILO,⁷ AND N. D'AMICO⁸

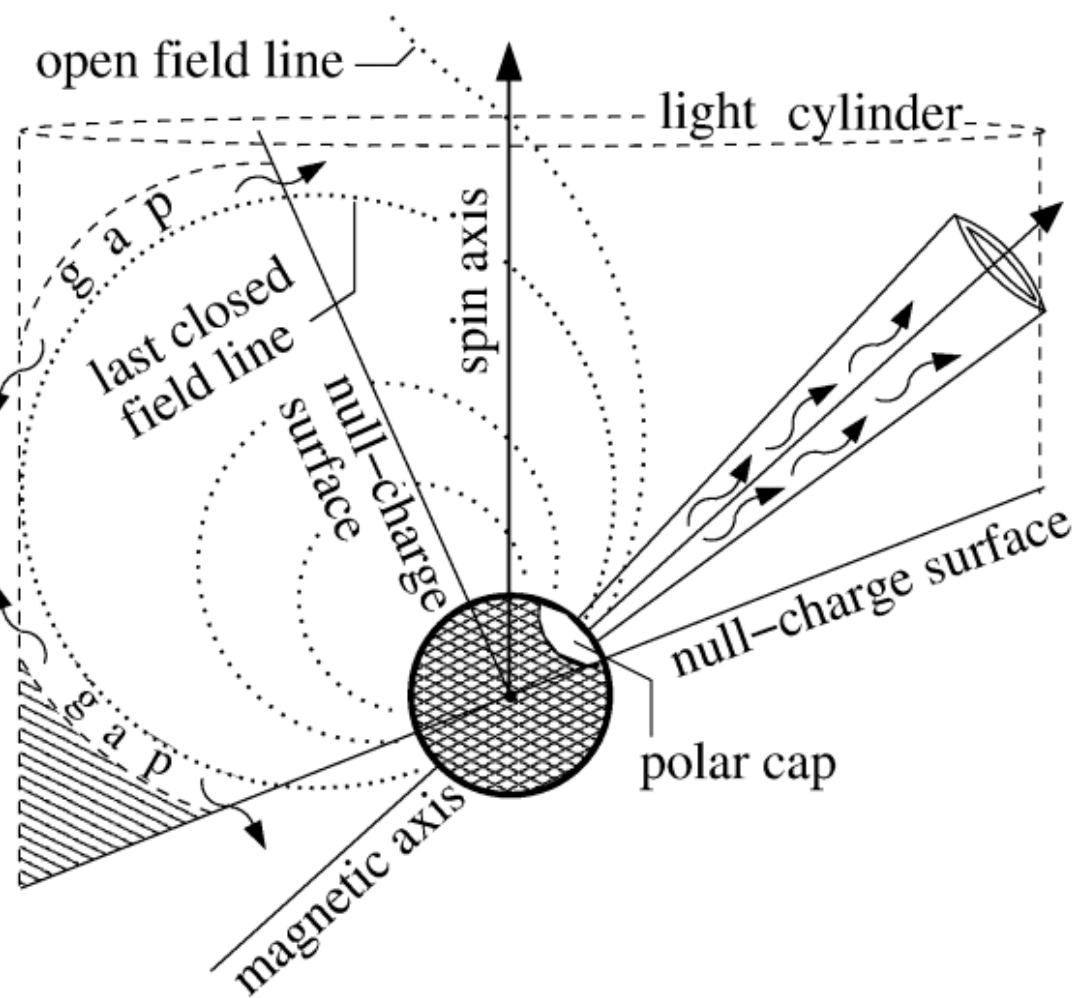
PSR J0737-3039B: A PROBE OF RADIO PULSAR EMISSION HEIGHTS

B. B. P. PERERA¹, D. LOMIASHVILI², K. N. GOURGOULIATOS², M. A. McLAUGHLIN^{1,3}, AND M. LYUTIKOV²

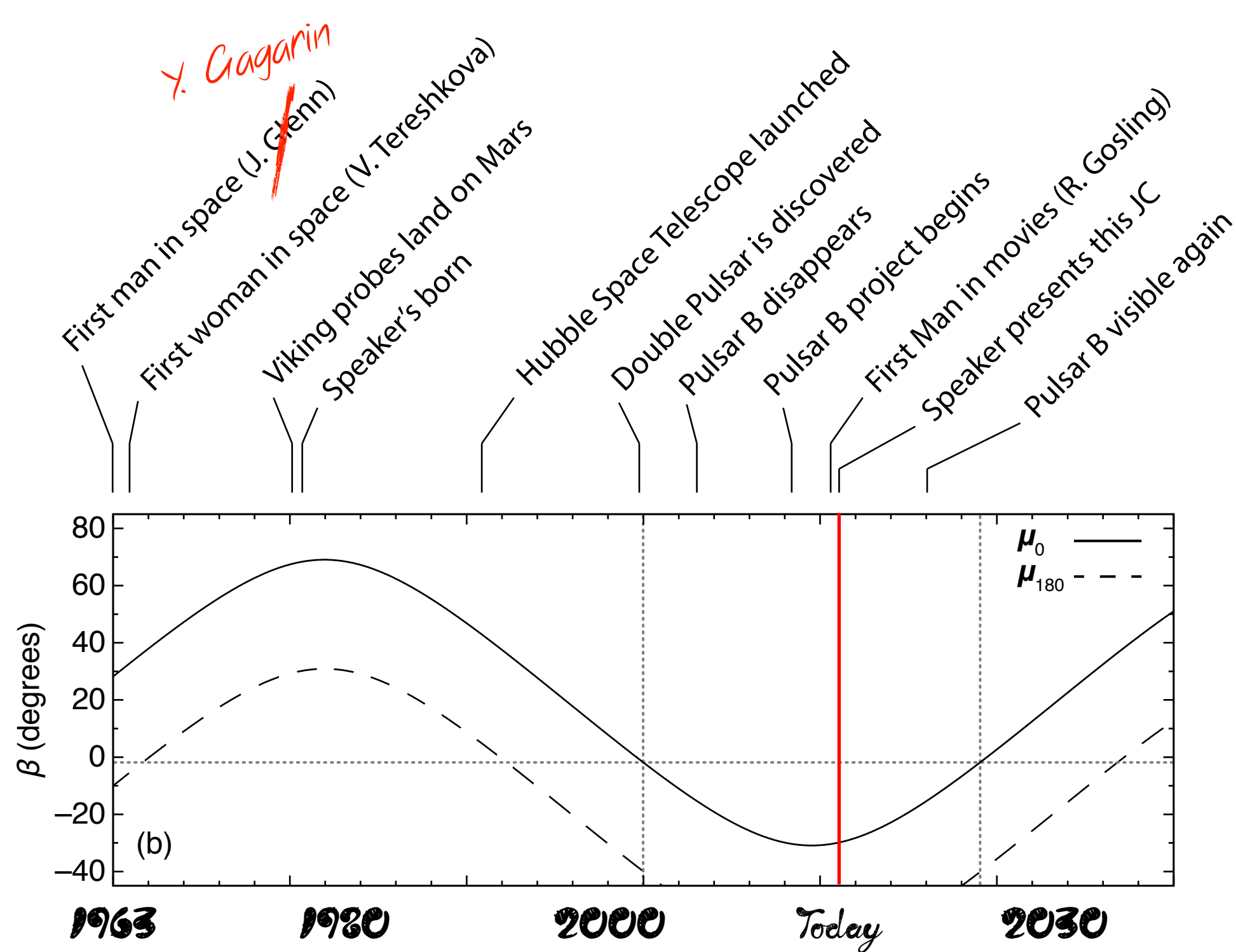
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Pulsar B is Coming Around

