Are gravitational waves shaping accreting neutron stars?

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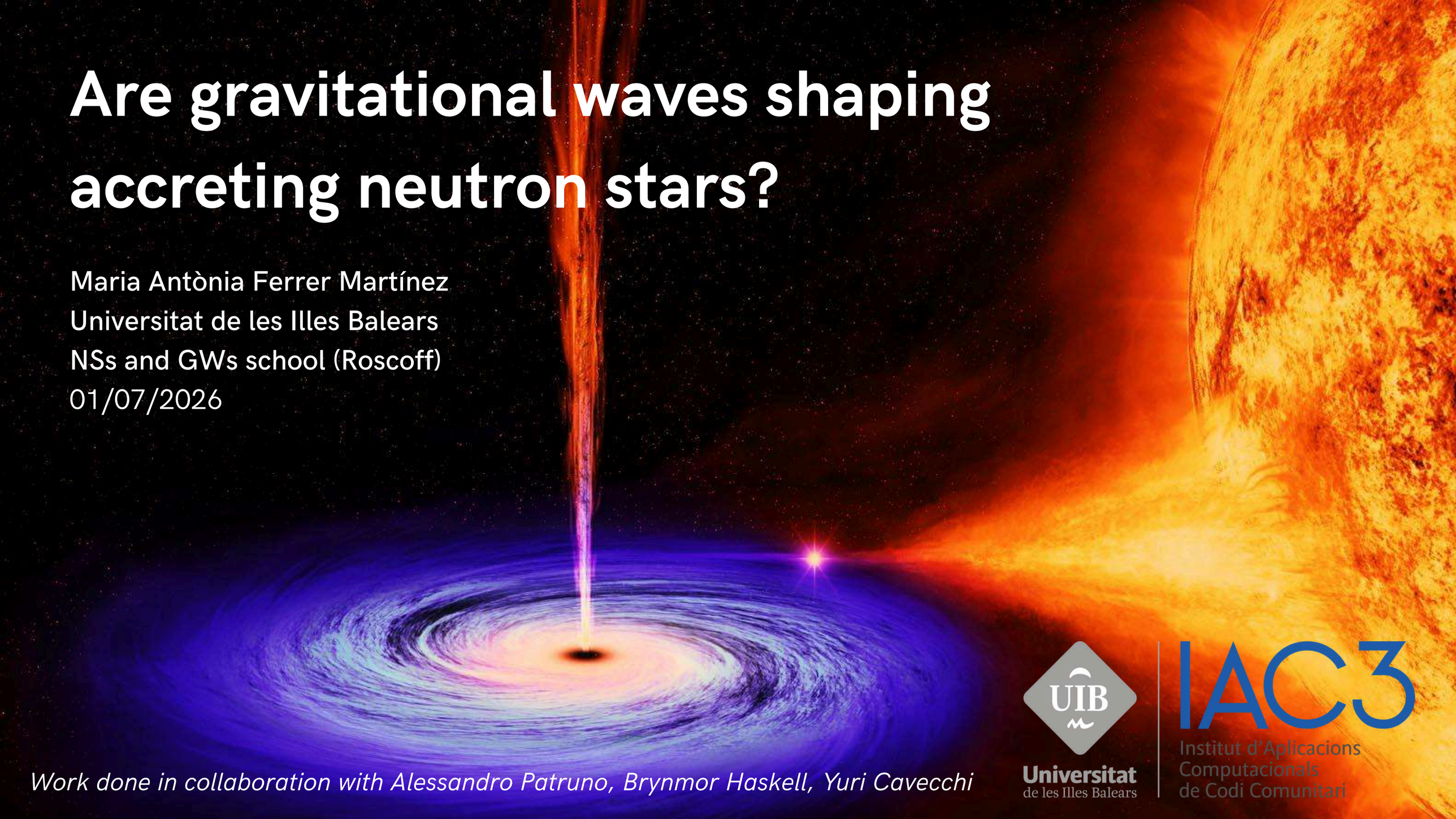
01/07/2026



Work done in collaboration with Alessandro Patruno, Brynmor Haskell, Yuri Cavecchi

