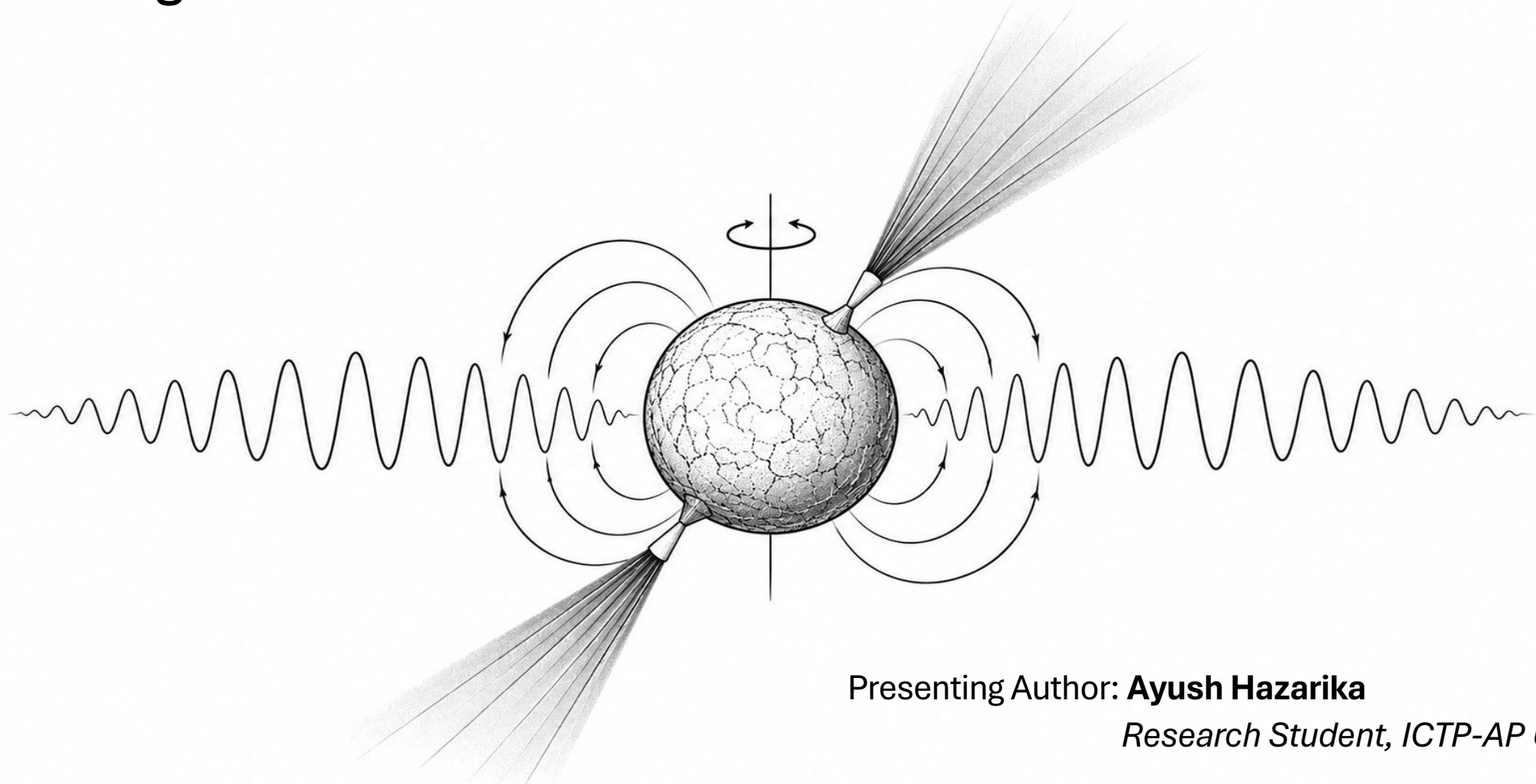


Rethinking: *Neutron-Star with Continuous Gravitational-Wave Constraints*



Presenting Author: **Ayush Hazarika**

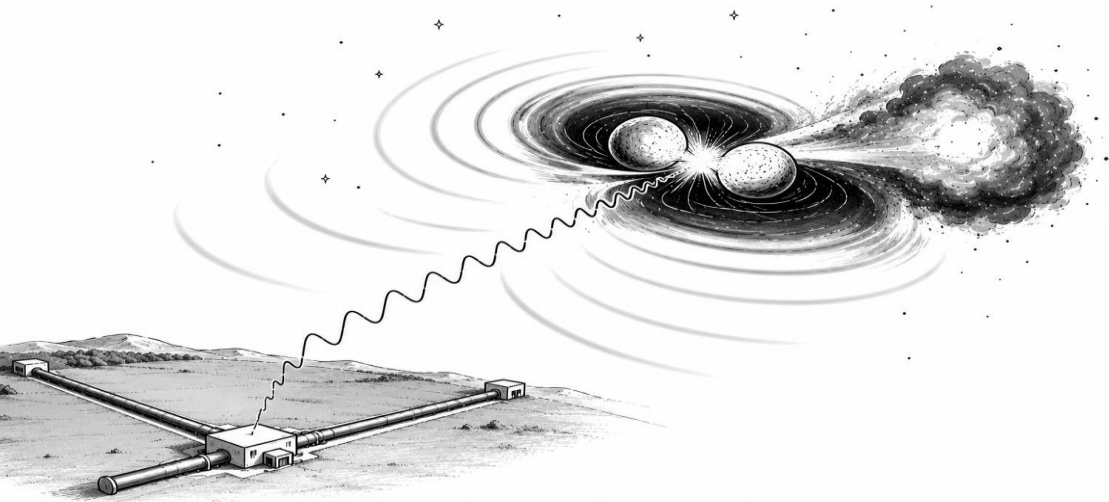
Research Student, ICTP-AP UCAS

hazarika4research@hotmail.com

<https://sites.google.com/view/ayushhazarika>

GW170817

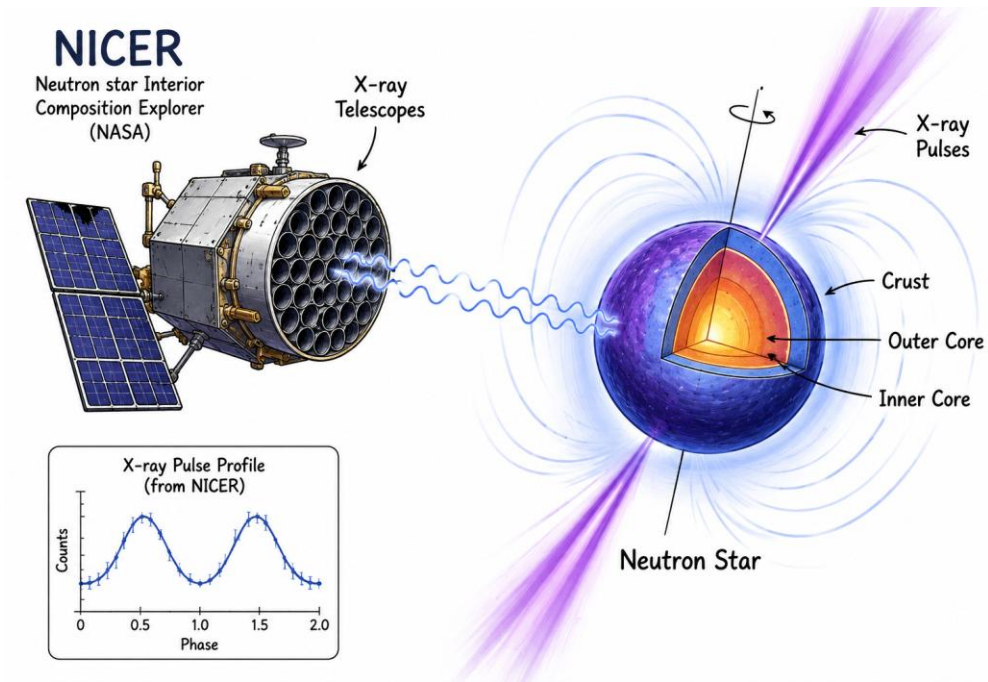
Measured - the tidal deformability during the late inspiral

