



Searches for Gravitational Waves from Known Pulsars at Two Harmonics in the Second and Third LIGO-Virgo Observing Runs

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Full paper at <https://arxiv.org/abs/2111.13106>

Pulsars (neutron stars)

- Compact stellar remnants
- High rotation frequencies (hundreds of Hz)
- Emit EM radiation from poles which we see as pulses
- Still lots we don't know about the structure!

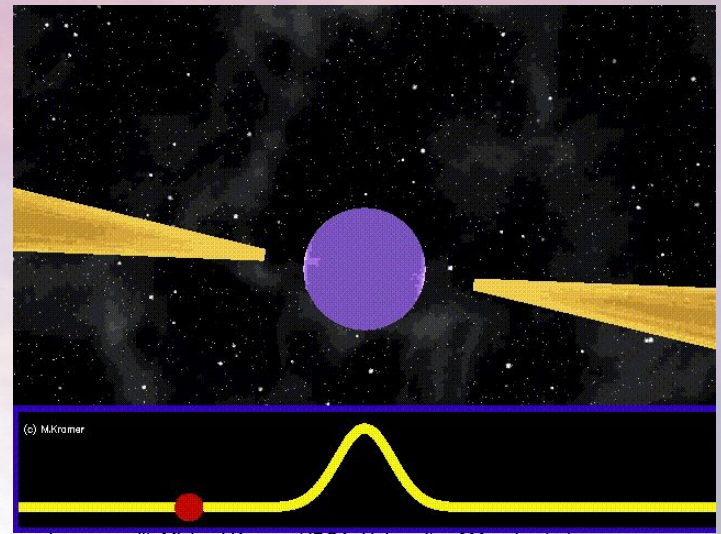
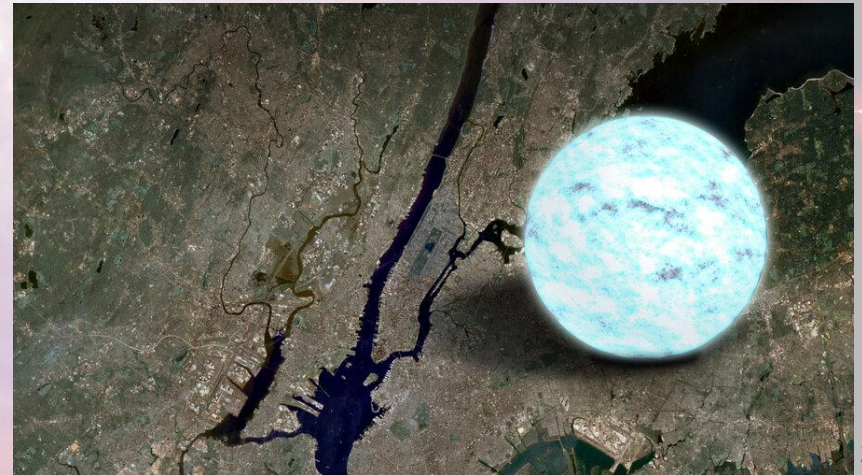


