James W. Gardner

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Education

Doctor of Philosophy (PhD) in Physics 2022–present
The Australian National University (ANU), Canberra ACT, Australia†
† Involving close collaboration with Yanbei Chen and others on an 3-year visit to Caltech (The California Institute of Technology), Pasadena CA, USA.

Bachelor of Philosophy (Honours) in Science with Honours in Physics 2018–2021
The Australian National University (ANU), Canberra ACT, Australia
Improving future gravitational-wave detectors using nondegenerate internal squeezing
Thesis available at https://jamesgardner.info/

Awards and scholarships

Partial travel stipend from the USA NSF under Award No. PHY-2011968 2022–present

ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav) Travel Grant 2022

ANU HDR Supplementary Scholarship 2022–present

Australian Government Research Training Program Domestic Scholarship 2022–present

Yale University Physics PhD offer 2022

The John Carver Physics Prize 2022
Rewards academic excellence in the ANU Physics Honours Specialisation 2021

ANU Chancellor's Letters of Commendation 2020–2022
For outstanding academic achievement in 2019–21

ANU First Class Honours 2021

ANU Achievement Prize for Third Year Physics 2020

ANU Dean's Science Education Commendation Award 2020

ANU National University Scholarship 2018–2021

Employment

Research Officer Grade 5/6 (35 hours per week)
ANU Centre for Gravitational Astrophysics (CGA)
Benchmarking of future gravitational-wave detector networks February–June 2022

Summer Research Intern (35 hours per week)
ANU Centre for Gravitational Astrophysics (CGA)
Analytic modelling of quantum optics configurations December 2021–January 2022
Experimental optics work in the CGA GW Laboratory December 2020–February 2021

Academic community

Teaching

Guest Lecturer, Caltech - Ph125c Lectures 2 and 3 2023
Introduction to density matrices and the quantum theory of measurement

Science Mentors ACT (pro bono) 2019

Committees

LIGO Caltech-MIT Student Catch-Up and Seminar, Organising Committee 2023

Outreach

OzGrav/CGA Student Symposium May 2022
From vacuum fluctuations to the next generation of ground-based gravitational-wave detectors

Membership

The Australian Institute of Physics (AIP) 2022–present

The Cosmic Explorer Consortium (ANU) 2022–present

The LIGO Scientific Collaboration (LSC - OzGrav - ANU) 2022–present

The ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav - ANU) 2020–present

The Centre for Gravitational Astrophysics 2020–present
Research School of Physics and Research School of Astronomy and Astrophysics, ANU

Research

Research interests

Quantum metrology, quantum optics for gravitational-wave detection, quantum squeezing

Publications

James W. Gardner, Tuvia Gefen, Simon A. Haine, Joseph J. Hope, and Yanbei Chen, 2024, *Achieving the Fundamental Quantum Limit of Linear Waveform Estimation*. Phys. Rev. Lett. **132**, 130801. https://doi.org/10.1103/PhysRevLett.132.130801

James W. Gardner, Ling Sun, Ssohrab Borhanian, Paul D. Lasky, Eric Thrane, David E. McClelland, and Bram J. J. Slagmolen, 2023, *Multi-messenger astronomy with a Southern-Hemisphere gravitational-wave observatory*, Phys. Rev. D **108**, 123026. https://doi.org/10.1103/PhysRevD.108.123026

James W. Gardner, Min Jet Yap, Vaishali Adya, Sheon Chua, Bram J. J. Slagmolen, and David E. McClelland, 2022, *Nondegenerate internal squeezing: an all-optical, loss-resistant quantum technique for gravitational-wave detection*, Phys. Rev. D **106**, L041101. https://doi.org/10.1103/PhysRevD.106.L041101

James W. Gardner, Hannah Middleton, Changrong Liu, Andrew Melatos, Robin Evans, William Moran, et al., 2022, *Continuous gravitational waves in the lab: recovering audio signals with a table-top optical microphone*, American Journal of Physics **90**, 286. https://doi.org/10.1119/10.0009409

Presentations and posters

Northwestern University - Shahriar Group Seminar December 2023
Realising the waveform-estimation Holevo Cramér-Rao Bound for gravitational-wave detectors

(Poster) Frontiers of Quantum Metrology: Fundamental Physics, Unexpected Connections, and Novel Applications – KITP UCSB October 2023
Optimal measurement for detuned–cavity based quantum metrology with applications to gravitational-wave detection

LIGO-Virgo-KAGRA collaboration (LVK) joint meeting of the advanced interferometer configurations (AIC), quantum noise (QN), and laser and auxiliary (LA) working groups September 2023
Proposal for realising the waveform-estimation Holevo Cramér-Rao Bound

Cosmic Explorer Consortium - Cosmic Explorer Science Call April 2023
Prospects for multi-messenger astronomy using an Australian gravitational-wave detector

OzGrav - Data/Astrophysics meeting March 2023
Prospects for an Australian gravitational-wave detector

LVK joint meeting of the AIC, QN, and LA working groups March 2023
Optimal measurement for detuned–cavity based quantum metrology with applications to gravitational-wave detection

American Physical Society (APS) March Meeting March 2023
Optimal measurement for detuned–cavity based quantum metrology with applications to gravitational-wave detection
(Poster also presented)

Gordon Research Conference (GRC) - Mechanical Systems in the Quantum Regime June 2022
Two-mode squeezing for gravitational-wave detection
Presented jointly with Mr Daniel Gould.
(Poster also presented, *Nondegenerate internal squeezing: an all-optical, loss-resistant quantum technique for gravitational-wave detection*)

LVK joint meeting of AIC, QN, LA working groups March 2022
Nondegenerate internal squeezing

OzGrav - Data/Astrophysics meeting February 2022
Continuous gravitational waves in the lab: recovering audio signals with a table-top optical microphone

LVK interferometer simulation working group December 2020
Verification of the newly-added non-linear element in Finesse for optical modelling of advanced gravitational-wave detector configurations

Media coverage

Universe Today August 2023
It's Time for a Gravitational Wave Observatory in the Southern Hemisphere
By Brian Koberlein

SciTechDaily April 2022
Continuous Gravitational Waves in the Lab

References are available upon request.
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