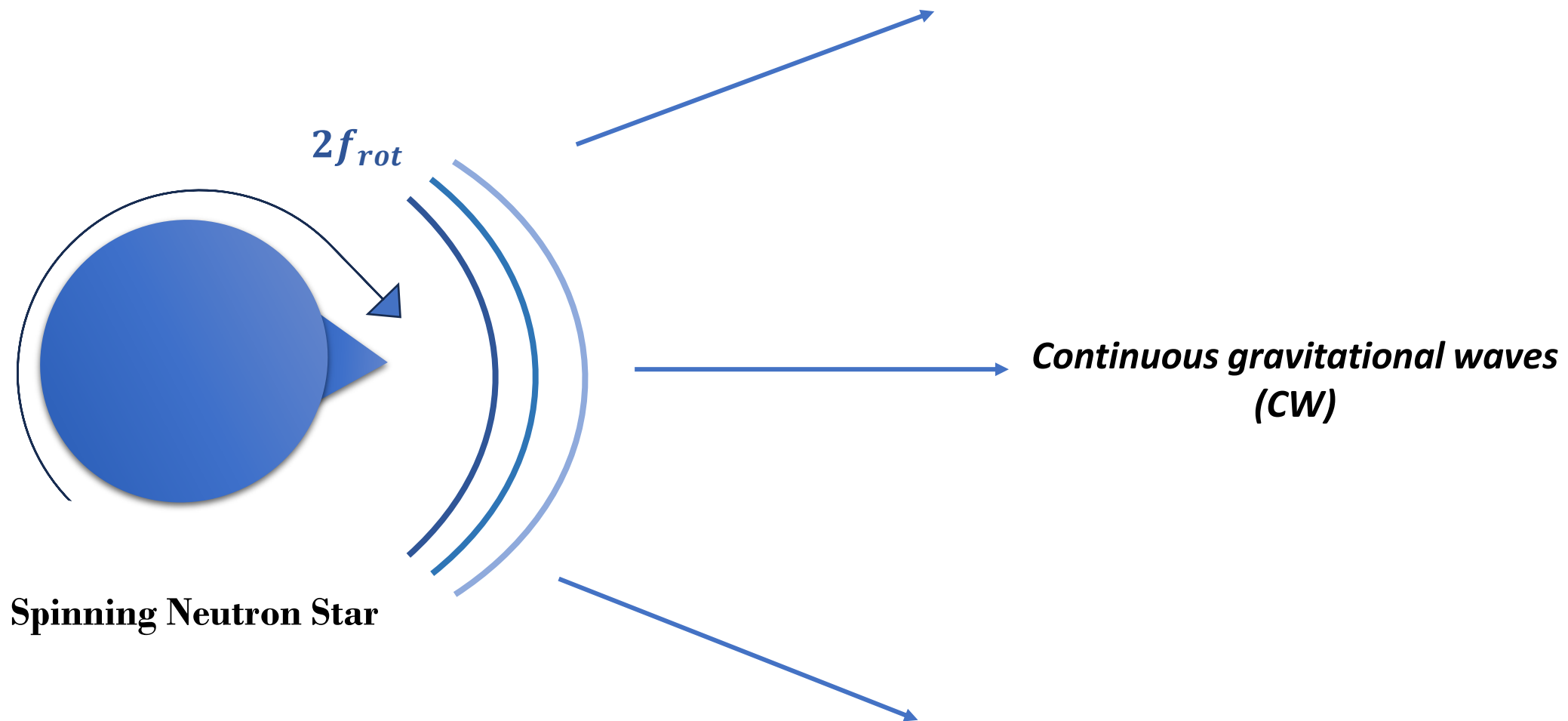


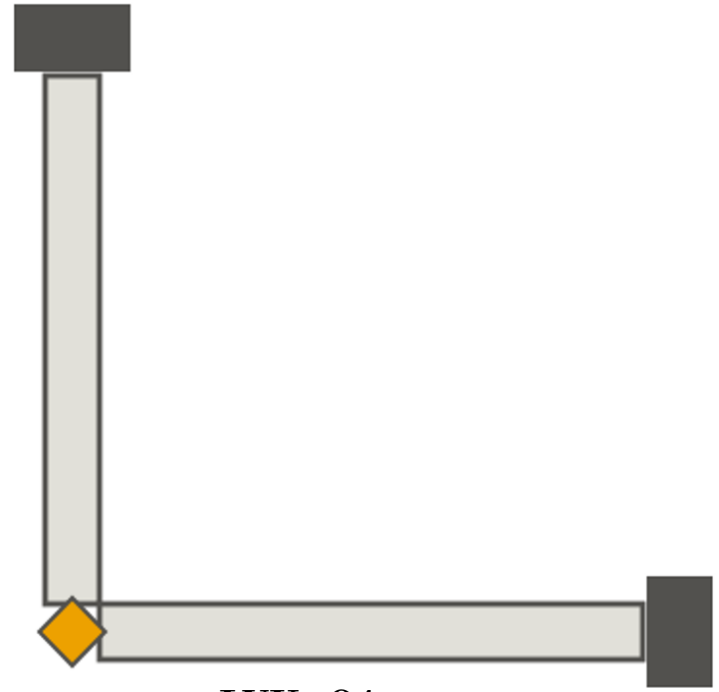
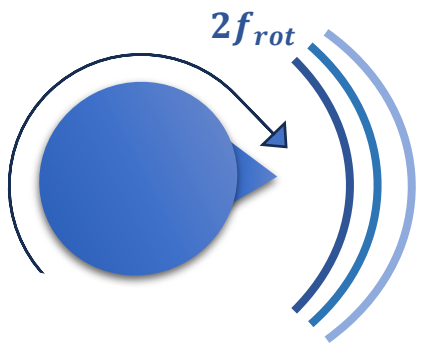
Neutron star Interior Composition Explorer (NICER)

Relativistically distorted X-ray pulses from surface hot spots

X-ray timing instrument on the ISS







LVK- 04a run

No detection $\rightarrow$ 95% UL on h_0



Search for Continuous Gravitational Waves from Known Pulsars in the First Part of the Fourth LIGO-Virgo-KAGRA Observing Run

THE ASTROPHYSICAL JOURNAL, 983:99 (34pp), 2025 April 20

Abac et al.

