

NEMO: Neutron Star Extreme Matter Observatory A kilohetrz-band gravitational-wave detector in the global network



Paul Lasky

On behalf of the OzGrav NEMO team



image credit: Carl Knox to appear in Sarin & Lasky (2020)









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<u>Tidal deformability, Λ</u>

- Changes gravitational-wave phase evolution
- more fluffy neutron stars are deformed more

• measurement of equation of state





Which path?

- Depends on progenitor masses (which we know) and
- Maximum non-rotating mass of neutron stars (which we don't know)
 - measurement of equation of state
- Measure path with gravitational waves and/or electromagnetically

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image credit: Carl Knox to appear in Sarin & Lasky (2020)



B

- Up to 79% of mergers
- Post-merger gravitational-wave signal:
 - depends sensitively on equation of state

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GW170817



credit: ESO/E. Pian/S. Smartt & ePESSTO/ N. Tanvir/VIN-ROUGE

- Significant information from inspiral
- No detection of gravitational waves post-merger
 - Expected with LIGO sensitivity

GW170817: post merger



What's next in gravitational-wave astronomy?



What's next in gravitational-wave astronomy?



Introducing NEMO











astrophysics

A NEMO needs to live in a heterogeneous network with broadband (lower frequency) interferometers

• Multimessenger

- Cosmology
- Gamma-ray burst physics
- Jet-launching mechanism
- Interstellar medium densities
- Heavy-element nucleosynthesis



other science: supernovae



- Proto-neutron star oscillations & low-T/|W| instability produce loud, kHz signals
- amplitude evolution differs between codes/groups
- Latter potentially detectable to ~ Mpc

f [Hz]

• Ongoing investigation for NEMO (e.g., Powell+ in prep) ¹⁸



other science: isolated neutron stars



NEMO: Neutron Star Extreme Matter Observatory SMONASH Ackley et al. 2020



University



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Extra Slides

Ground-based gravitational-wave Astronomy in Australia: 2019 White Paper (arXiv:1912:06305)



17 August, 2017



Pulsar observations:

- J0348+0432 (Antoniadis+2013)
- J0740+6620 (Cromartie+2020)
- J0030+0451

 (Raaijmakers+2020;
 NICER)

GW170817 tidal deformability0.5

First 40 LIGO/Virgo events (Hernandez Vivanco+2019)



Radius (km)

25



GW190425: The ANZAC day event

Abbott+2020



GW190814: a 2.6 solar mass neutron star or black hole? Abbott+2020



GW170817: post merger



- No gravitational waves (not surprising)
- Colour of kilonova
- kilonova light-curve fitting (some groups fit with long-lived remnant, others without)



Ground-based gravitational-wave Astronomy in Australia: 2019 White Paper (arXiv:1912:06305)

Item	Years	Cost (AUD)
Australian Gravitational-Wave Pathfinder (Stage 0a)	2020-2025	\$5M
Australian Gravitational-Wave Pathfinder (Stage 0b)	2026-2030	\$7.5M
OzHF Construction & Commissioning	2030-2033	~\$100-200M
OzHF Operation	2034-2038	~\$40-60M
Cosmic Explorer South Construction & Commissioning	2039-2043	~\$1B
Cosmic Explorer South Operation	2044-	~\$100M/yr

GW170817: post merger



- No gravitational waves (not surprising)
- Colour of kilonova
- kilonova light-curve fitting (some groups fit with long-lived remnant, others without)
- X-ray bump at 160 days

Short-lived, long-lived neutron star? we don't really know



NEMO: preliminary design