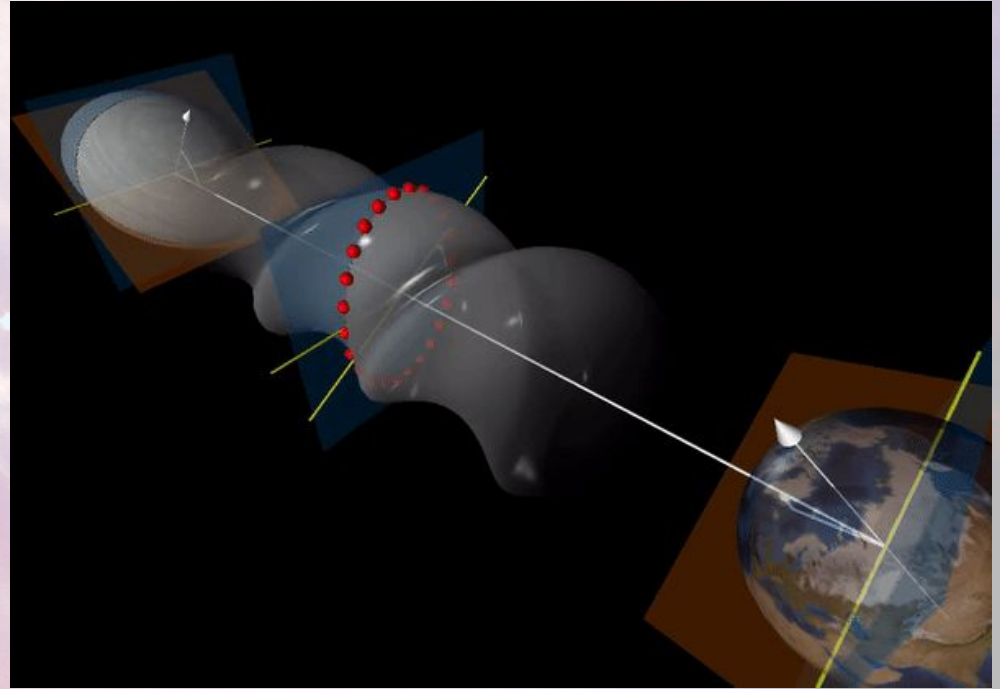
Image credit: Michael Kramer (JBCA, University of Manchester).



Credit: NASA's Goddard Space Flight Center

Gravitational waves from pulsars

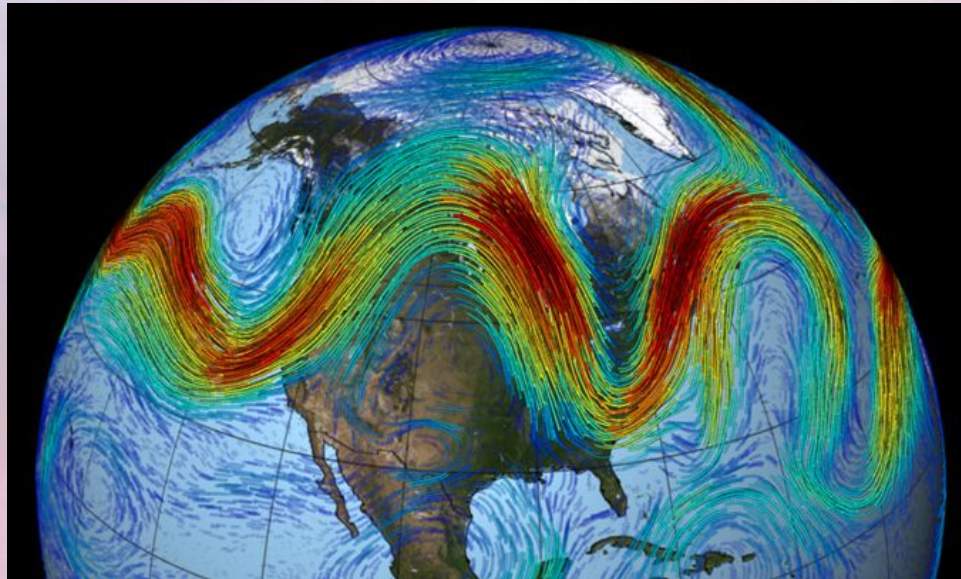
- Non-axisymmetric deformation \rightarrow mass quadrupole moment
- Amplitude of GW scales with f_{rot}^2
- Spin-down upper limits assume all rotational energy lost as GW
- Expect GW wave at $2x$ (maybe $1x$) f_{rot}



Credit: Graham Woan

Motivation

- Maximum deformation depends of EoS
- Prove existence of various processes



Credit: NASA/GSFC

The pulsars

- Targeted search
- Pulsar information obtained in collaboration with EM astronomers
- 236 pulsars (vs 221 in the O1+O2 analysis with 74 new pulsars)
- 168 in binary systems, 161 millisecond pulsars