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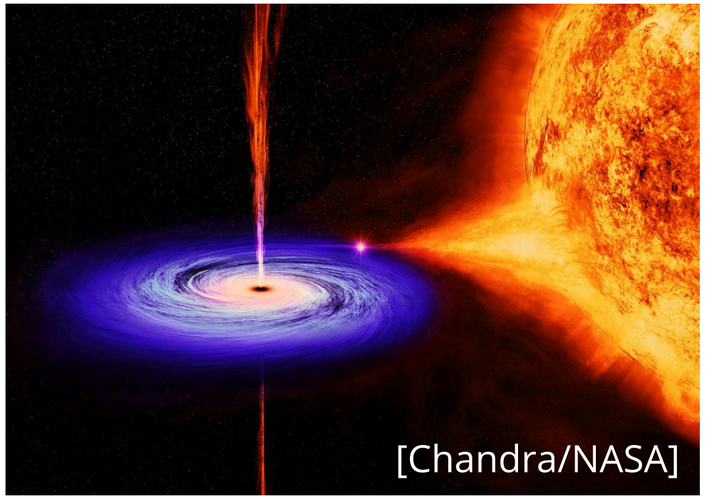
Continuous Waves: introduction & motivation

Accreting neutron stars in **low-mass X-ray binaries** (LMXBs) are one of the most promising CW targets.



- Observed maximum spin: **619 Hz** << Expected breakup limit: $f_{\max} \geq$ **1000 Hz**
- Accretion **spins-up** the NS: where are the sub-millisecond pulsars?
- There should be some mechanism that **spins-down** the system:

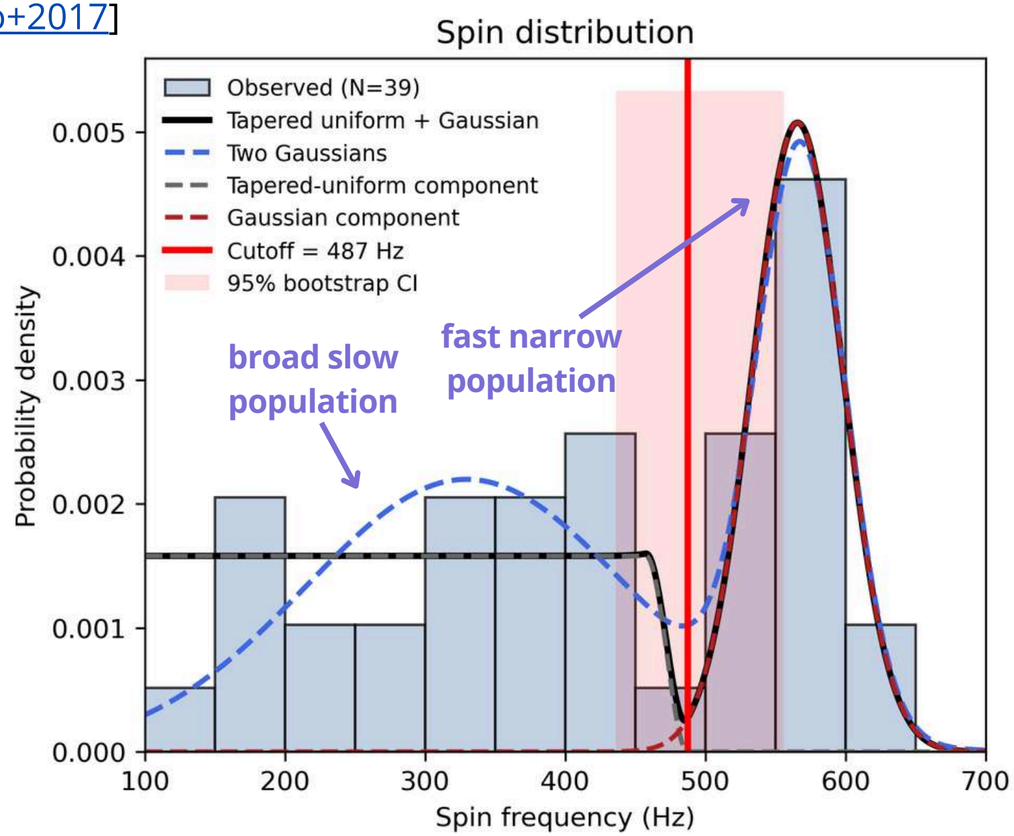
  1) **electromagnetic (EM) emission** ⟶ requires fine-tuned magnetic field & accretion rate

  2) **GWs:** from thermal mountains or r-modes

Question: could gravitational-wave emission be limiting their spin?

