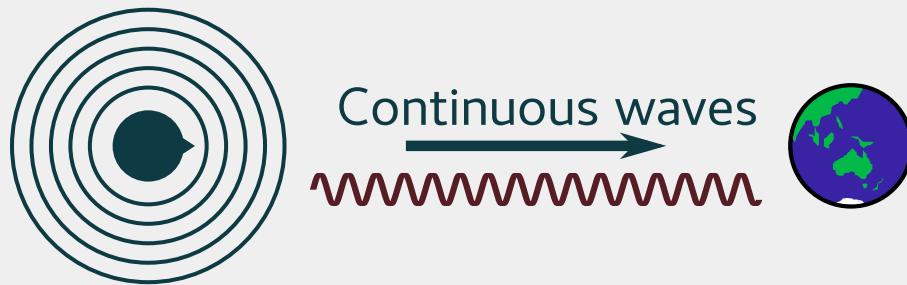


# What are continuous gravitational waves?

A **spinning neutron star** which has some asymmetry (e.g. a mountain in the crust) emits **continuous gravitational waves**.

Detectors on the Earth, like LIGO and Virgo, are searching for continuous waves.



Continuous wave signals should be present in the detector data **all the time**. The task is to find them!

In this work, we search for continuous waves from spinning neutron stars in low mass X-ray binaries

## Gravitational waves so far

Transient gravitational wave signals have been observed from **mergers** of black holes and neutron stars by ground-based detectors: **LIGO** (Laser interferometer gravitational-wave observatory) and **Virgo**.

Continuous gravitational waves are **yet to be detected**.

# Search targets: Low mass X-ray binaries

Our search targets five low mass X-ray binaries (LMXBs)

In a binary, the continuous waves from the neutron star are Doppler shifted.



Knowledge of the rotation frequency of the neutron star and the orbital parameters from X-ray observations are used to guide the continuous wave search.

We search five targets where the binary properties are well measured by X-ray observations.

## LMXBs

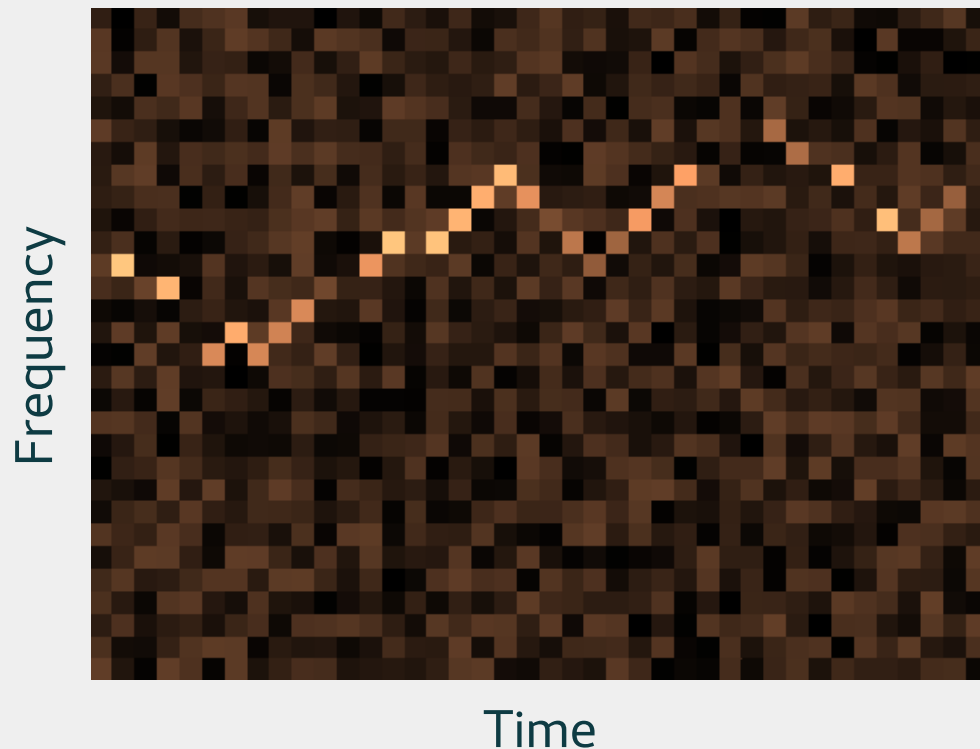
A low mass star (less than the mass of our Sun) in orbit with a compact object such as a neutron star or a black hole.

## Search targets

HETE J1900.1-2455  
IGR J00291+5934  
SAX J1808.4-3658  
XTE J0929-314  
XTE J1814-338

# Search Method

The frequency of a continuous wave signal can wander slowly and unpredictably over time. Therefore, a search needs to be able to track the signal through a time-frequency grid.



We use the Viterbi path finding algorithm to calculate the most likely path of a signal through the grid [Viterbi 1967].

This method has been used in numerous continuous wave searches including:

- Scorpius X-1 (an X-ray bright LMXB) [Abbott+(2017), Abbott+ 2019)]
- Supernova remnants [Sun+ (2018), Millhouse+(2020)]
- Neutron star post merger remnant [Abbott+(2019)]

# Results & the future

## Results of this search

This is the **first search** for continuous waves from these targets. The search takes advantage of X-ray observations to **inform the search range**. We use data from Observing Run 2 (November 2016 to August 2017). We make **no detection**.

## But the search continuous!

Stay tuned for results of a follow-up search using new data from Observing Run 3 (April 2019 to March 2020).

## Find out more

This work: Middleton, Clearwater, Melatos, & Dunn, PRD 102, 2 (2020) arXiv:2006.06907

More on this search method: Suvorova et al. (2016, 2017)

## Get in touch

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