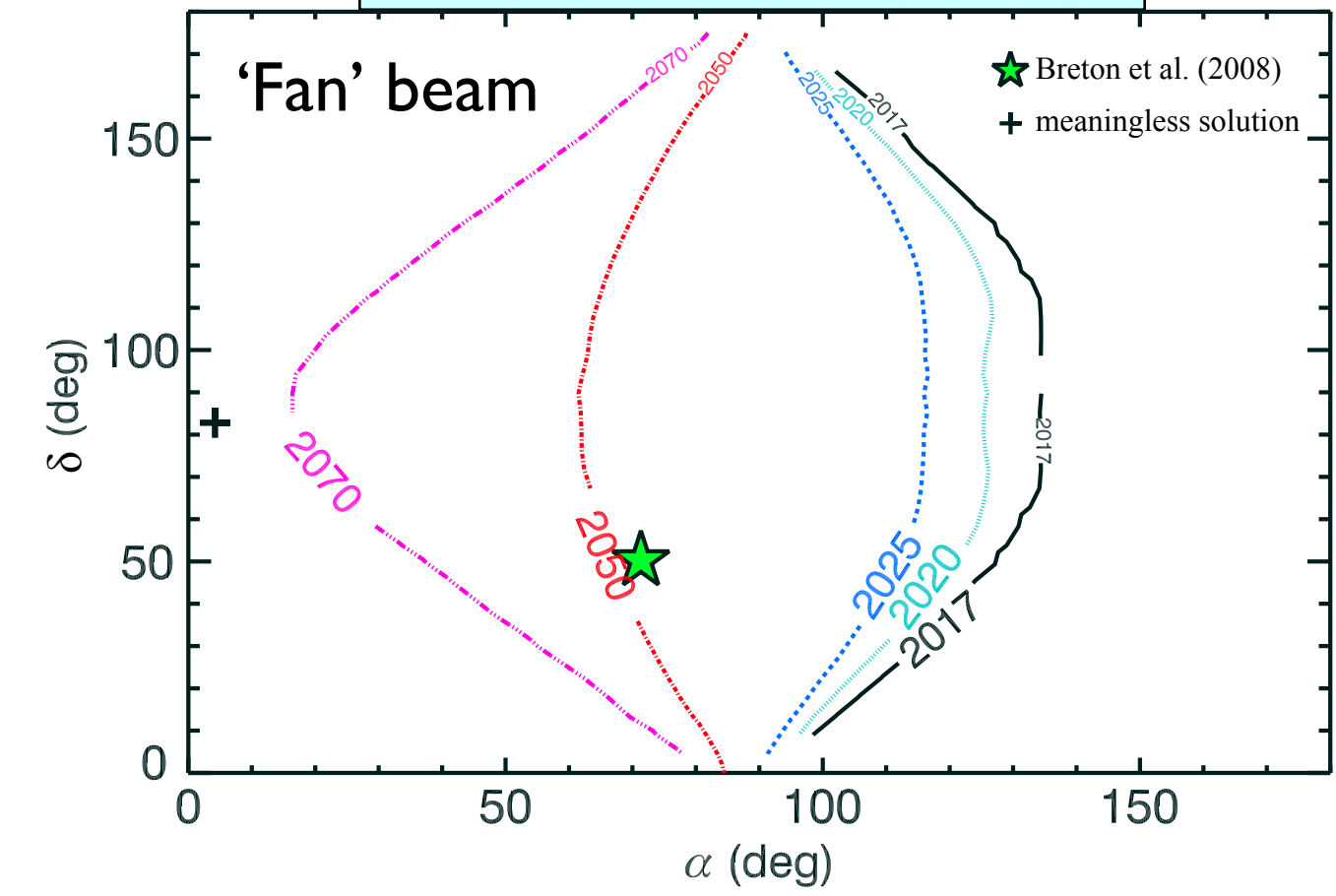
Breton et al. (2008) / Perera et al. (2012)
Reappearance in **2024**