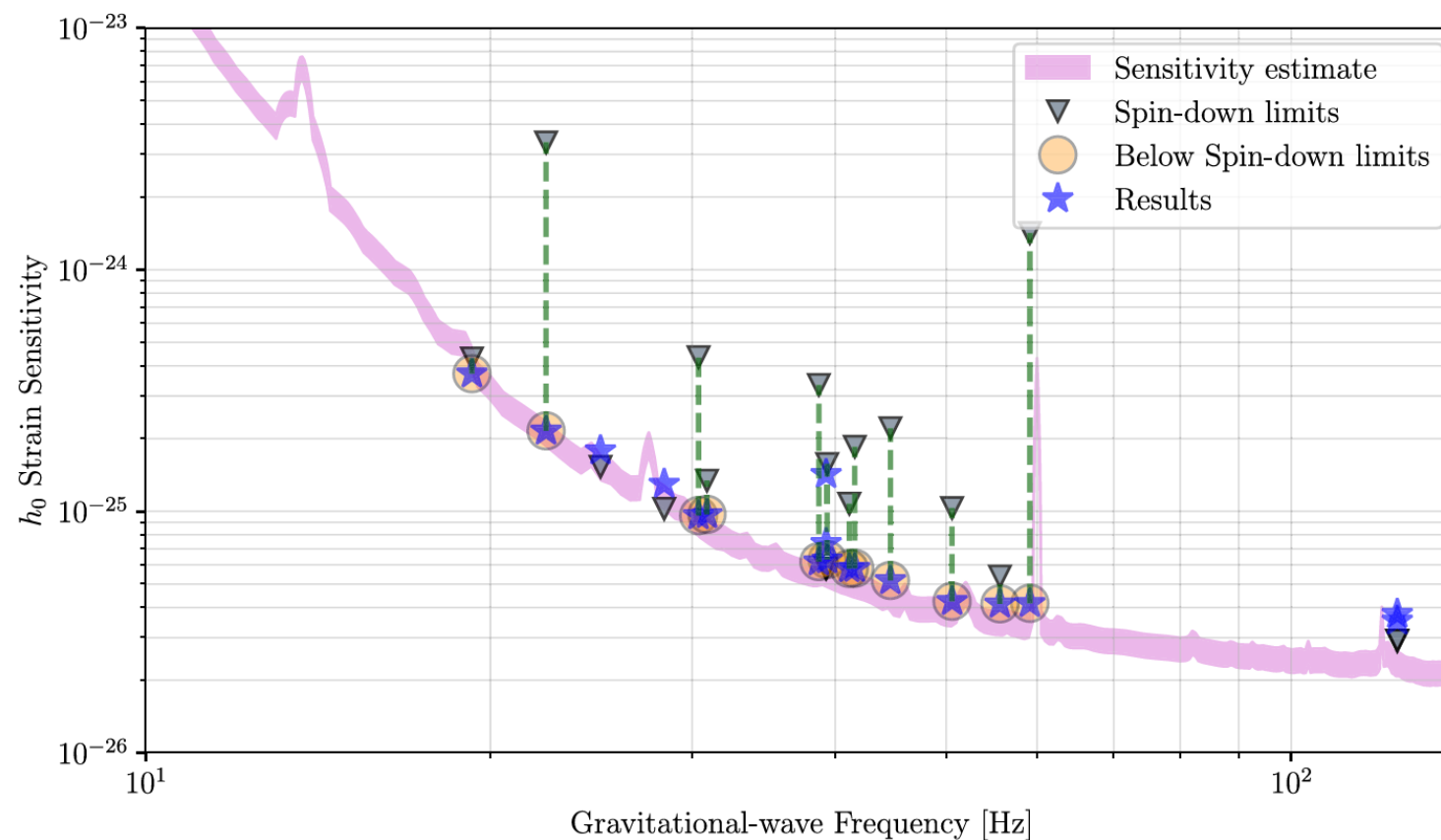
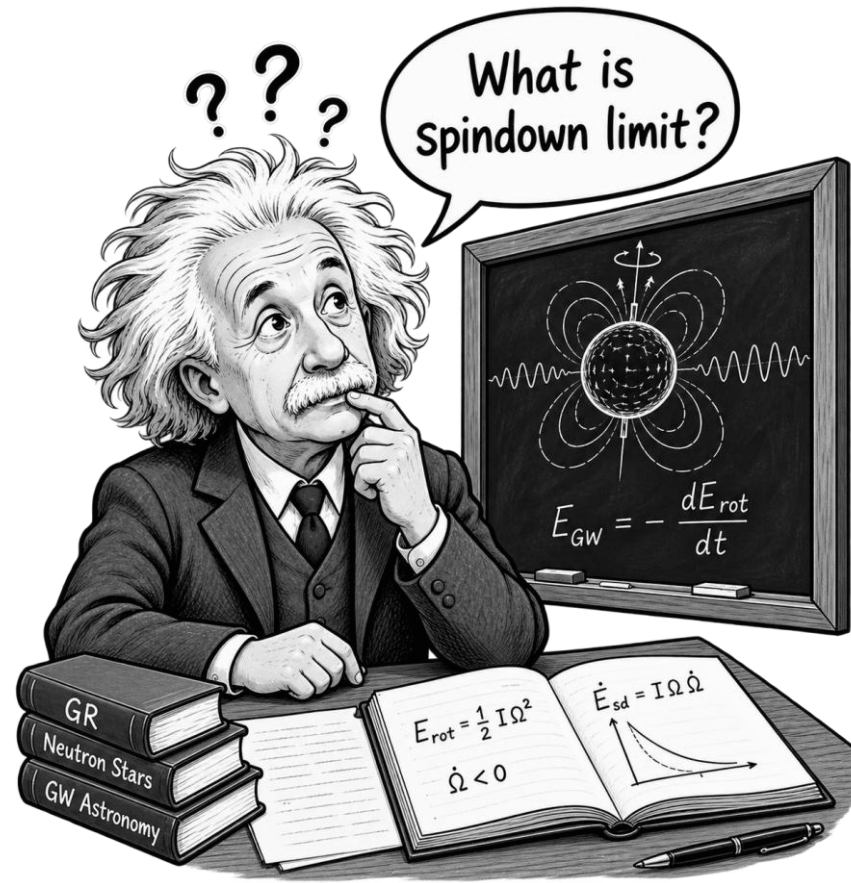
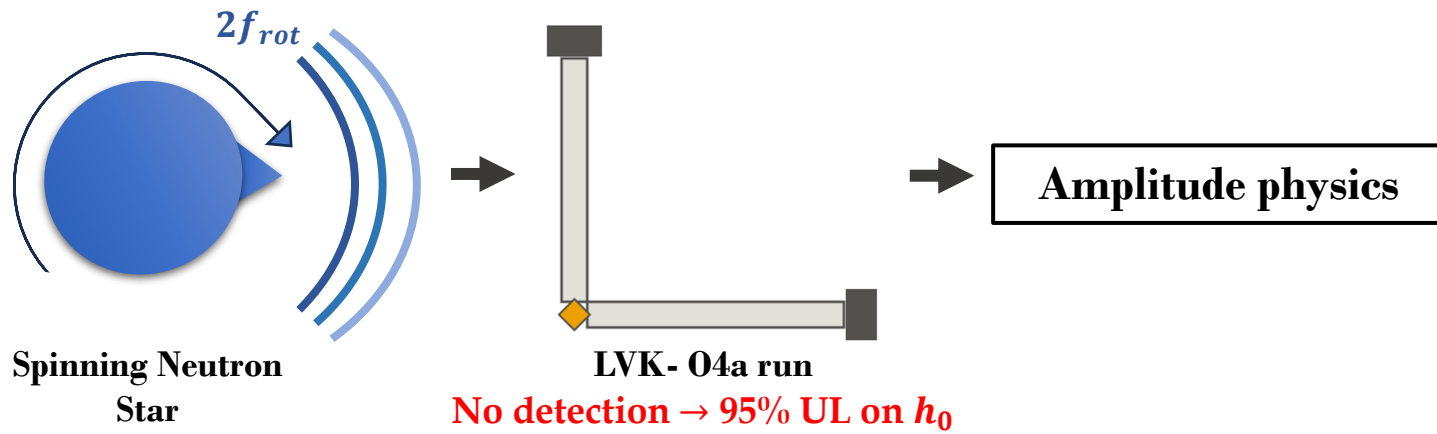


Figure 5. Expected sensitivity of the narrowband search using the O4a (shaded pink region) data set from the two LIGO detectors considering the single-harmonic emission model. The curve is compared with the spin-down limits (triangles) and the upper limits (stars) averaged over all the 10^{-4} Hz bands for each source. Upper limits below the spin-down limit are highlighted with orange circles.

