High Frequency All-Sky Search for CWs

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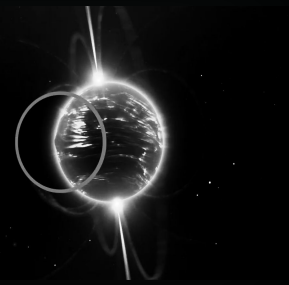
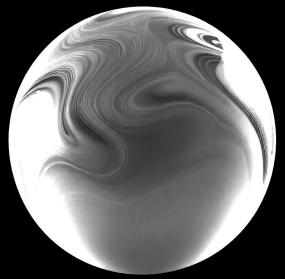
This Search

- **Data:**
  - 6 months of LIGO O3a public data
- **Parameter Space:**
  - All-sky
  - $800\text{Hz} \leq f \leq 1684\text{Hz}$
  - $-2.7 \times 10^{-9}\text{Hz/s} \leq \dot{f} \leq 2 \times 10^{-10}\text{Hz/s}$
- **Extension of Steltner *et* al.** [1]



$$f_{\text{GW}} = 2f_r$$



$$f_{\text{GW}} = \frac{4}{3}f_r$$

Computational Cost

- Waveform templates searched: 1.4×10^{18}
- A millennium of compute power!

Credit: M. Fiorito/Max Planck Institute for Gravitational Physics

“Toplists” and Clustering

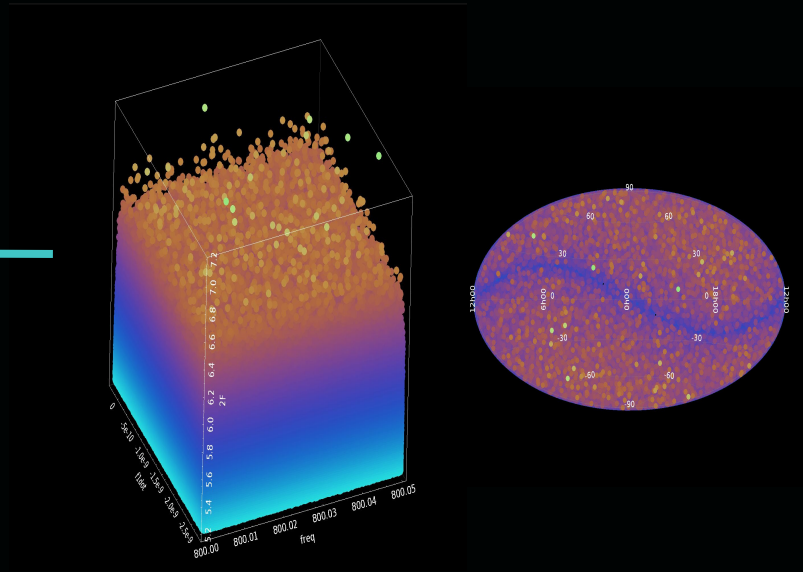
1.4×10^{18}

Loudest N cands per fixed volume

4.8×10^{12}

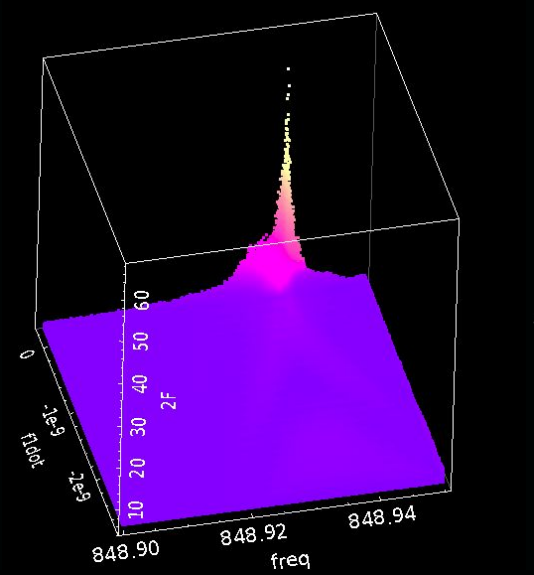
1.3×10^{7}

Clustering [2]