Evidence for two spin populations in LMXBs

- Reanalyse spin-distribution of LMXBs with more systems [Patruno+2017]
- **Broad slow** population extending from ~100–500 Hz
- **Narrow fast** population centered at ~570 Hz



Additional correlations:

- ✦ **Fast** population
  - Longer orbital periods
  - Higher quiescent temperatures
- ✦ **Slow** population
  - Present across all orbital periods
  - Cooler on average

Question: Can **long-term torque evolution** naturally generate the observed features?

Can torque evolution explain the observations?

Model spin evolution as **deterministic** spin-down + **stochastic** noise:

$$d\nu = -K\nu^n dt + \sigma_{\rm br} dW_t$$

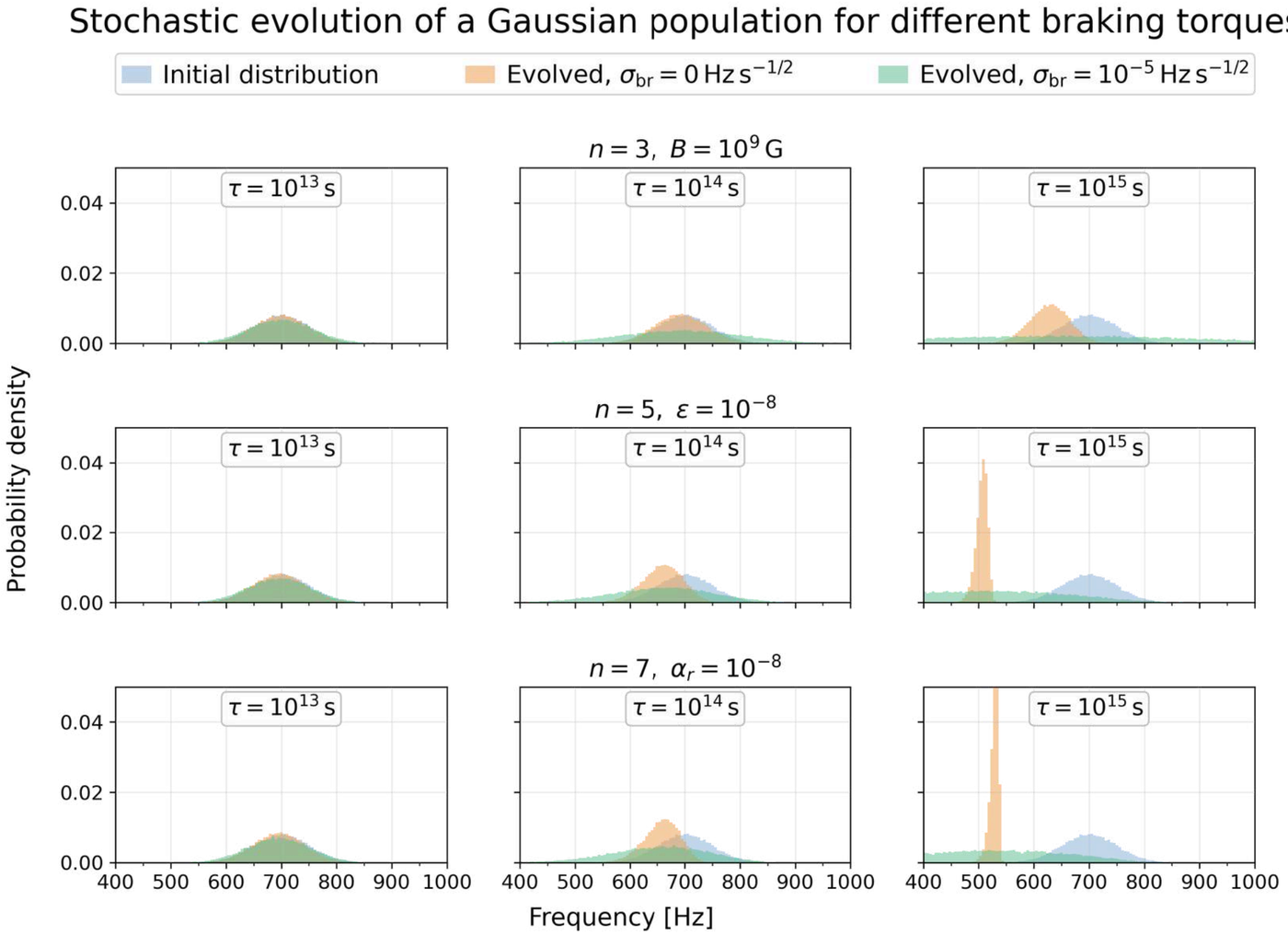
Evolution shows competition between:

- **deterministic** spin-down: **shifts** & can **sharpen** the distribution
- **stochastic** noise: **broadens** it

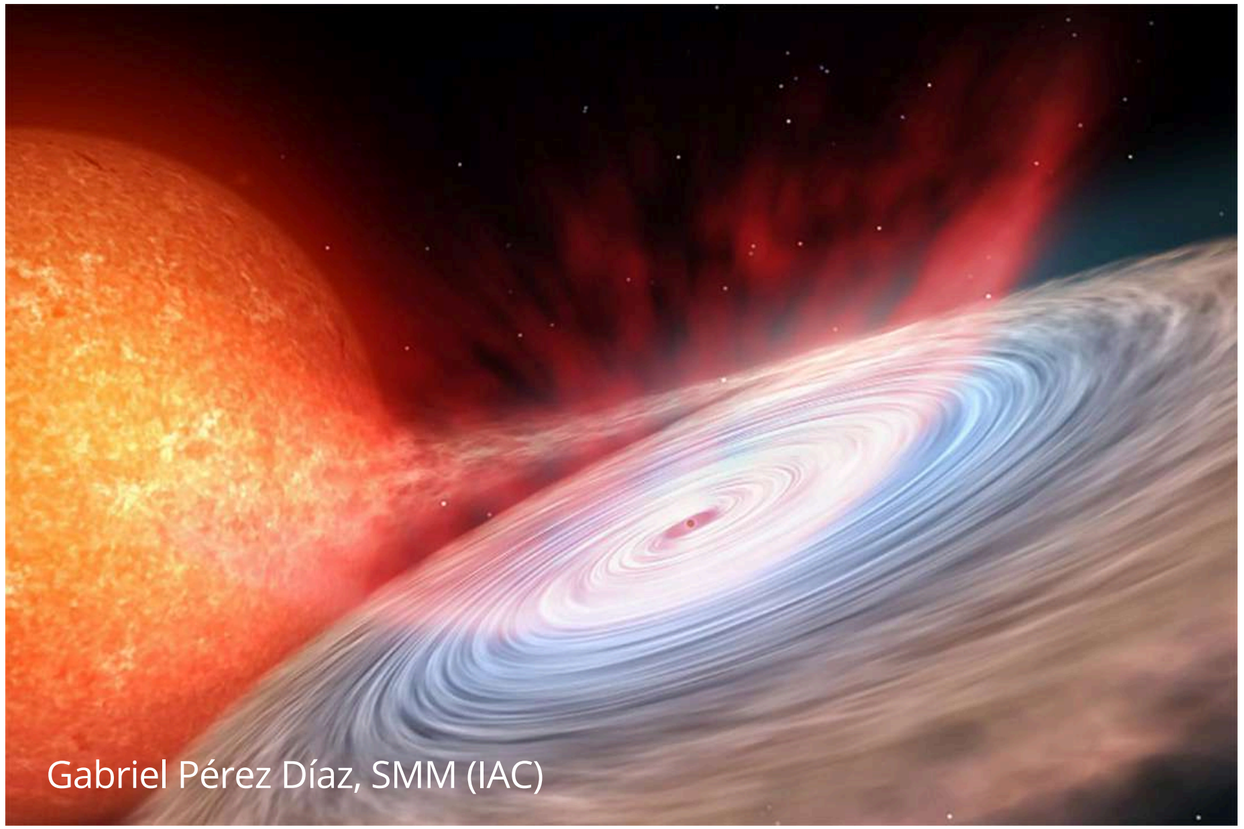
Realistic **noise torque** ($\sigma_{\rm br} \sim 10^{-8}\ \mathrm{Hz\,s^{-1/2}}$) is too weak to modify the spin distribution.

Long-term **GW emission** can narrow and shift a population on Myr timescales.

- This could make fast systems promising CW targets.



Conclusions & take-home message



- Realistic **stochastic** torque fluctuations are too **weak** to broaden an initially narrow population.
- Long-term **GW**-like braking can generate a **narrow fast**-spinning branch.
- Fast-spinning LMXBs therefore remain promising **CW targets**.