**Project I: Real-time low-latency detection of gravitational waves using ground-based interferometers for prompt electromagnetic follow-up.**

Supervisors: Linqing Wen, David Blair

[www.gravity.uwa.edu.au](http://www.gravity.uwa.edu.au) (under Data Analysis)

Description:

Several advanced ground-based laser interferometer gravitational-wave detectors are expected to be operational around 2015. These include two LIGO detectors in the US and VIRGO in Europe. Direct detections of gravitational waves from compact binaries of neutron stars and black holes are likely around 2017. A real-time search pipeline that uses newly developed time-domain search technology has been developed in our group with support from the international gravitational-wave community - the LIGO Scientific Collaboration. The aim is to detect gravitational waves in real-time from the advanced detector data and pass event triggers to conventional telescopes for prompt follow up observations. The pipeline has passed initial tests on existing detector data and on simulated online data from engineering runs for advanced detectors. We are actively engaged in getting the pipeline ready to detect gravitational waves online for the first Science Run of LIGO next year.

Project:

The student will have the opportunity to contribute to the on-going effort to further improve this search pipeline and get it ready for next year’s science runs to detect gravitational waves. This includes (1) using Matlab or Mathematica to help testing the capability of the method to detect gravitational waves from coalescing binaries of spinning neutron stars and black holes, (2) extend the existing pipeline to generate “early warnings”, that is, to send out triggers whenever there is enough signal to noise ratio, (3) use Matlab or C code to help test search methods that optimally combine data from all gravitational wave detector for detection and localization.

**Project II: High-performance computing using Graphics Processing Units (GPUs).**

Supervisors: Linqing Wen, David Blair

[www.gravity.uwa.edu.au](http://www.gravity.uwa.edu.au) (under Data Analysis)

Description:

We use the powerful cost-effective GPUs http://www.nvidia.com/object/what-is-gpu-computing.html together with CPUs to accelerate the gravitational wave signal processing. A GPU accelerated search engine has been developed and a CPU-GPU hybrid pipeline has been developed for the real-time low-latency search mentioned above. We also look into the GPU application in industry, e.g., for resource exploration.

Project:

The student will help using GPUs to accelerate some of the existing functions and filtering software written in C for detection and localization of a gravitational wave. The student will have the opportunity to use the 96-node GPU cluster from iVEC/Pawsey Fornax cluster located at the UWA. This project requires students to have basic computational skills, e.g., C programming. Knowledge of GPU/CUDA programming will help.

**Project III: Use Pulsar Timing Array data to detect gravitational waves from supermassive black hole binaries.**

Supervisor: Linqing Wen

[www.ipta4gw.org](http://www.ipta4gw.org)

Description:

A passing gravitational wave will affect the local space-time metric on the travel path of a radio pulse and can lead to observable fluctuations in its arrival time at Earth. There is an international effort in using pulsar timing arrays (PTAs) to detect gravitational waves. A direct detection of nanoHertz gravitational waves using PTAs is possible within this decade. The Parkes Pulsar Timing Array (PPTA) in Australia observes 20 millisecond pulsars at 2-3 weeks interval with regular monitoring commenced early 2005. PPTA offers the most regularly monitored millisecond pulsars among all efforts.

Project:

The student will help test some of the new methods to detect and localize gravitational waves using the PTA. The student will have the opportunity to work with experts from the PPTA project and use data from the Parkes telescope to search for gravitational waves from binaries of supermassive black holes. Specifically, the student will be involved in testing methods on optimal detections and localization of individual gravitational wave sources, test signal-based detection verification method, and apply the method to detect anisotropy of the gravitational wave background.