ARC Centre of Excellence for Gravitational Wave Discovery

Highlights from the inference program

Greg Ashton (Monash)

Inference program overview

- Develop and use easy-to-use tools extracting the best science across the Data/Astrophysics theme

- Increase the number of researchers involved with core LIGO parameter estimation activities

- Foster inter-program communication using inference as the common language to discuss astrophysics.

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Bilby: A user-friendly Bayesian inference library for gravitational-wave astronomy

- Python-based parameter estimation code

- Built using standard software best-practises

- https://git.ligo.org/lscsoft/bilby

- https://arxiv.org/abs/1811.02042 (under review by ApJ Supplements)

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Australia releases rare marsupial bilby into the wild in NSW

9 hours ago

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Bilbies feed on plant roots, ants, beetles and spiders

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Bilby: A user-friendly Bayesian inference library for gravitational-wave astronomy

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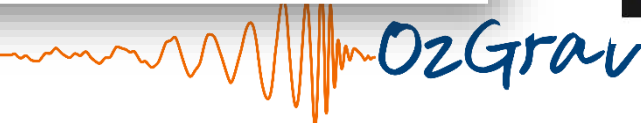[10] Ozgrav, Swinburne University of Technology, Hawthorn VIC 3122, Australia
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Bilby: A user-friendly Bayesian inference library for gravitational-wave astronomy

- Bilby has been selected by the LVC PE group chairs as successor to LALInference
- O3 plan:
  - Run bilby in parallel to LALInference for review/testing until it is trusted
  - Official switch to bilby during O3
- O3 readiness:
  - Injection/recovery studies
  - Testing of different samplers/setups
  - Run on known events and compare with catalouge
- Lots of development/testing yet to be done
- **Please chat if you want to get involved!**

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"The Bayesian Search" (TBS): Inference-based search for the background of CBCs

- Deploys full PE on all available data to:
  - Infer the merger rates of merging black holes / neutron stars in the gravitational-wave background
  - Infer the population-level properties (mass/spins/redshift etc... distributions) of unresolvable binaries in the background
  - Being developed as a joint Stochastic + CBC search (working on MDC)

Featured in Physics   Open Access

Optimal Search for an Astrophysical Gravitational-Wave Background

Rory Smith and Eric Thrane
Phys. Rev. X **8**, 021019 – Published 16 April 2018

Physics See Viewpoint: Listening for the Cosmic Hum of Black Holes

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More

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Parameter estimation rota (PE-rota) 16/97

- Moritz Hübner
- Colm Talbot
- Rory Smith
- Sylvia Biscoveanu*
- Greg Ashton
- Jade Powell
- Daniel Reardon
- Hannah Middleton

- Matt Pitkin*
- Eric Howell
- Shaon Ghosh
- Nikhil Sarin
- Robert Ward
- Francisco Hernandez
- Atul Divakarla*
- Karl Wette

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Inference workshops

July 2018, 3-day inference workshop

- ~30 members across all nodes + int. visitors

- Worked on projects:
  - Getting binary neutron star inference into bilby
  - Application of inference to detector science
  - Inference for pulsations in X-ray data from LMXB's
  - Inference for radio pulsar data
  - + more

November 2018, 1-day bilby workshop

- ~20 members

- Worked on projects:
  - Understanding cross-compatibility of bilby and BayesWave
  - Bilby_pipe and development towards O3
  - Updating the core bilby documentation and examples

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Inference beyond CBC events

- Inference group has interests in
  - Detecting gravitational-waves from pulsar timing array data
  - Radio pulsar parameter estimation
  - Using X-ray data from LMXB's to infer spin frequencies
  - Developing PE tools for other sources in the LIGO/Virgo band, e.g. Supernova's & Continuous Waves,
- Bilby has been developed as a general inference code
- Already, bilby has been used/tested for
  - Hyperparameter inference for population estimation
  - GRB X-ray afterglow data fitting

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Summary and outlook

- OzGrav inference program is active and exciting

- Lots of collaboration
  - between nodes
  - between science topics
  - and with the broader LVC

- LVC PE F2F to be held at Monash in February 2018

- By the next retreat we will have a detection publication using bilby

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