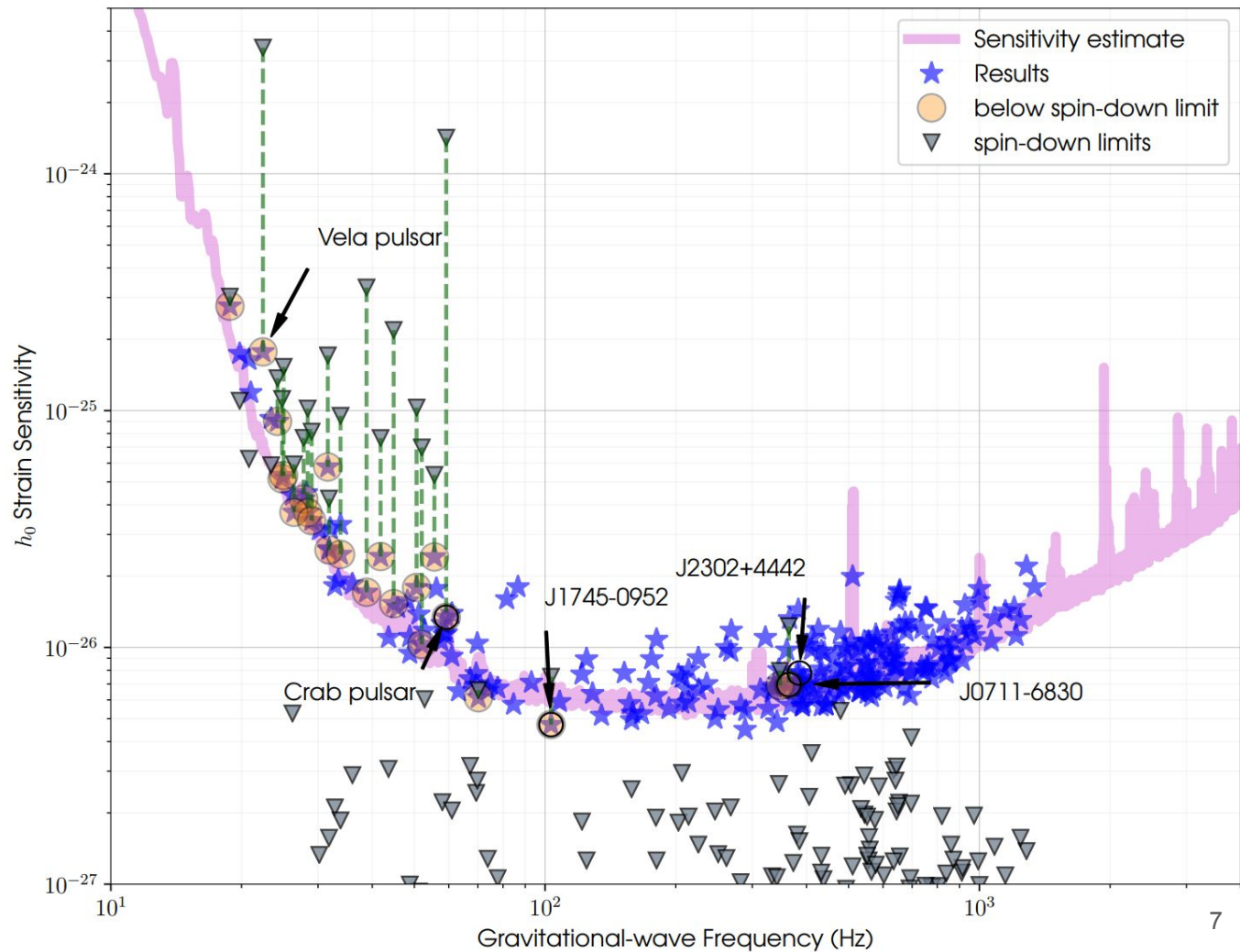


Credit: Getty Images

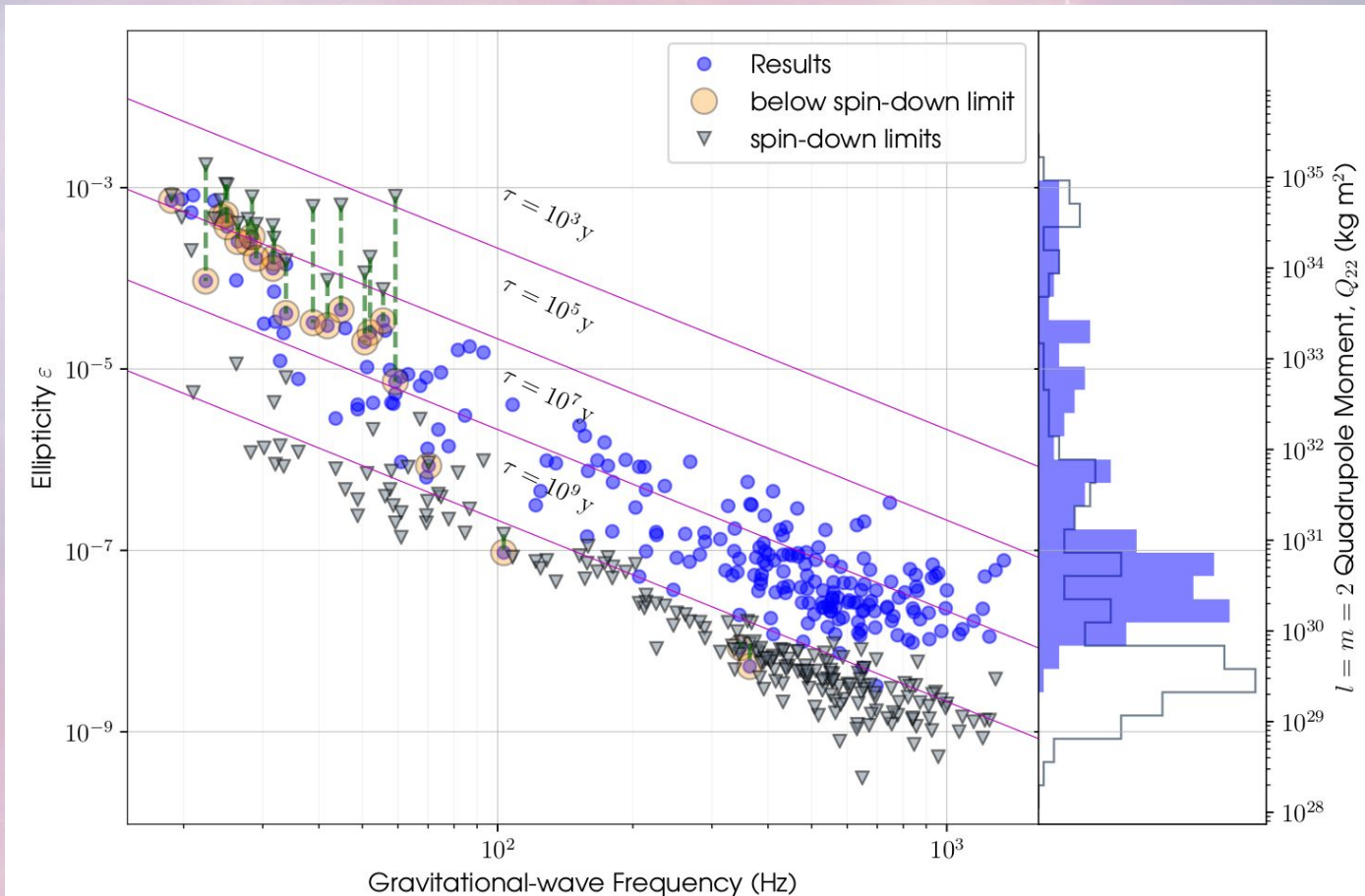
This search

- Searches for evidence of CWs from known pulsars in O2 and O3 data from LIGO-Virgo
- Follows on from previous analysis on O2 data (<https://arxiv.org/abs/1902.08507>)
- Time domain Bayesian analysis performed on all pulsars
- Subset analysed with F/G/D-statistic and 5n-vector methods
- Searches at 2x and both 1x and 2x the rotation frequency

- No GW detected in any search pipeline
- 23 pulsars surpassed their spin-down limits
- Crab: <0.009% energy lost via GWs, <2cm “mountain”



- Millisecond pulsars set strict ellipticity limits
- Younger pulsars surpass spin-down easier





Thanks for listening!