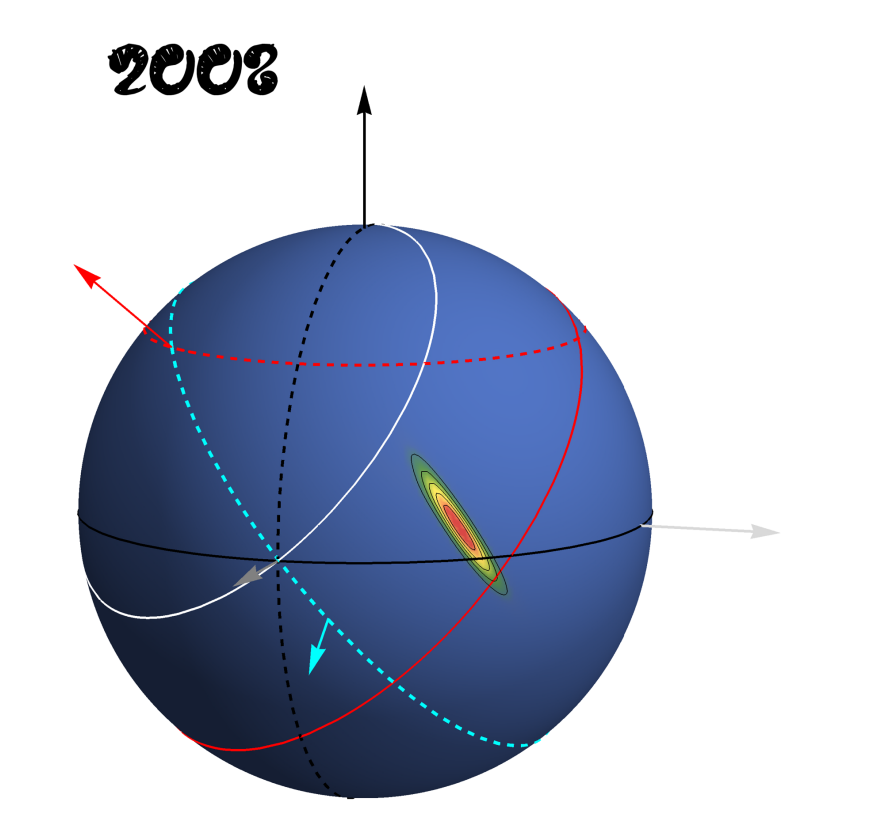
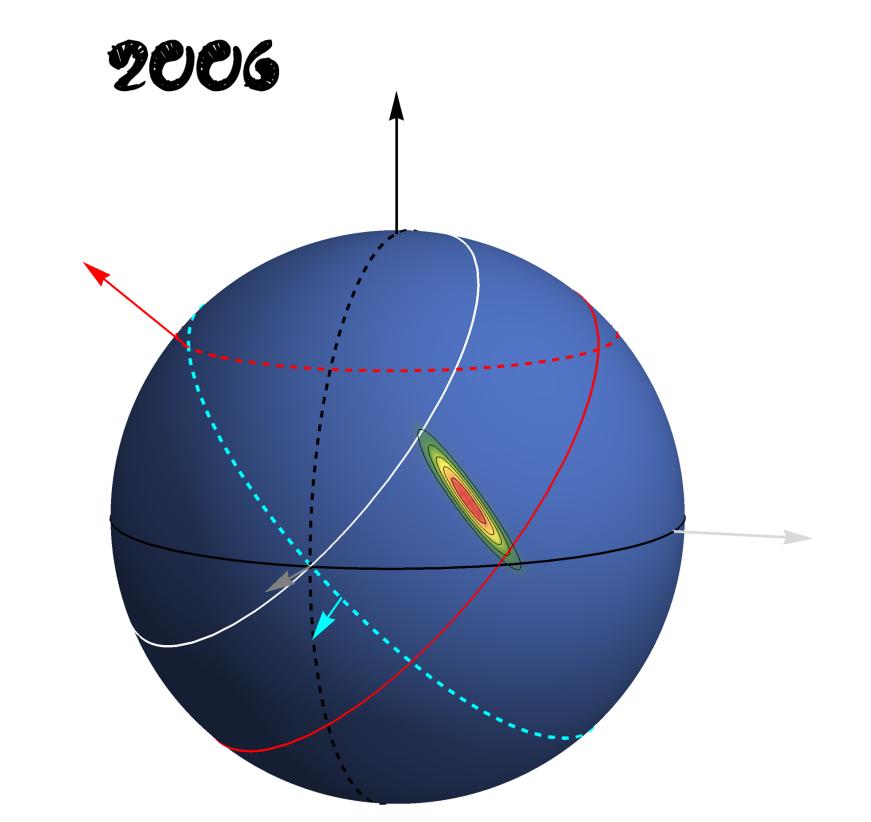
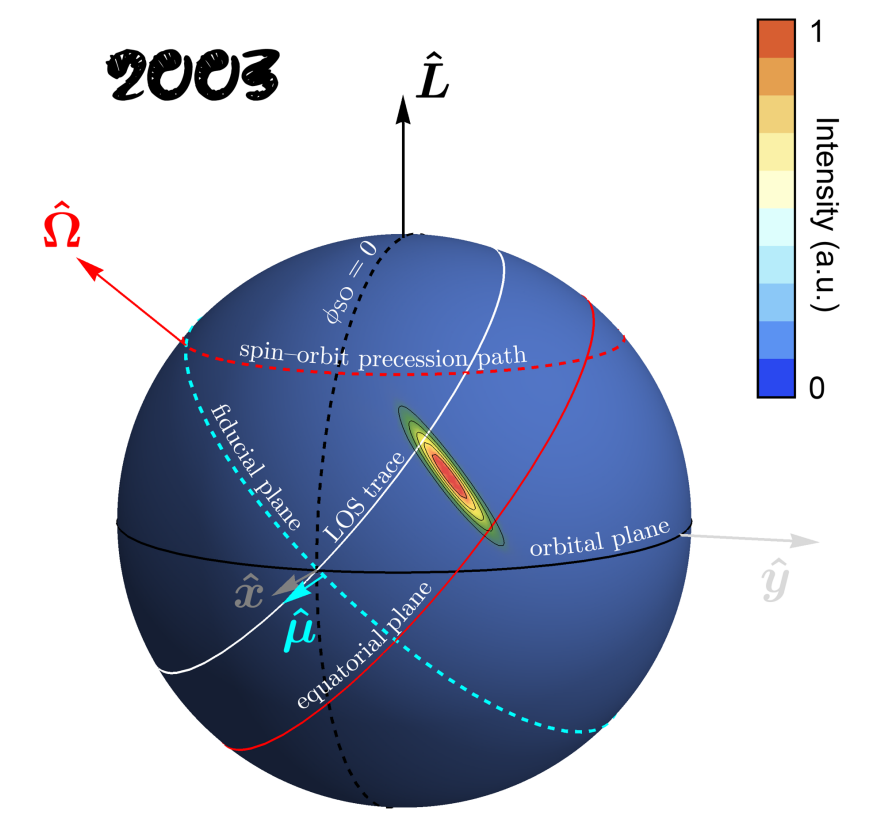
Lomiashvili & Lyutikov (2014)
'Horseshoe beam' model
Reappearance in
2034 or **2043** (two-pole configuration)
depending on whether the emission is generated only near the null-charge surface or everywhere where $\Omega \cdot \mathbf{B} \geq 0$
or
2066 (single-pole emission)