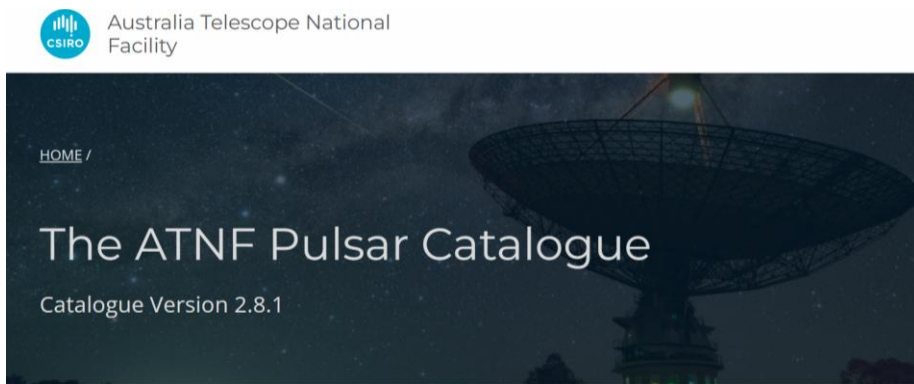


Maximum physically allowed ellipticity under the assumption that GWs account for 100% of the observed spin-down



$$h_0 = \frac{16\pi^2 G}{c^4} \frac{I_{zz} \varepsilon f_{rot}^2}{d}$$

$$\equiv A_j I_{zz} \varepsilon$$

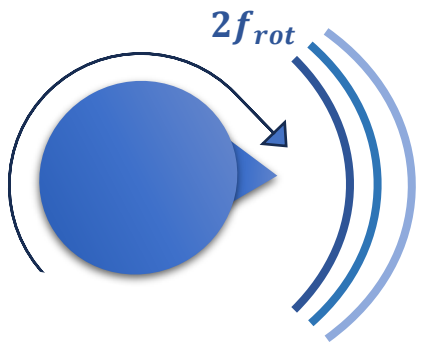


f_{rot} - spin frequency

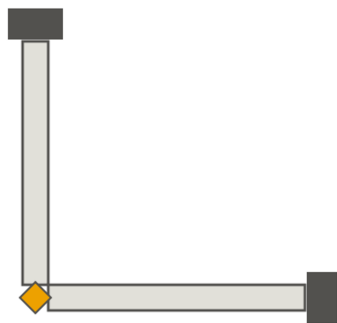
d - distance of the source

The equatorial ellipticity:

$$\varepsilon \equiv \frac{|I_{xx} - I_{yy}|}{I_{zz}}$$



Spinning Neutron Star



LVK-04a run



Amplitude physics

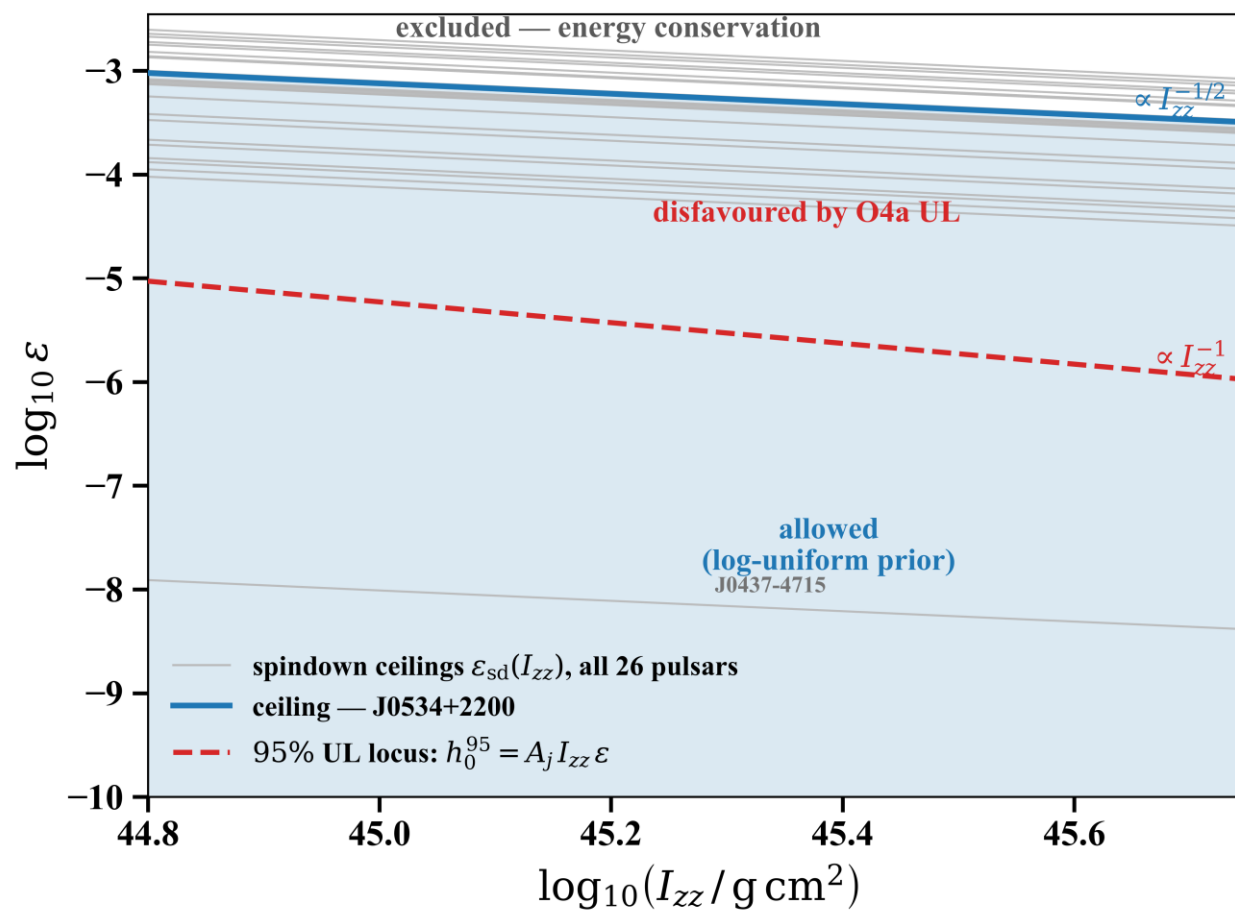
$$h_0 = \frac{16\pi^2 G}{c^4} \frac{I_{zz} \varepsilon f_{\text{rot}}^2}{d}$$

