PAWSEY supercomputing centre

PARTNER INSTITUTION
THE UNIVERSITY OF WESTERN AUSTRALIA

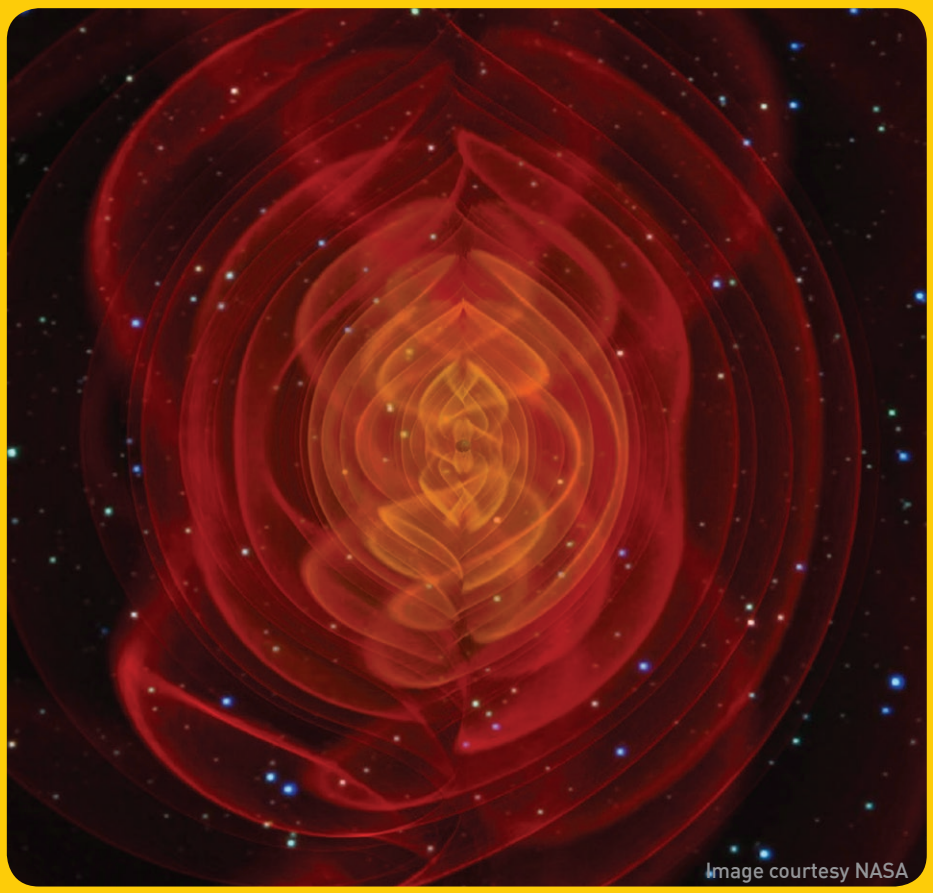
Image courtesy NASA

PROJECT LEADER
WINTHROP PROFESSOR
DAVID BLAIR
PROFESSOR LINQING WEN
Australian International
Gravitational Research Centre

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SYSTEM
FORNAX

TIME ALLOCATED
12,000 HOURS

AREA OF SCIENCE
Physical Science

APPLICATIONS USED
FFTW packages, Gstreamer with devel, CUDA libraries, GridFTP, LAL packages, GSTLAL

GRAVITY WAVES

A research project undertaken by the Australian International Gravitational Research Centre, which is based at the University of Western Australia (UWA), is using Pawsey Supercomputer Centre's resources to implement a pattern recognition technique that can be used to detect gravitational wave signals in real-time.

2012

REAL-TIME GRAVITATIONAL WAVE SEARCH

THE CHALLENGE

Gravitational waves are a bit like sounds that travel through space at the speed of light. A single gravitational wave detector, like a single human ear is unable to specify the direction of a gravitational wave, but once widely spaced detectors are connected, it will be possible to calculate the direction of a wave from the varying times of signals at each location. Professor Wen demonstrated that the addition of a southern hemisphere detector in Gingin, Western Australia could greatly improve the global array capability. However, the director of the Australian International Gravitational Research Centre, Winthrop Professor David Blair, says while the latest generation of detectors should be sensitive enough, the signals are so buried in background noise that new methods that require enormous computing resources are needed to dig the signals out of the noise.

Until recently, all gravitational wave data analysis was backdated. Researchers in gravity waves recorded all of their data before analysing it using very powerful computers. The long delayed analysis meant that any light or radio flashes that might have accompanied a powerful gravity wave burst would be long gone by the time the data was analysed. This meant that the best way of proving that a possible signal was real event was out of reach.

THE SOLUTION

Pawsey Supercomputing Centre has helped The University of Western Australia gravity group with their undertaken by granting them access to its resources. The team has negotiated to bring gravitational wave signals from all the detectors in the northern hemisphere into Perth. Soon they also hope to have a direct fibre optical link to the Gingin gravity wave research centre. Already Pawsey has carried out real-time analysis of data from the new US Advanced LIGO detectors.

This analysis uses a specially implemented digital filters known as the Summed Parallel Infinite Impulse Response (SPIIR) filter using its graphics processor-enabled supercomputer. The SPIIR filter mimics the signal processing of the combined human cochlea and human brain, and was developed by Professor Wen and her students. It enables the researchers to recognise one single waveform out of tens of thousands of different possible waveforms arriving at the detectors. The system is still being optimised, but is expected to enable the researchers to detect gravitational wave signals thousands of times more efficiently than previous techniques.

OUTCOME

The technique developed using Pawsey Supercomputing Centre's resources could bring enormous advantages to Western Australia by placing the state at the centre of international gravity wave research. Additionally, the technique can also be applied to other areas such as improving computer speech recognition. Professor Blair says Pawse has provided a fantastic opportunity for the UWA research team by granting them access to its systems and expertise.

"As we are inventing new techniques, we are required to make particular configuration changes and it's not easy to do that unless we have direct contact with the operating staff."

He also believes that his research team couldn't have implemented new ways of detecting gravity waves if not for the Centre assistance.