Saha & Dyks (2017)

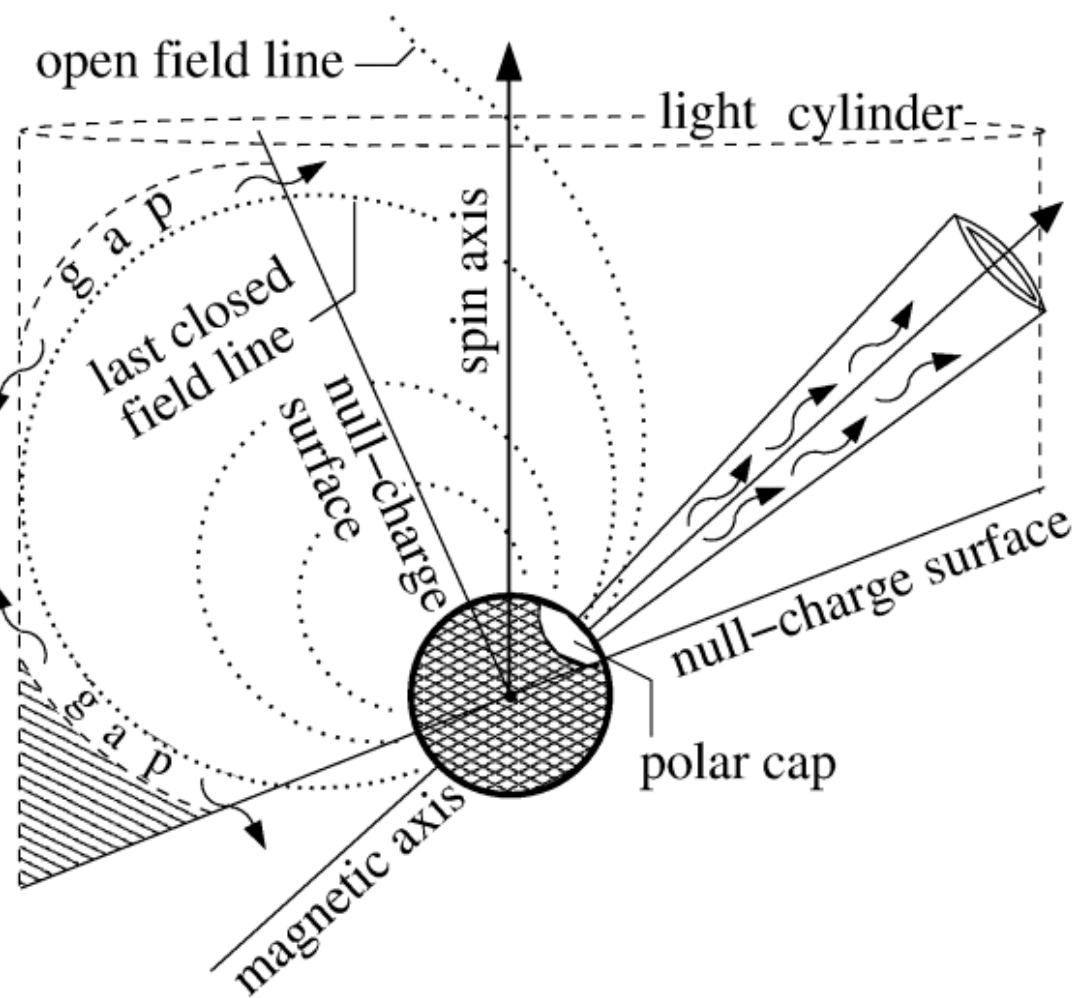


Noutsos et al. (in prep.)
Double-Gaussian beam model
Reappearance in **2024**

