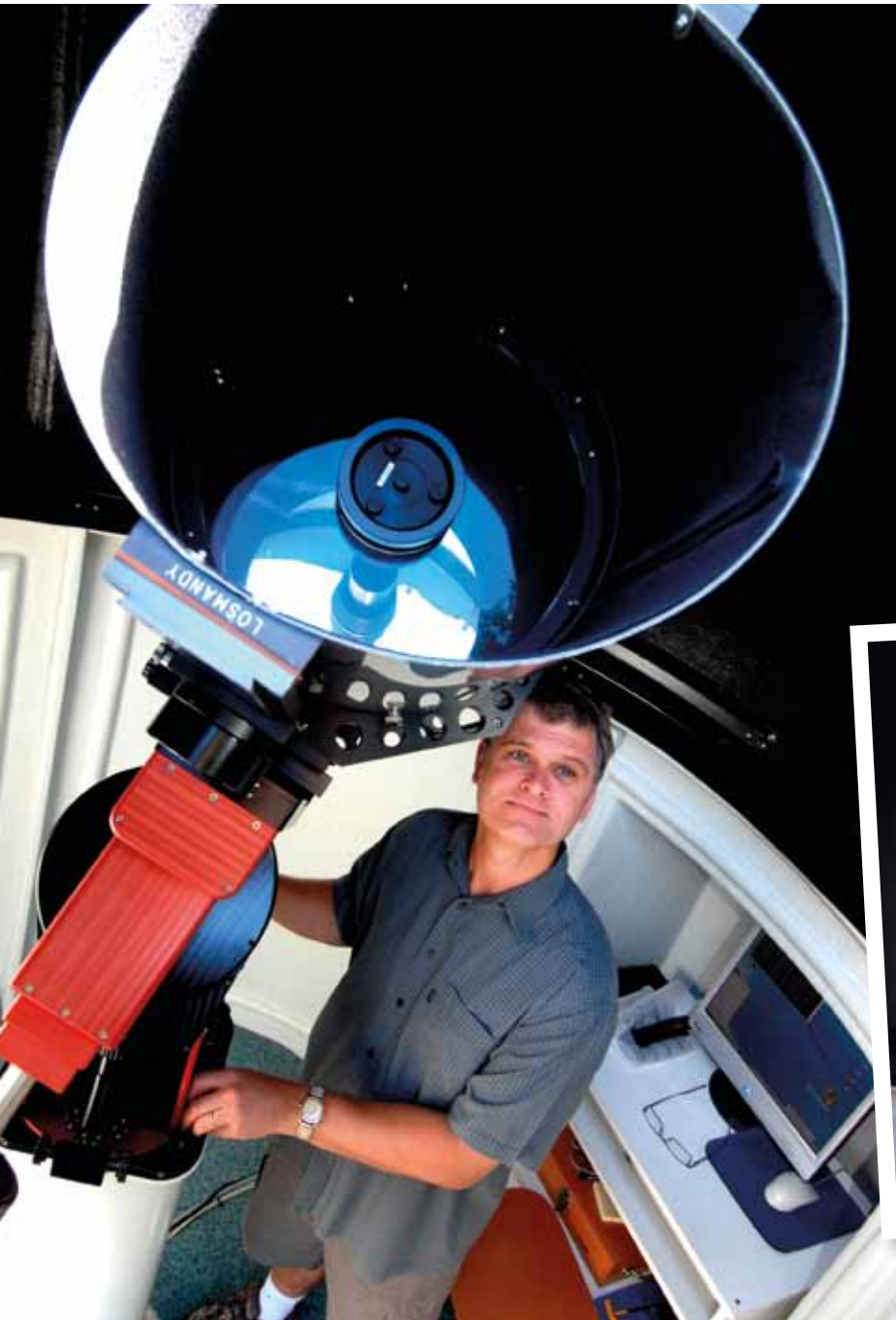


The SPIRIT Telescope Initiative

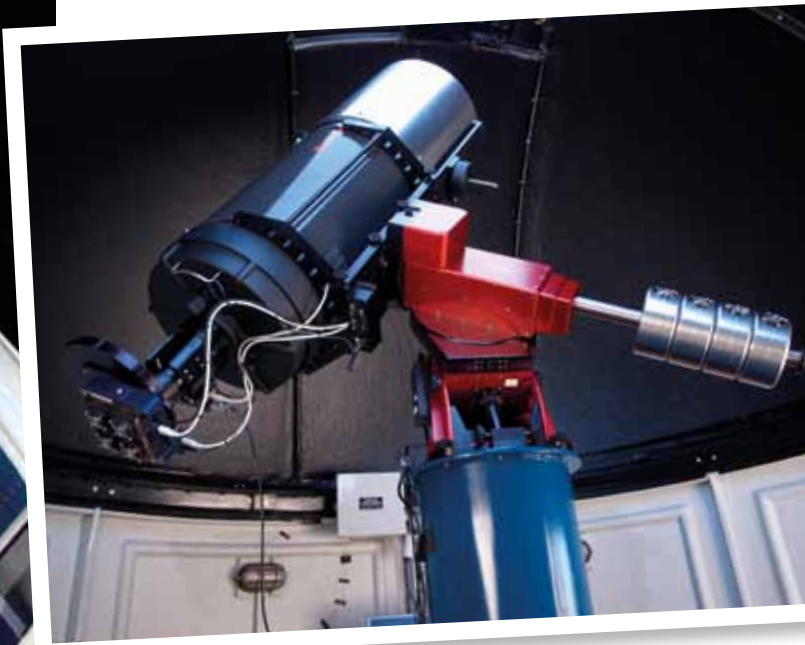
Bridging the gap between research and education Paul Luckas



