Gravity Wave Astronomy

Submission to Decadal Plan Working Group 3.1

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The Australian Consortium for Interferometric Gravitational Astronomy (ACIGA), represents the gravity wave research community in Australia. Core Universities are ANU, UWA, U of A, with Monash University, and the University of Melbourne now associated. The Mission of ACIGA is to enable Australian participation in the discovery of gravitational waves and their exploitation for astronomy and Cosmology. Partnership in the advanced LIGO project will ensure our role in the first direct detection of gravitational waves and access to data for astrophysical searches. The Australian International Gravitational Observatory will provide the key southern Hemisphere detector required to fully exploit the gravity wave spectrum.

Australian partnership in Advanced LIGO:

Since 1995 ACIGA has been carrying out R&D in advanced inferometry with a particular emphasis on upgrading the LIGO detectors in the USA. ACIGA universities were founding members of the LIGO scientific collaboration. Such was the success and importance of our program that when LIGO sought partners for its US$200M upgrade project – Advanced LIGO – it invited ACIGA along with GEO (The British-German Project) to join for a modest investment of A$7M (2.5% of full facility). With this investment Australia will have full access to all data from A/LIGO, will have a seat on the oversight committee (consisting of stakeholders), and will participate in the management of the project.

Australian International Gravitational Observatory

AIGO has been planned for more than 10 years, and since 1999 has been under active development. It was identified in the Decadal Review of Astronomy in 1995. The project has been led by the Australian Consortium for Gravitational Astronomy. The AIGO research facility has been developed on a specially designated site 80km north of Perth, operated by UWA. Total investment in the facility and associated university facilities exceeds $29M, including major corporate donations towards AIGO's award winning public education centre, the Gravity Discovery Centre. Through the Australian activity, CSIRO Centre for Optical Technology won the contract for major optical fabrication for the US LIGO project. To bring the facility to the stage where it can begin to function as the key southern hemisphere arm of a global array of gravitational observatories requires a further investment of ~ $40M.

Like all major facilities, AIGO offers the opportunity both to spawn new industries and to support major industrial development. A study of the vacuum industry opportunities and

benefits to Western Australia is underway. funded by the WA Government. A major industry development of advanced vibration isolators for airborne mineral exploration is underway, and many lasers and optical devices have significant commercial potential.

AIGO is currently a National Facility in all but name. Five Australian universities have been actively participating in research at AIGO. IT is part of an international research project at the frontiers of science and technology. Its research program is strongly linked to the US LIGO project and is supervised by an international advisory committee.

Once it has become a full scale detector, AIGO will be the southern hemisphere detector essential for the world array to extract full directional information from incoming signals while simultaneously allowing greatly improved sensitivity to be achieved through the 5 additional independent baselines that will be created by a single detector in Australia.

Observatories are long lived facilities. AIGO is likely to require moderate recurrent funding over a long period of time, and like all observatories is never likely to be commercially viable. The WA Government has announced a Centre of Excellence in Gravitational Astronomy which will provide academic support for AIGO. The development of AIGO is strongly supported by the international community. AIGO already participates in collaborative research with all the other major international projects. Major components of AIGO have to date been donated or loaned by other projects and similar in kind contributions can be expected for the next stage of development. Much of the development of AIGO to date was funded through Systemic Infrastructure as the first half of a 5 year program for partnership in Advanced LIGO.

International Planning Meeting

An International Planning Meeting held at the AIGO facility in April 2004 . This identified the main research priorities (now underway) and also emphasised the need for AIGO in the world wide array. It was considered that the minimum acceptable length for the southern detector should be 1km but preferably more. The pipe diameter should enable AIGO to be extendable to 5km (the limit of the site without additional land aquisition). For the present purposes we have considered 2km to be a practical compromise between cost and sensitivity, and a 1km facility being the minimum useful length.

Gravity Wave Research Centres in Australia.

ACIGA: Australian Consortium for Gravitational Astronomy
Gingin High Optical Power Facility and AIGO Prototype Laser Interferometry UWA personnel + other ACIGA staff
Australian International Gravitational Research Centre University of WA Laser Interferometry and spin offs (Blair, Burman + 4 postdoc + 9 PhD)
ANU: Centre for Gravitational Physics Laser Interferometry AND SPIN OFFS (McClelland, Gray, SCOTT + 1/2 Lam + 1 postdoc + 8PhD)
University of Adelaide Center for Laser Physics (Munch, Veitch, Hamilton) +2 postdoc + 4 PhD
Sources:Monash Dept of Applied Mathematics(Lun +1, 2 Phd students)

University of Melbourne (MElatos +2 PhD students)

Gravity Wave Data Analysis Facilities
ANU: ADAC Cluster
Swinburne: Supercomputer (mainly pulsar timing)
UWA Cray supercomputer (funded 2004, to be installed 2005)

Astronomy Linked to AIGO
Gamma Ray Bursts and Supernova studies
MSSO,(Schmidt) Perth Observatory (Williams) and new GRB project with Zadko-Sikora telescope at Gingin facility (Coward, Burman,Blair plus Obs de Haute Provence M. Boer)

Gravity Wave groups not directly connected to AIGO (pulsar timing technique)
Swinburne Pulsar Timing (Bailes +1 +1PhD)
ATNF Pulsar timing Manchester
SKA project: pulsar timing goals
collaboration and partnership program with the US LIGO project.

SWOT analysis

A/LIGO

Strengths: Strong History of Australian involvement in GW detection. Strong Data Analysis Group could make most of A-LIGO Data. Long involvement in Advanced GW detector research . Strong international support and collaborations

Weakness:
Weak connection with Astronomical Community .
Relatively small research community(but growing)

Opportunities:
Opportunity to be part of the detection of Gravity Waves, opening up a new area of Astronomy.
Data analysis team has chance for large scientific term on modest investment in a very expensive facility

Development of key skills in advanced GW detection
Development of the capacity and capability, including project management, required to build and Australian Detector.

Threats:
non-detection of Sources
Failing to reach proposed sensitivity

AIGO:

Strengths:
Strong History of Australian involvement in GW detection

Strong Industry and Western Australian Government Support
Leverages scientific returns from other, more expensive facilities

Weakness:
A 2nd generation instrument could miss the first discoveries.
Difficulty of working in large international collaborations

Opportunities:
Chance to leverage significant international money from investment
Advanced technologies with many spin offs
Already established Public Outreach offers huge educational opportunities

Threats:
non-detection of Sources
Failing to reach proposed sensitivity