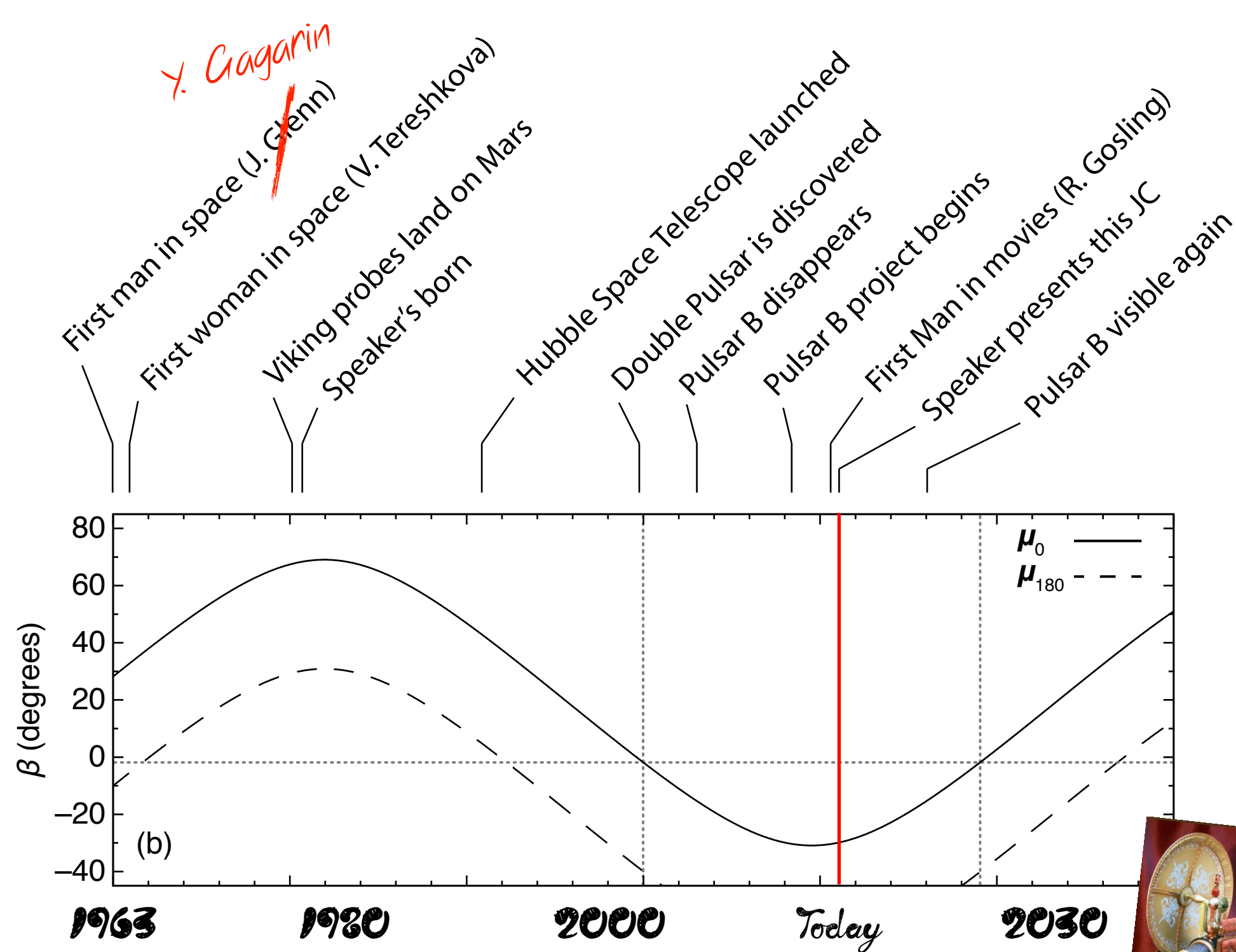


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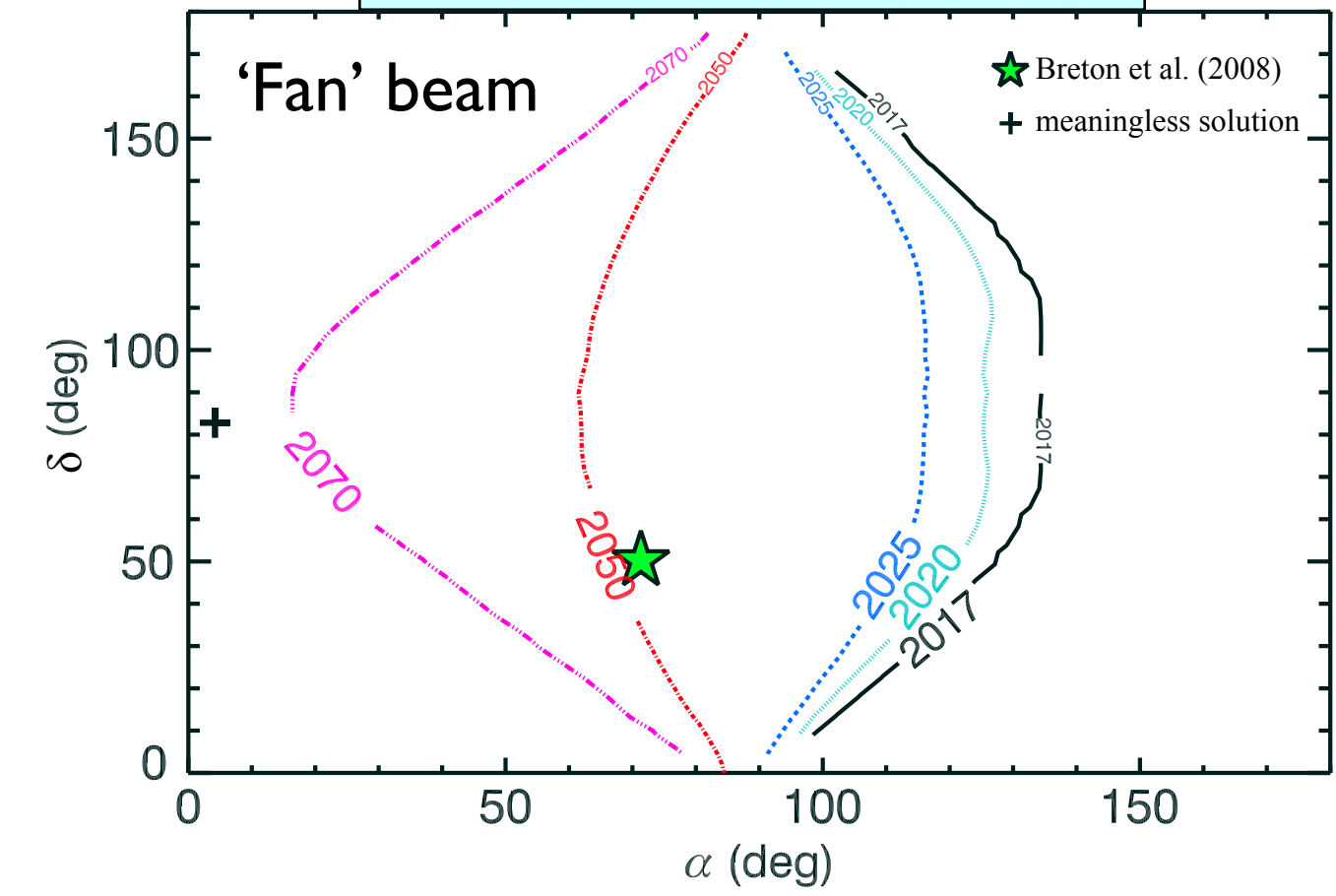
