SEARFE – Students Exploring Australia’s Radio-frequency Environment

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Introduction

Astronomers use optical telescopes to study the light from objects in space. Radio astronomers use radio telescopes to find objects in space that emit radio waves. Radio waves can tell us about the size, shape, and behaviour of the object, what it is made of and what lies between it and the Earth.

Radio telescopes receive and concentrate radio waves. These waves can then be processed by computers and interpreted by astronomers. Radio telescopes are often dish-like, and the bigger the dish the more sensitive the telescope. Radio astronomy dish antennas, like those at Parkes and Narrabri in NSW, are familiar to us all.

The bigger the telescope, the more sensitive it can be – the more easily it can detect very faint radio signals. The next generation of radio telescopes will use many small antennas linked electronically by computers. Such a system allows a very large array or set of antennas to behave like a huge dish that can probe the universe for very faint radio signals.

As the cost of designing and building such an array is prohibitive for any one country, an international consortium of astronomers is working collaboratively to raise the funds, design the array, and find the most radio-quiet location to build the array. This array is now known as the SKA (Square Kilometre Array) telescope. It will have a collecting area 100 times that of the current largest radio telescope. There are two papers that describe this international project in more detail (Robertson 2001, Irion 2002).

Astronomers from the CSIRO Australia Telescope National Facility (ATNF) are monitoring radio frequency use in Australia to find our radio-quiet areas. Once we have this information, we can bid for Australia to be the site of the SKA. This facility would have many benefits in terms of international recognition, employment opportunities and stimulating Australian science, engineering and high-technology industry.

The SEARFE Project is a collaborative outreach project involving High School teachers and students in the search for the best site for the Square Kilometre Array. The SEARFE Project is being coordinated jointly by CSIRO ATNF, the School of Physics (University of Sydney) and the Faculty of Engineering (University of Technology Sydney).

The aims of the Project include:
- Giving students hands-on experience in using radio-science equipment, making measurements and interpreting data in a real-life research project
- Providing teachers with material and activities relevant to the radio-frequency wave propagation and astronomy units in the Physics, Senior Science and Engineering Studies HSC syllabuses
- Helping students reach a better understanding of the use and value of the radio spectrum for telecommunications
- Enabling communication between city and country school students, giving them valuable experiences in use of the Internet for collaborative research
- Helping students gain an appreciation of radio-quietness as a significant natural resource
- Giving students the satisfaction of contributing to the search for the Square Kilometre Array telescope site.

The Project

At least ten high schools will be involved in the project in 2002 and 2003 and the research will also run in two university outreach activity centres. There is a waiting list of schools that would like to participate, once we have funds and equipment to enable them to do so. We hope to continue to run SEARFE over many years and include as many schools in Australia as possible.
Each school involved in SEARFE will be supplied with:
- An AOR AR3000A radio-frequency scanning receiver
- An IBM laptop computer for data acquisition and display
- Software for spectrum acquisition and display
- 25-1300 MHz discone antenna and all necessary cabling
- Resource Kit including operating instructions, experimental notes and background information.

The software is written in the Java programming language. The Java language was chosen for its computer and operating system platform independence, as well as its large public domain software library and development tools. The graphic display routines use the VisAD (Hibbard, 1998) package while Sun Microsystems’ Forte for Java Integrated Development Environment Community Editions was used in developing the software. Spectra of radio frequencies scanned can be displayed as they are acquired. Publicly available packages along with the relevant source code will be made available to the students to allow them to extend or develop the software further.

By working as part of the SEARFE research team students will be able to:
- Discover radio-frequencies used in their area and identify the source of some of the signals
- Monitor variations in signals and learn about radio-frequency propagation
- Learn about the equipment they are using; for example, by exploring differences with different antennas and different antenna positions
- Use an Internet-based database and conferencing system to communicate with students in other areas and learn about the differences in use of the radio-frequency spectrum between city and country areas
- Make a valuable contribution to the knowledge-base upon which Australia’s bid to host the international SKA telescope will depend.

Over time the SEARFE project will build up a database of radio-frequency use around Australia. This will be useful for radio astronomy in general, as well as being specifically useful for the SKA site studies.

The Process

Students and teachers will be involved in setting up their own equipment then using it in a variety of ways.

To become familiar with the equipment and radio frequency use in their area the activities will guide students to:
- Tune directly to a local radio station using the receiver
- Scan for a local radio station using the SEARFE software
- Tune to a local TV channel
- Print the scans they have collected
- Experiment with various antenna positions

Students will then scan the radio spectrum over the whole range being investigated. They will be able to print their results and also send them electronically to the SEARFE website where they will be able to compare them with scans from other areas across Australia. By scanning at different times of the day and days of the week, a better picture should emerge of radio frequency use in each area. Students should also be able to identify radio-quiet frequencies and times for their area. This information will be useful for the SKA site search.

Project Launch and Opportunities for Involvement

The SEARFE Project will be launched on June 21, 2002 and equipment will be in schools involved in August. Educational benefits are being formally assessed by the Education Research and Development unit of Abbotsleigh School, Wahroonga.

The SEARFE website is http://www.searfe.atnf.csiro.au/. Project documentation will be available on this site as it is developed and students will be able to log questions, comments and results via the site. We welcome feedback on the Project, and if you would like your local schools to become involved, please contact Michelle Storey on michelle.storey@csiro.au.

Supporters and Sponsors

People who have helped with the SEARFE Project so far include:
Duncan Campbell-Wilson (Uni Sydney), Anne Green (Uni Sydney), Peter Hall (ATNF), Julienne Harnett (Uni Technology Sydney), Betty Jacobs (Uni Technology Sydney), Paul Krautil (Pymble Ladies College), Oliver Mather (UNSW/Uni Newcastle), Vince McIntyre (ATNF), Janet Pemberton (Abbotsleigh School), Michelle Storey (CSIRO Publishing/ATNF), George “Nyima” Warr (ATNF), Andrew Wright (ATNF).
Supporters and sponsors of the SEARFE Project include:

- CSIRO ATNF
- School of Physics University of Sydney
- Science Foundation for Physics University of Sydney
- Faculty of Engineering, University of Technology Sydney
- School of Physics, University of NSW
- IBM Australia
- BAE Systems Australia
- Perth Observatory
- Australian Geographic

Appendices

The Appendices include samples of the SEARFE documentation from the Resource Kit. The documents included in the Appendices are:

- EasyGuide: Receiver
- EasyGuide: Operating the Receiver from the Computer
- EasyGuide: Installing the Antenna
- Students Activity Guides
- Background Notes: Science with the Square Kilometre Array telescope
- Background Notes: Radio-quiet Reserves and SEARFE Research

References