Left: The author stands in his home observatory. The setup is used as a testbed for modifications to the SPIRIT telescope, and students at times have accessed this telescope for observing. BRIAN RICHARDS

It is a reality that much of modern observational astronomy is accomplished through the use of robotic telescopes. From highly automated minor planet survey instruments adding dozens of new discoveries each week, to robotic telescopes that respond rapidly to satellite detections of gamma ray bursts, the universe is now observed and measured by unattended instruments often located in remote parts of the world.

It is with this in mind that a successful collaboration between The University of Western Australia, the International Centre for Radio Astronomy Research (ICRAR), and the Western Australia Department of Education's "SPICE" program has



Above: The SPICE Physics ICRAR Remote Internet Telescope (SPIRIT) PAUL LUCKAS / SPICE



Above: Teachers are able to utilise the Centre for Learning Technology at The University of Western Australia for a variety of SPIRIT workshops. PAUL RICKETTS / SPICE



Above: This wonderful image of the galaxy NGC 253 was captured with the SPIRIT telescope. PAUL LUKAS / SPICE

developed the SPIRIT initiative. SPIRIT, which stands for “SPICE, Physics, ICRAR, Remote Internet Telescope” provides access to a research-grade robotic telescope system for students located in Western Australia and beyond. Through the innovative use of commercially available components together with a fully supported educational program, high school students are able to participate in ‘real science’ through a number of activities.

The prototype SPIRIT telescope was commissioned in mid 2010 and has recently completed its first year of formal operations. Dozens of teachers have attended professional

development provided through the SPICE program and students from both local and regional schools now routinely use the instrument in a variety of activities. In all cases, access to SPIRIT is provided at no cost to schools and researchers.

The innovative design of the system makes use of commercially available hardware and software. This was done for a number of reasons. First, the project endeavours to demonstrate the idea that highly reliable automated research instruments can be deployed relatively quickly and inexpensively. Second, the implementation seeks to provide a design that can be easily replicated.

State-Of-The-Art Equipment

SPIRIT itself is located on the roof of The University of Western Australia’s School of Physics, making use of a pre-existing 3.5-metre Sirius dome. At the centre of the dome is a Paramount ME robotic mount, upon which a Celestron 35-cm (14-inch) Schmidt-Cassegrain telescope paired with an Apogee Alta U6 CCD camera provides just over 20 arcminutes of field at a resolution of 1.2 arcseconds per pixel. A nine-position filter wheel includes a set of parfocal photographic and photometric filters, and the entire image train is held firmly in place with an Optec TCF-S3 temperature controlled focuser which provides an extremely reliable means of maintaining focus throughout the

night. The configuration presents a broad range of imaging and data gathering possibilities, ranging from basic and advanced astrophotography of deep space objects, to minor planet astrometry, supernovae survey work, and even photometry.

All observatory software is installed on a single server, which also provides the interface to authorised users who access the telescope with nothing more than an Internet browser. The back-end system utilises commercially available telescope and camera control software including ACP and MaxIM DL, as well as a number of ASCOM components which have had only minimal scripting applied to them in order to engineer a fully automated dusk-until-dawn routine — including calibration frame acquisition and full weather monitoring.

The observatory server also provides front-end web and ftp services to the now several dozen teacher and student groups who have registered to use the telescope. Users acquiring images with SPIRIT are provided with both RAW and calibrated FITS images, which can be downloaded directly from the web interface or via FTP for large numbers of images. A high quality JPEG version of each image is also automatically generated for activities that do not require the complexity and size of the astronomical FITS format. As most modern browsers are able to natively display JPEGs, students experience a level of “instant satisfaction” as their

images appear on the screen before them.

SPIRIT has been designed to be extremely robust and easily maintained by a sole program manager. During 2011, the facility enjoyed 100% operational up time with only minimal maintenance.