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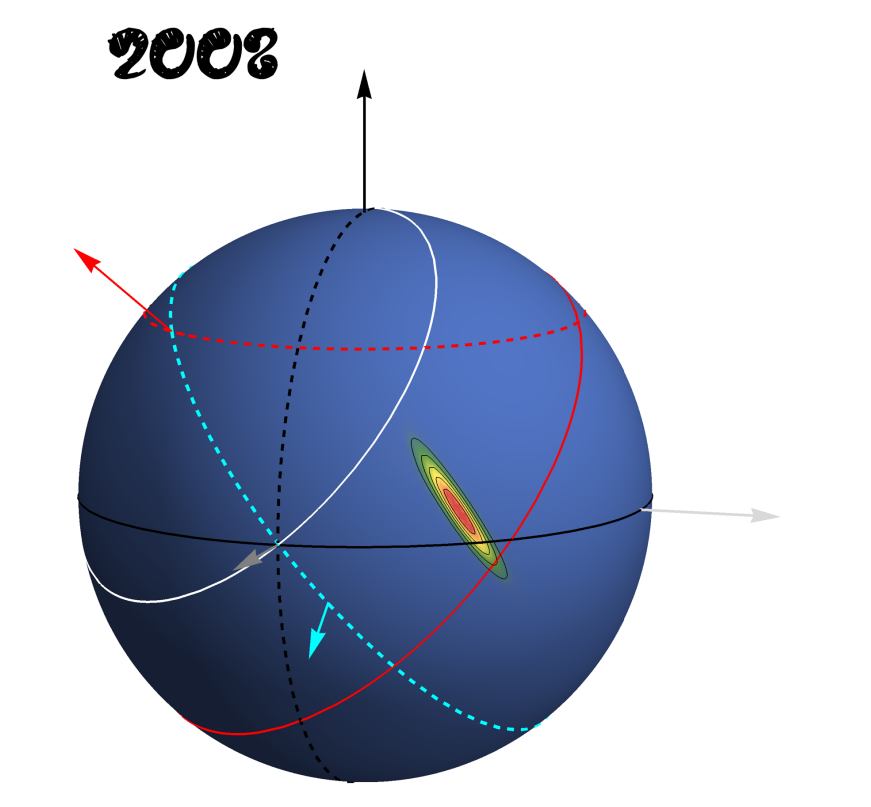
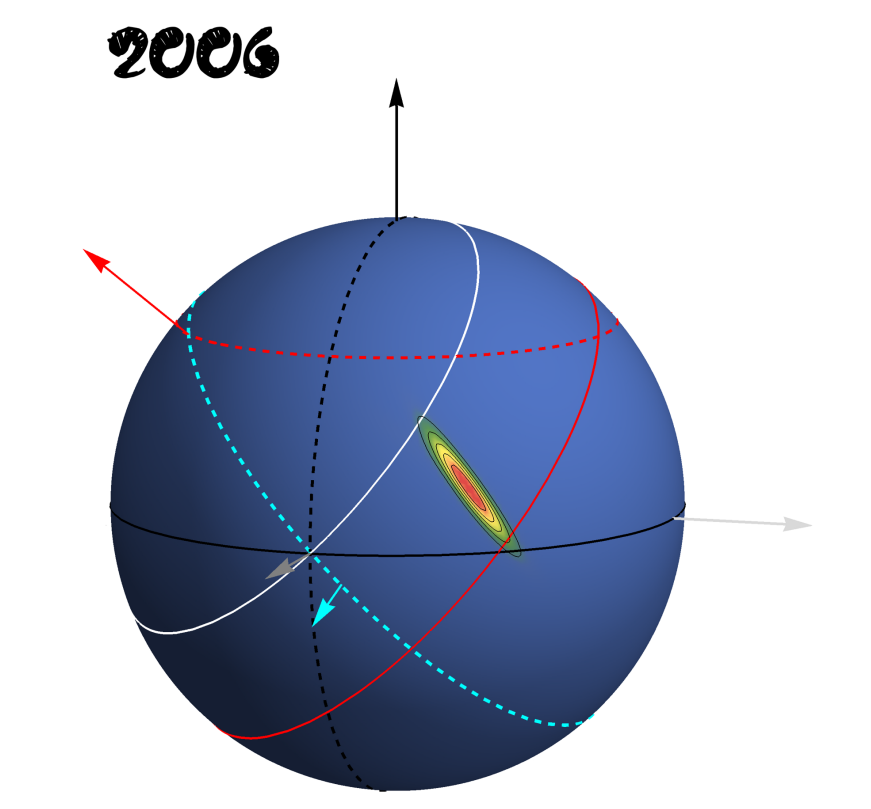