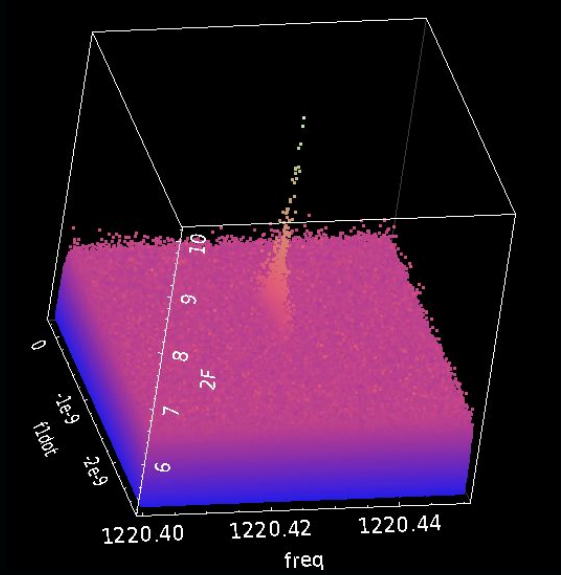


Follow Up:
See Jasper Martins’ talk

HW Injection 1



HW Injection 7

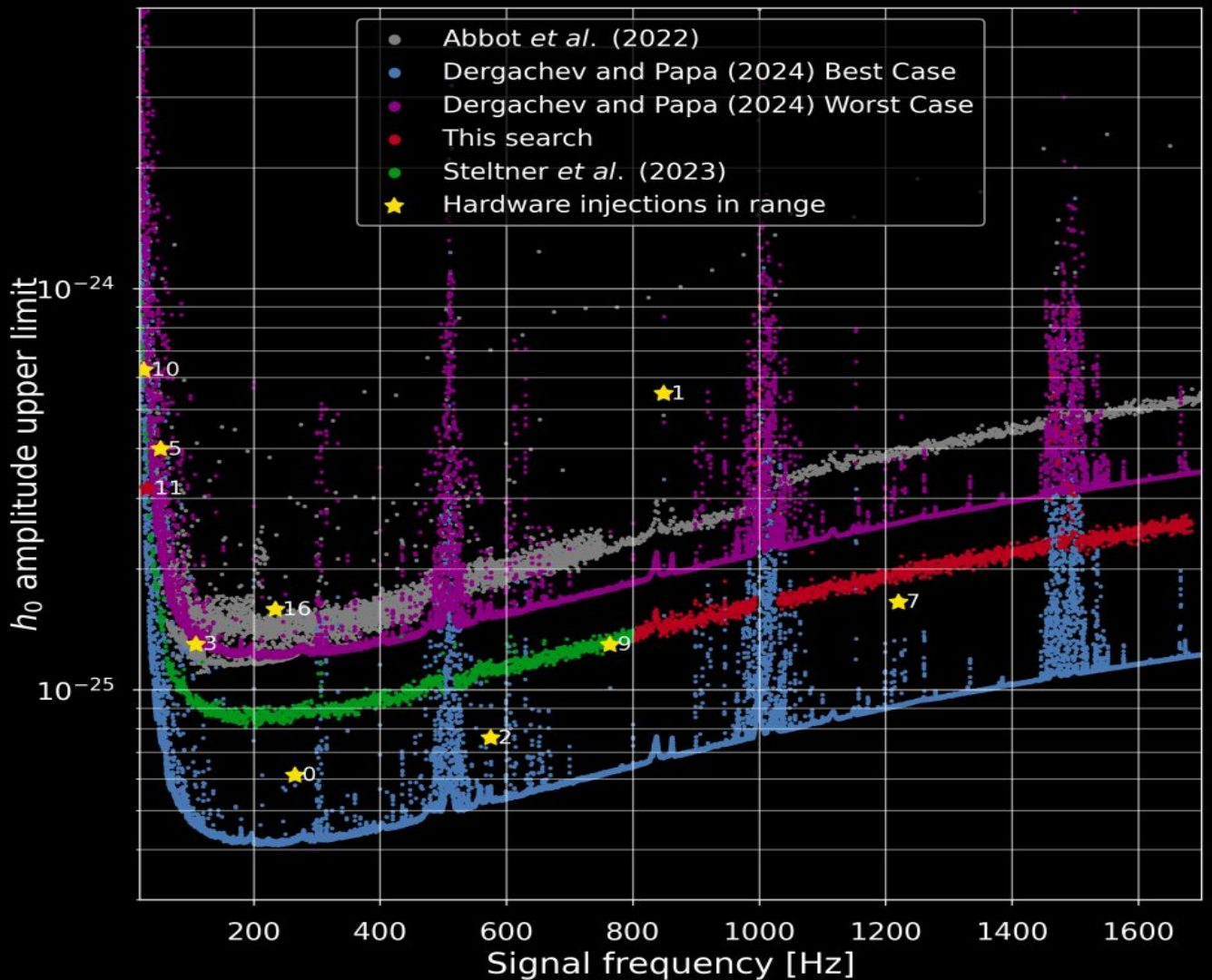


Results

- Both hardware injections found
- No other signals detected

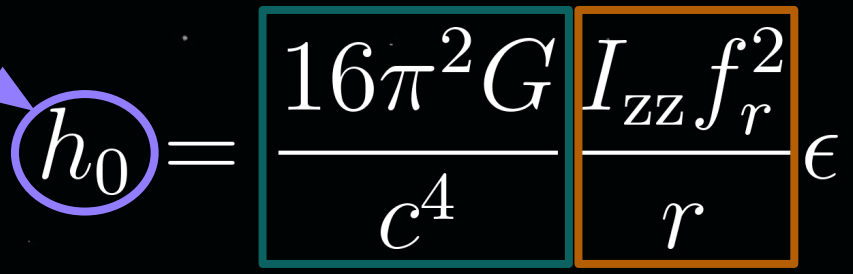
Interesting Upper Limits

$$h_0 = \frac{16\pi^2 G}{c^4} \frac{I_{zz} f_r^2}{r} \epsilon$$


Abbot et al. (2022)
Dergachev and Papa (2024) Best Case
Dergachev and Papa (2024) Worst Case
This search
Steltner et al. (2023)
Hardware injections in range
h_0 amplitude upper limit
10^{-24}
10^{-25}
10
1
5
11
16
7
3
9
2
0
200
400
600
800
1000
1200
1400
1600
Signal frequency [Hz]