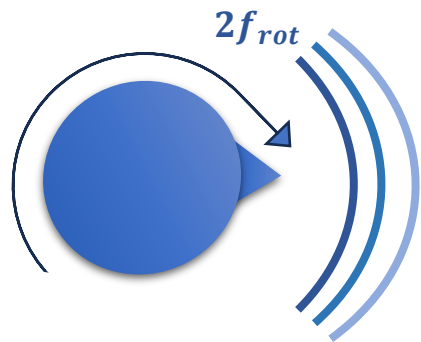
$$\equiv A_j I_{zz} \varepsilon$$



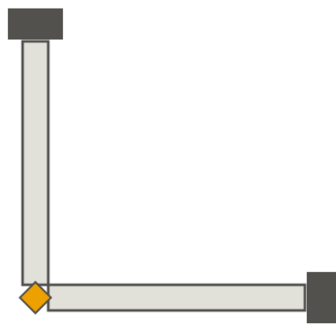
Spindown Wedge

No detection $\rightarrow$ 95% UL on h_0





Spinning Neutron Star



LVK- 04a run

No detection → 95% UL on h_0



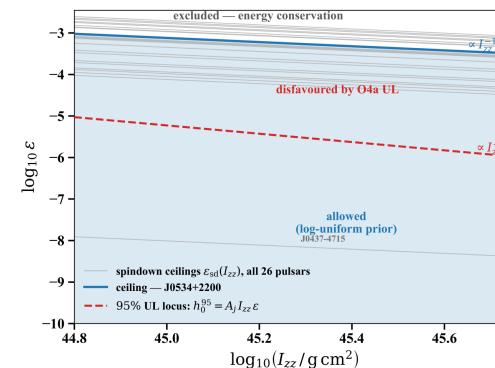
Amplitude physics