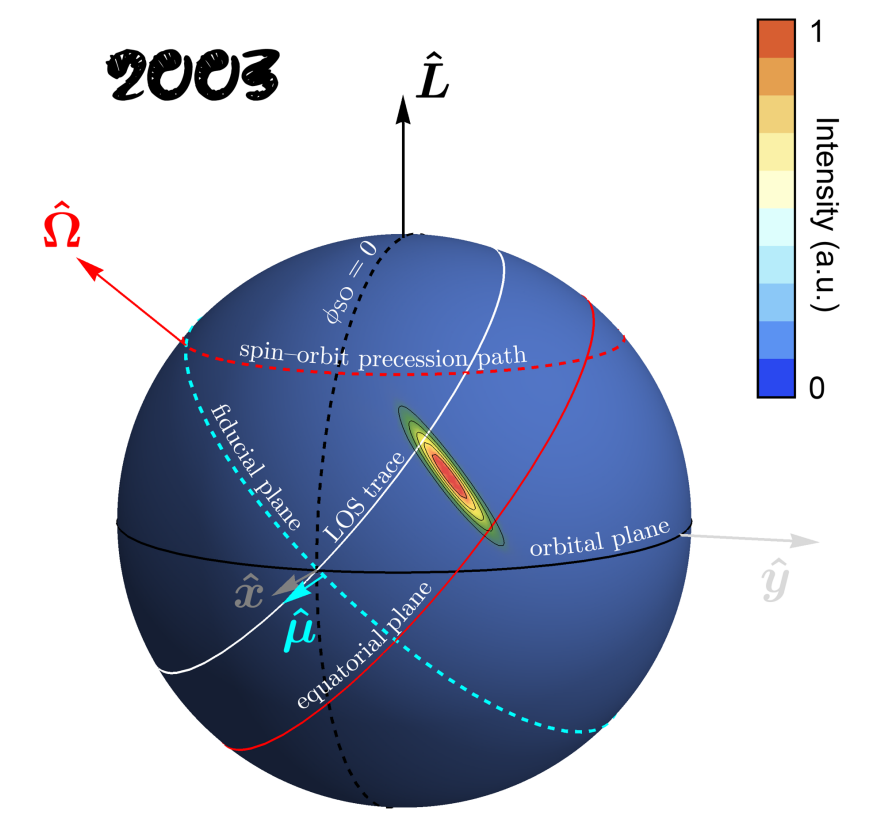
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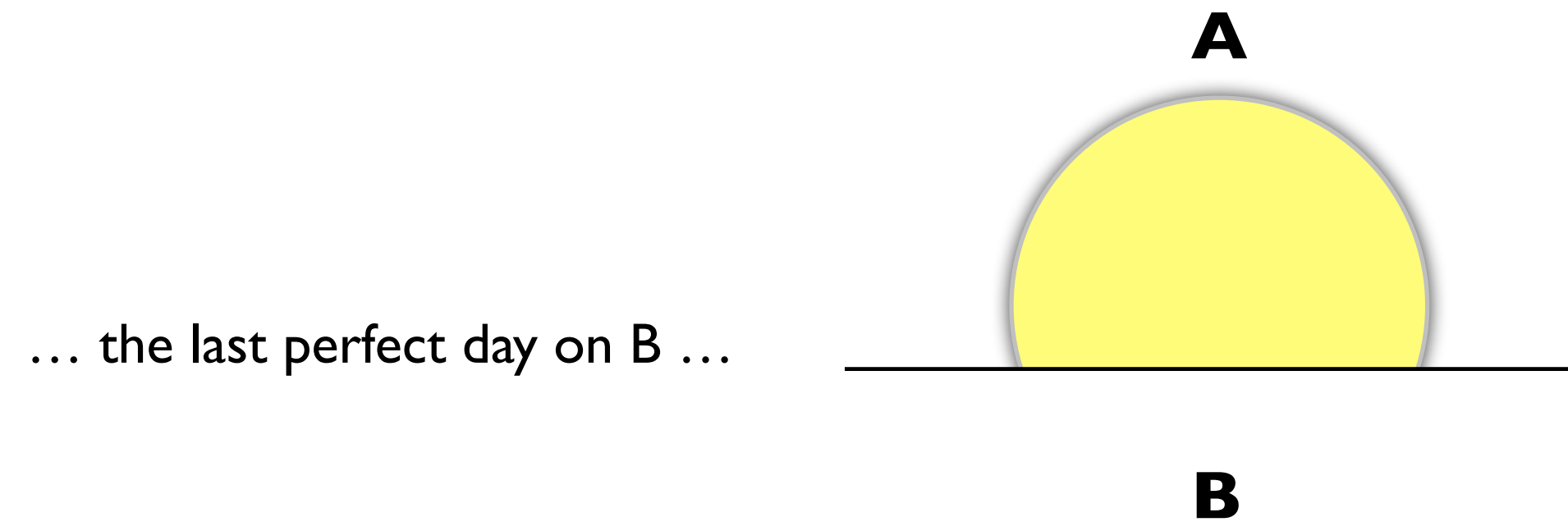