Ease Of Use

The real innovation of the SPIRIT design is in the implementation of a 'multi mode' operational capability, to provide for the varying needs of students who range in age from primary school to university graduates. Three distinct modes of operation are currently available with SPIRIT:

In 'mode 1', students access the telescope in real time, using nothing more than a web browser. Negating the need for any specialised software allows regional and remote students the same experience as their city counterparts. Indeed, anyone on the planet can operate the SPIRIT telescope as if they were literally sitting in the observatory. Secure browser access is provided through ACP's "Share your Sky" application, though the default web pages have been customised to simplify the look and feel as well as provide a seamless experience for first-time users.

Individual tabs on the home page provide access to numerous features including:

- Booking calendar
- Observatory web cam
- Equipment descriptions and observatory status
- Basic and advanced image acquisition screens
- User image and log file folders
- Help, FAQ, and downloads

The system also includes a number of enhanced features that assist first time users. Together with the ability to target fixed objects using RA and Dec coordinates, ACP includes a fixed object database, allowing users to input targets using common catalogue numbers. This feature has been extended to provide automated ephemerides generation for moving targets from the Minor Planet Centre's online asteroid and comet databases, calculated automatically at the time of imaging.

A low-light web cam provides instant feedback on what the telescope is doing, and output from a Boltwood



A student acquires images with SPIRIT from home.
PAUL RICKETTS / SPICE

// It is these unattended modes of operation that allow students to participate in professional astronomy, and even the prospect of real discovery. //

weather sensor provides an indication of sky conditions as well as providing automated observatory shutdown in the event of inclement weather. Mode one has proven extremely popular with students afforded the ability to 'drive' a professional telescope in real time, imaging faint deep-sky objects that are hundreds of millions of light-years away.

Doing Science

As students grow in confidence, they can make use of the second mode of operation which provides the means to upload target lists for unattended image acquisition while they sleep. In this way, students can undertake data acquisition that mimics the automated systems of larger and more expensive

survey instruments. In late 2010 a group of students from two Perth high schools successfully utilised this mode of operation to image a number of faint minor planets and submit astrometry to the IAU's Minor Planet Centre — successfully attaining the University's Minor Planet Centre observatory code in the process.

Since then, numerous users and groups have created increasingly demanding target lists in order to undertake survey work or gather large amounts of data for in-class analysis. In all cases, SPIRIT has risen to the occasion, sometimes imaging hundreds of targets per night from dusk until dawn. Aside from engaging students in astrophotography and undertaking minor planet astrometry, SPIRIT also provides a research-quality instrument capable of serious photometric work. Students have recently undertaken differential photometry of rotating asteroids and a number of advanced students have used the photometric filters in order to construct basic Hertzsprung-Russell diagrams of bright globular clusters.

Though not yet fully implemented, the final mode of operation will



Above: The computer lab at the Centre for Learning Technology at The University of Western Australia, home to the SPICE program. PAUL RICKETTS / SPICE



Above: Students from a local Perth high school visiting the SPIRIT Observatory at The University of Western Australia. PAUL RICKETTS / SPICE

provide a fully automated multi-user request and scheduling environment geared primarily towards professional research and multi-user scenarios. It is these unattended modes of operation that allow students to participate in professional astronomy, and even the prospect of real discovery. The potential for users to produce publishable observations and measurements adds a dimension to educational telescope outreach that is welcomed by both teachers and students.

The provision of three distinct modes of operation, from basic real-time access to fully unattended operations, provides a great deal of versatility. Whether used as a tool to engage high school students, or as a supernovae search machine, SPIRIT provides a successful blueprint for comparatively low-cost research instruments for educational outreach.

To complete the full life cycle of a truly useful educational outreach instrument, the SPIRIT initiative is supported by the WA Education Department's "SPICE" Program (www.spice.wa.edu.au/). SPICE provides student resources and teacher

professional development for the SPIRIT initiative. Three workshops are currently provided to teachers: SPIRIT 101 — which introduces potential users to the use of a robotic telescope for astronomy; SPIRIT 102 — imaging minor planets with SPIRIT; and SPIRIT 103 — advanced astrophotography. Additional resources are in development, including a Hertzsprung-Russell diagram activity for year 12 Physics students based on similar activities undertaken by their University counterparts.

The success of the first year's operation has not gone unnoticed. With a generous donation from the Hawaiian Property Group in Perth, a second observatory — SPIRIT II — is

scheduled for deployment in 2012. Using a larger telescope (a Planewave CDK 17) and a more sophisticated CCD camera (Finger Lakes Instrumentation Proline 16801), this second instrument will provide enhanced capabilities, as well as double the capacity of the current program. ♦

SPIRIT is the brainchild of Paul Luckas, who manages the SPIRIT program at The University of Western Australia. As an advanced amateur astronomer, Luckas has well over 1,000 published observations including the co-discovery of 11 supernovae and 3 minor planets, and has participated in dozens of near-Earth-object (NEO) confirmations and recoveries via his own backyard robotic telescope. He can be reached at paul.lucas@uwa.edu.au