Interesting Upper Limits

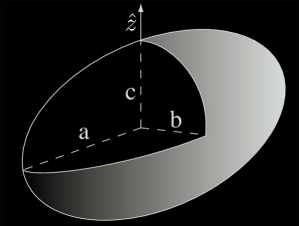
Measure with injection search simulations

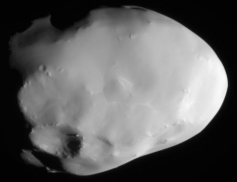


We probe astrophysically interesting regions of ellipticity

Ellipticity

$$\epsilon \approx \frac{a-b}{a}$$

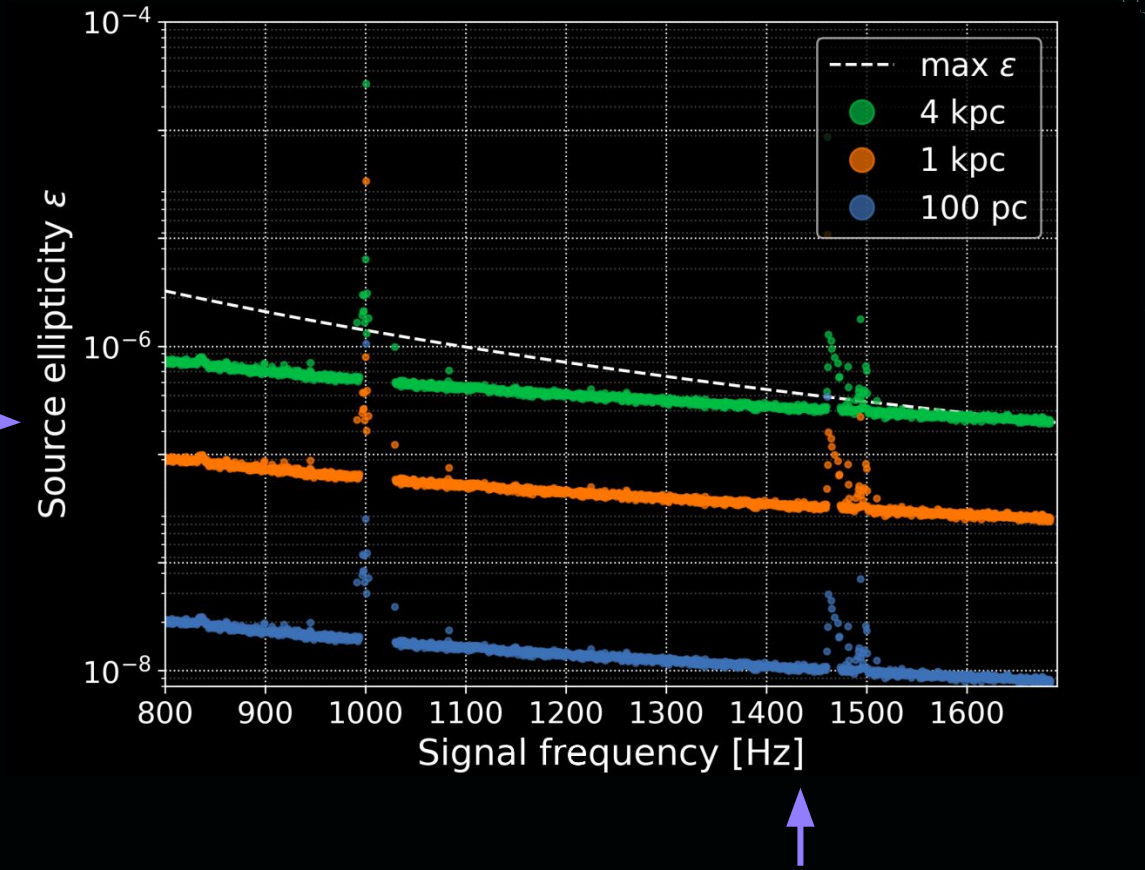




$$\epsilon \approx \frac{1}{3}$$

$$\epsilon \approx 3.3 \times 10^{-3}$$

$$\epsilon \approx 3.8 \times 10^{-7}$$ [3]



Fastest Spinning Known Pulsar

Thanks!

References

[1] B. Steltner *et al* 2023 *ApJ* **952** 55

[2] B. Steltner *et* al. Phys. Rev. D **106**, 104063

[3] https://www.nist.gov/si-redefinition/kilogram-silicon-spheres-and-international-avogadro-project

[4] Dergachev, Papa arXiv:1909.09619