$$h_0 = \frac{16\pi^2 G}{c^4} \frac{I_{zz} \varepsilon f_{\text{rot}}^2}{d}$$

$$\equiv A_j I_{zz} \varepsilon$$



Spindown Wedge



Hierarchical Bayesian Inference



Assumptions

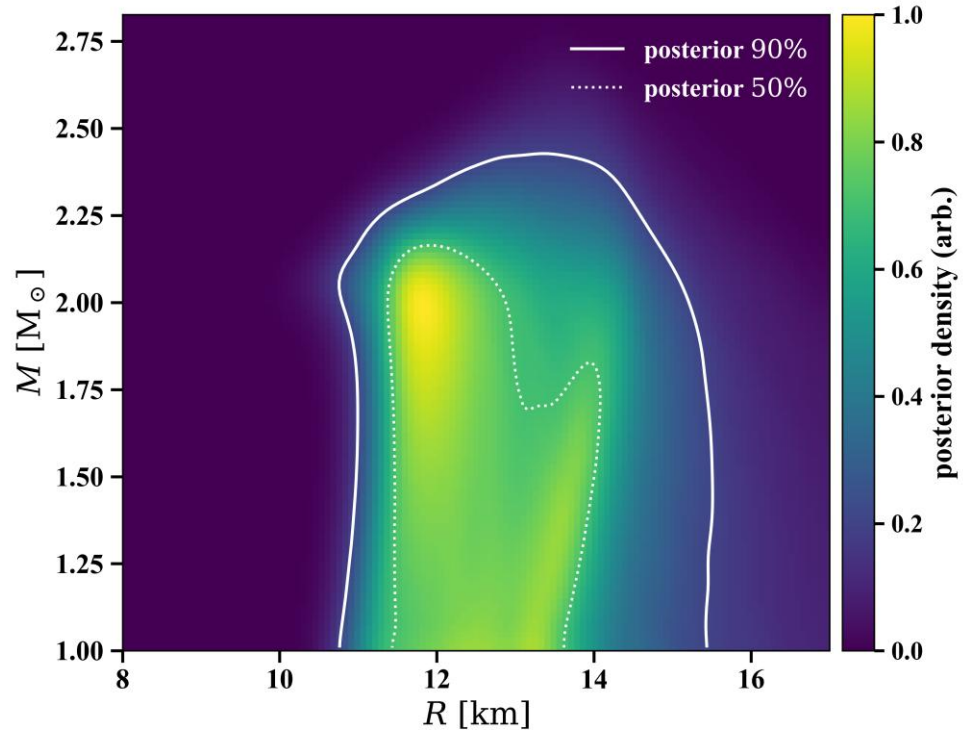
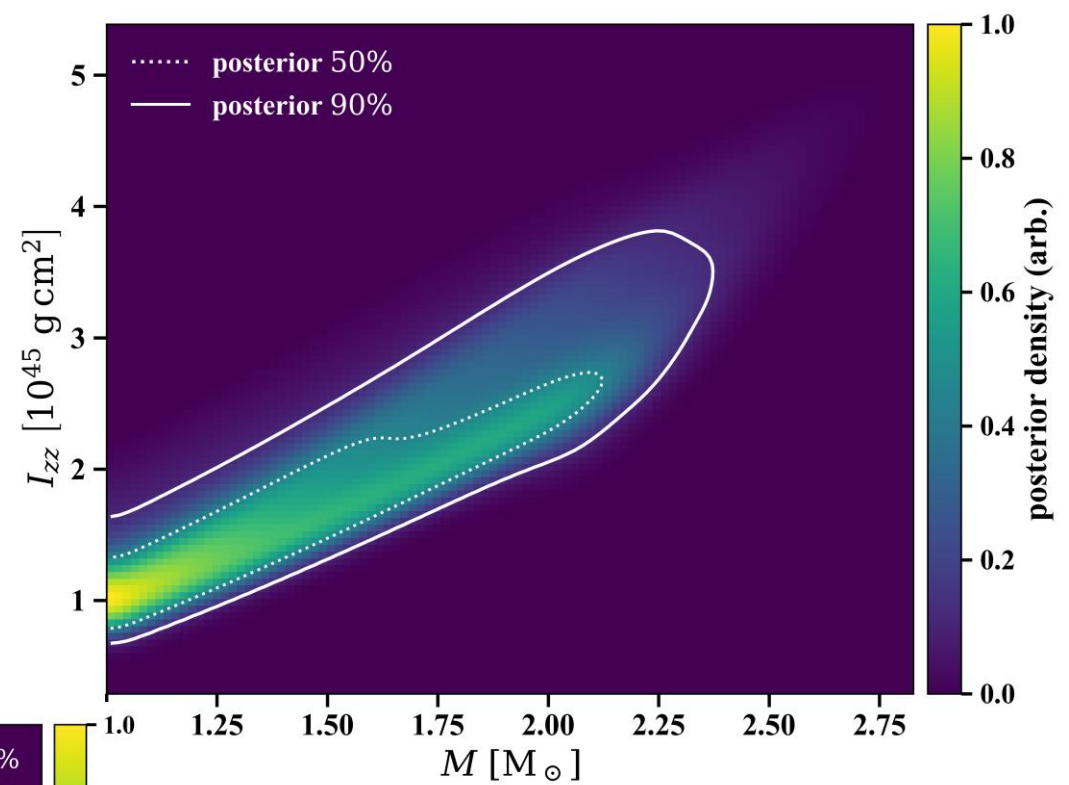
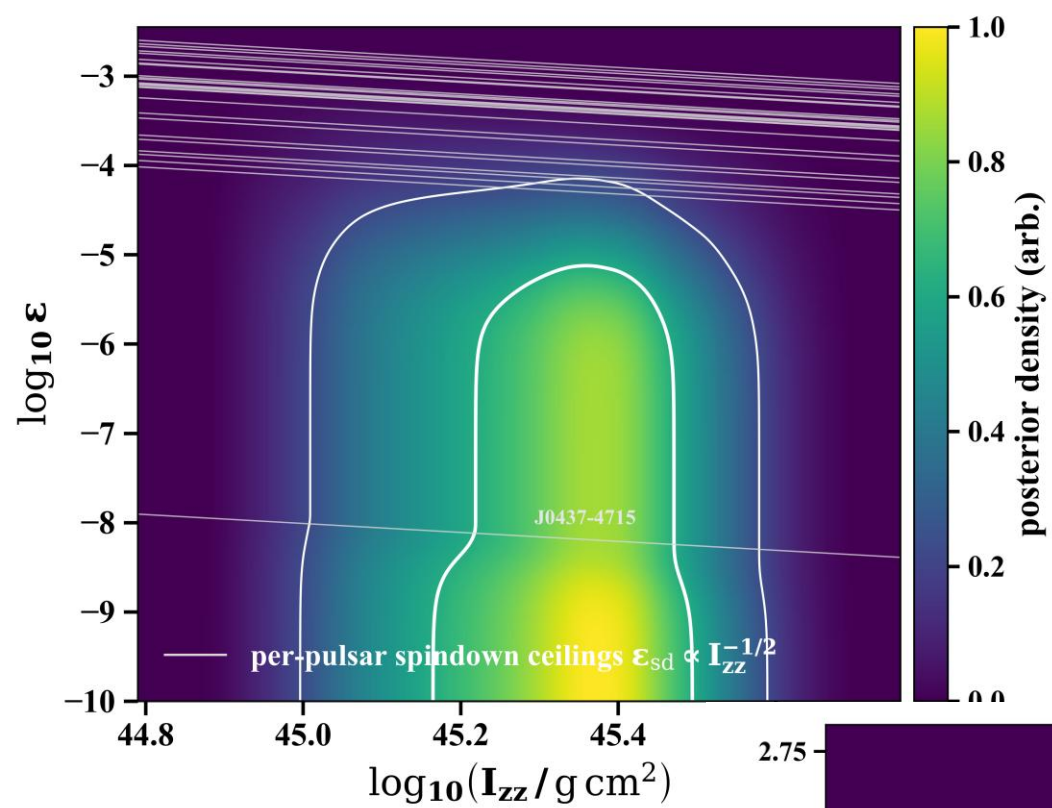
TOV + Hartle rotation