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The Last Slide

In about 85 Myr from now ...



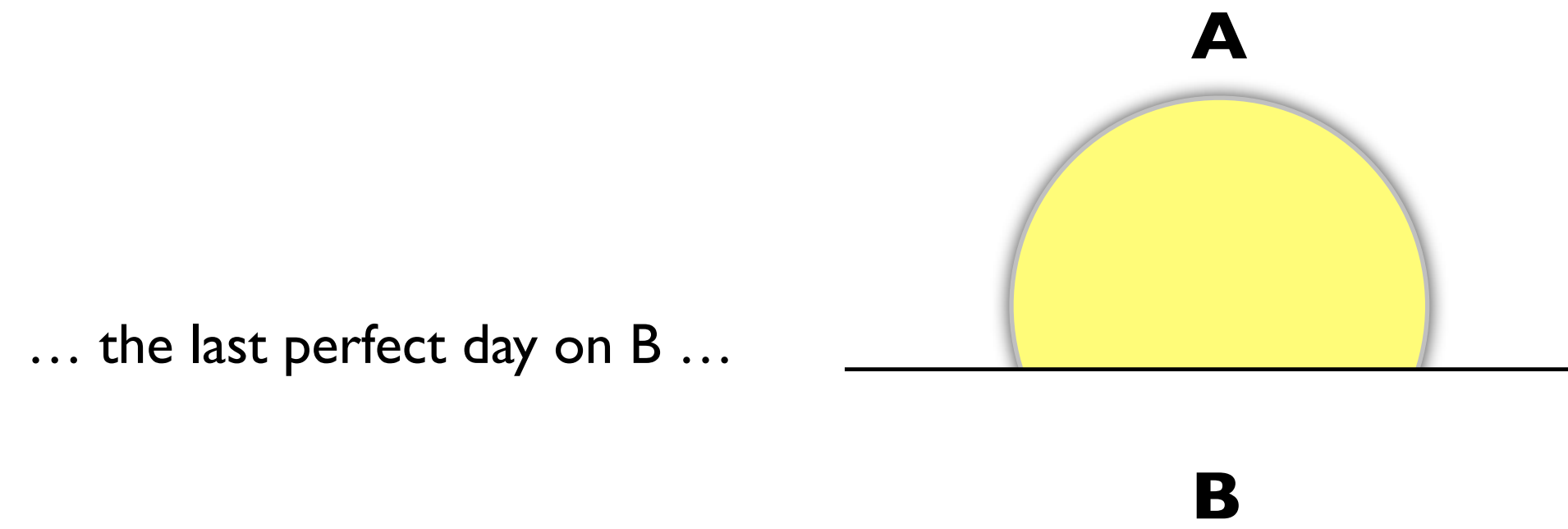
... then the last slide ...



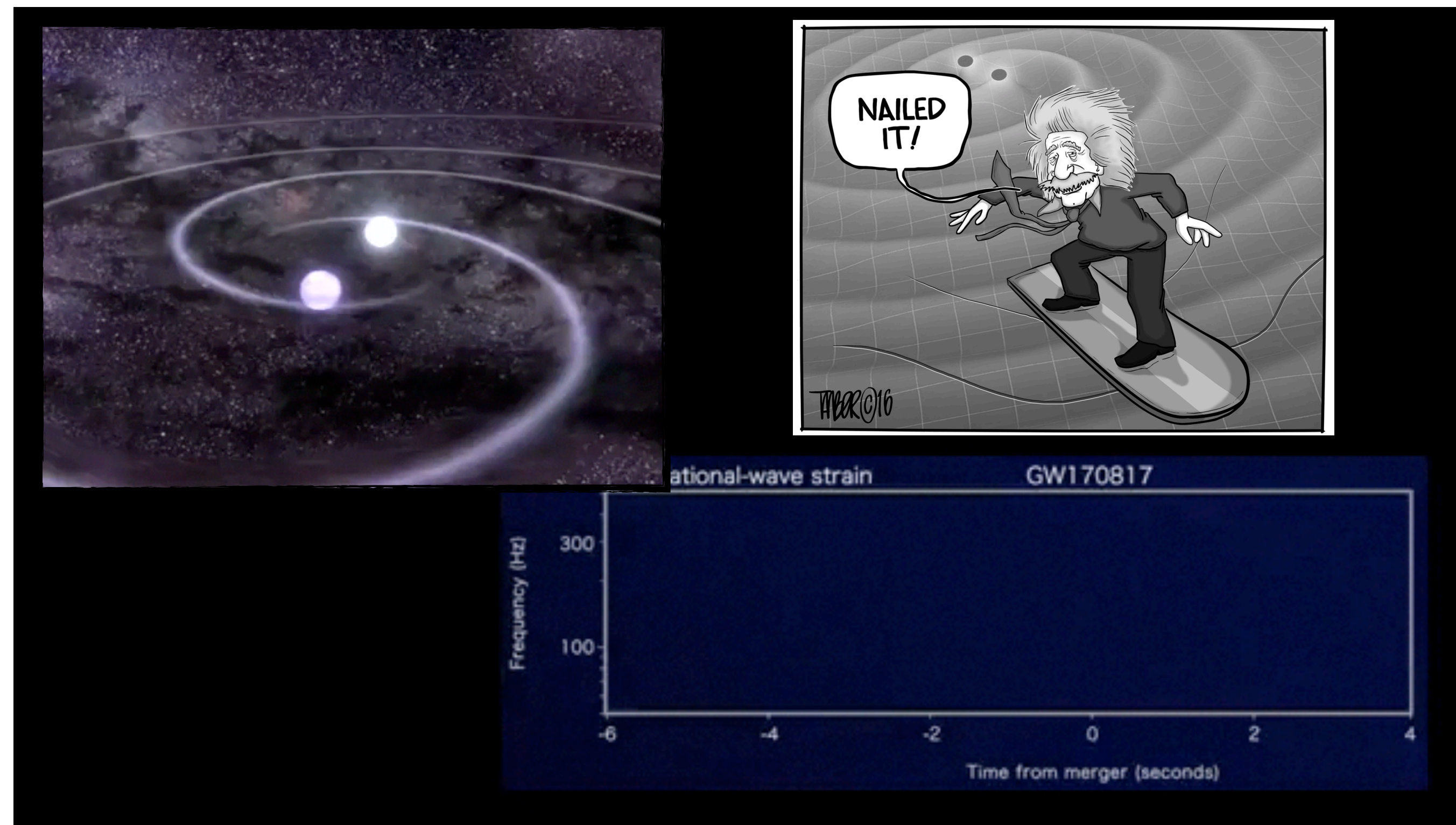
So, enjoy it while it lasts!

The Last Slide

In about 85 Myr from now ...



... then the last slide ...



So, enjoy it while it lasts!