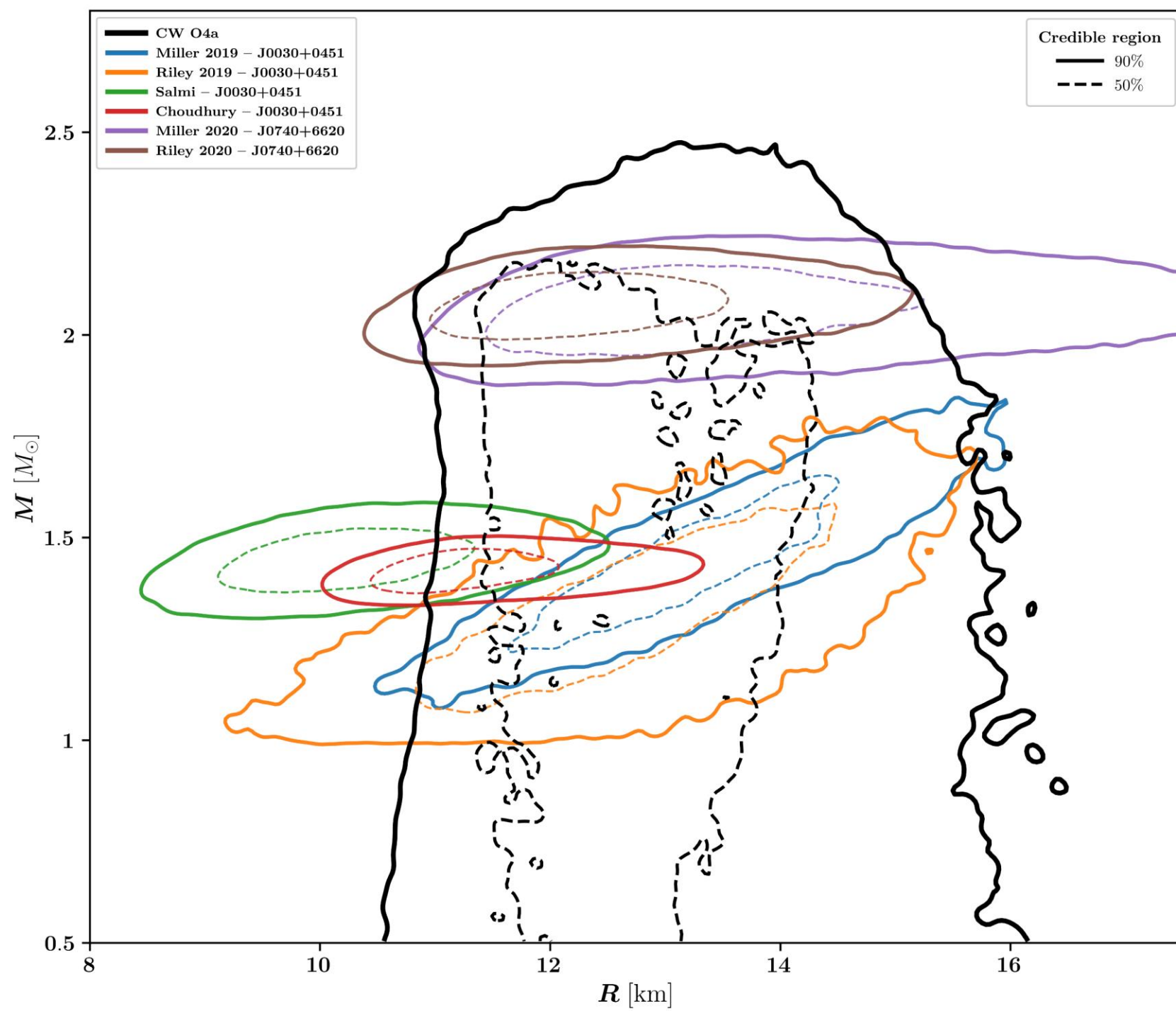
EoS Bank - 100000

SLy crust + piecewise polytropes

Prior range

Heavy PSRs





GW170817 + nuclear data + low-mass X-ray binaries

$$I_{1.4} = 1.43^{+0.30}_{-0.13} \times 10^{38} \text{ kg m}^2, \Lambda_{1.4} = 390^{+280}_{-210}$$

$$R_{1.4} = 11.8^{+1.2}_{-0.7} \text{ km}$$

NICER PSR J0437–4715

$$R = 11.36^{+0.95}_{-0.63} \text{ km}$$

CW O4a Run (*no detection*)

$$R_{1.4} = 13.2^{+3.3}_{-1.9} \text{ km}$$

$$I_{1.4} = 1.69^{+0.60}_{-0.35} \times 10^{45} \text{ g cm}^2$$



The Equation of State and Some Key Parameters of Neutron Stars: Constraints from GW170817, the Nuclear Data, and the Low-mass X-Ray Binary Data

Jin-Liang Jiang^{1,2}, Shao-Peng Tang^{1,2}, Dong-Sheng Shao^{1,2}, Ming-Zhe Han^{1,2}, Yin-Jie Li^{1,2}, Yuan-Zhu Wang¹,
Zhi-Ping Jin^{1,2}, Yi-Zhong Fan^{1,2}, and Da-Ming Wei^{1,2}
¹ Key Laboratory of dark Matter and Space Astronomy, Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing, 210033, People's Republic of China
tangsp@pmo.ac.cn, yzfan@pmo.ac.cn
² School of Astronomy and Space Science, University of Science and Technology of China, Hefei, Anhui 230026, People's Republic of China
Received 2019 August 3; revised 2019 September 12; accepted 2019 September 13; published 2019 October 29

A NICER View of the Nearest and Brightest Millisecond Pulsar: PSR J0437–4715

Devarshi Choudhury, Tuomo Salmi, Serena Vinciguerra, Thomas E. Riley, Yves Kini, Anna L. Watts, Bas Dorsman, Slavko Bogdanov, Sebastien Guillot, Paul S. Ray [Show full author list](#)
Published 2024 August 8 • © 2024. The Author(s). Published by the American Astronomical Society.
[The Astrophysical Journal Letters, Volume 971, Number 1](#)
Citation Devarshi Choudhury *et al* 2024 *ApJL* 971 L20
DOI 10.3847/2041-8213/ad5a6f

Paper loading.....

Current focus

To do a forecasting analysis

To reduce assumptions

To do an example study with CW constraint

To study tidal deformability

To increase machine accuracy

Acknowledgement



Naresh Patra

nareshkumarpatra3@gmail.com

Postdoctoral researcher

The Chinese University of Hong Kong - Shenzhen, China



Andrew L. Miller

andrew.miller.ligo@ucas.ac.cn

Assistant Professor

International Centre for Theoretical Physics – Asia Pacific (ICTP-AP),
University of Chinese Academy of Science (UCAS)



Our group @ ICTP-AP



Andrew L. Miller
Group Leader

andrew.miller.ligo@ucas.ac.cn

Students

Charchit Kumar Sethi



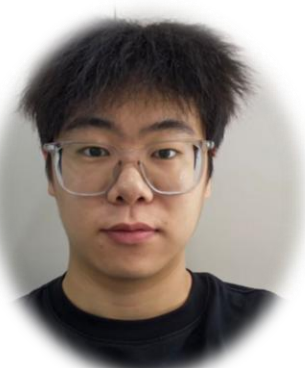
GW probes of BBHs with
DM spikes

Ayush Hazarika



CWs to constrain NS

Hang Yang 杨航



GW from mass transfer of
boson clouds in BBHs

Postdocs (Joining in ~Oct.)

Lalit Singh Bhandari



GWs from DM induced
effects in binary systems

An Kiet Pham



Direct searches for DM with
LIGO; SGWB searches

Debroy Das



Search for EMRIs in future
detectors; testing GR

Verónica Vázquez-Aceves



Visiting Scientist

EMRIs, intermediate mass
BH, GW physics

Jiahang Wang 王佳杭



Intern (UG student)

Generalized Frequency
Hough Transform algorithm

THANK YOU

