THE SPIRIT LIVES ON

TEACHING ASTRONOMY BY REMOTE CONTROL

A high-tech telescope facility in Perth is giving students a taste of what it is to do real science, from the comfort of their classrooms and homes.

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The reality of modern observational astronomy — that it is accomplished through the use of robotic telescopes — is increasingly reflected in educational materials and astronomy outreach programs. First profiled in the Aug/Sep 2012 issue of *Australian Sky & Telescope*, the SPIRIT telescope initiative continues to provide students in Western Australia and beyond, a unique opportunity to explore the night sky in real time using such tools. Now in its seventh year of operation, this highly successful outreach program continues to experience new milestones and achievements.

Since the 2012 article was written, a second telescope has been commissioned adjacent to 'SPIRIT I' on the roof of the School of Physics at The University of Western Australia. While doubling telescope capacity, SPIRIT II also provides students with yet more powerful instrumentation. The telescope is a PlaneWave CDK17, equipped with a Finger Lakes Instrumentation ProLine CCD camera using a Kodak 16801 (non-anti-blooming) sensor. This combination provides a 40 arcminute field of view — exactly double that of SPIRIT I — at a variety of resolutions.

With the reduced sensitivity provided at SPIRIT II's native resolution (0.6 arcseconds per pixel), students are now able to image the Moon up to first quarter using a very short, filtered exposure. At the other end of the sensitivity scale, using 3×3 pixel binning (1.8 arcseconds per pixel), students can acquire images of faint galaxies with exposures of as little as 60 seconds.

As with SPIRIT I, the image train includes a filter wheel with both photographic and photometric filters catering for a variety of observational and scientific goals. Composite materials used in the construction of the CDK telescope negate the need for temperature controlled focussing, and the system continues to retain excellent focus across Perth's seasonal temperature fluctuations. Both SPIRIT telescopes are housed in Sirius Observatories domes, complete with weather monitoring, and use Paramount ME mounts.

A single observatory computer model is employed in each of the SPIRIT domes, with all control software and front-end web server software installed on the same PC. A customised implementation of the commercially

Above: **Year 9 students from Iona Presentation College Perth, visiting the SPIRIT facilities.**

available ACP / MaxIm DL software combination provides an extremely robust multi-mode, web-enabled telescope control and image acquisition system.

Students can 'drive the telescope' in real time from the comfort of their living room computers, targeting single objects by common catalogue name, or schedule multi-target data acquisition to take place unattended while they sleep. Accordingly, teachers can tailor programs to meet their needs, from simple student engagement activities to extensive research projects. Images are generated in both FITS and JPEG formats so that students can share the experience quickly via the SPIRIT Facebook page or the social channel of their choice.

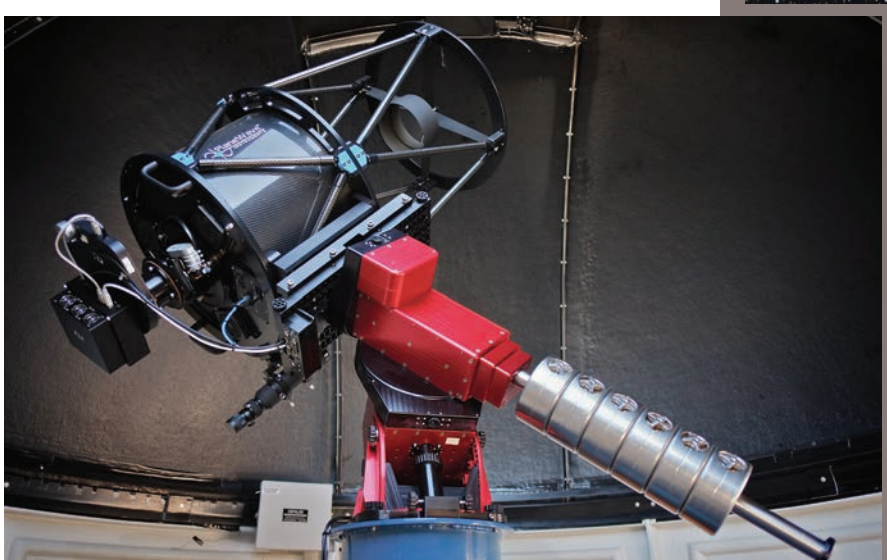
Real science

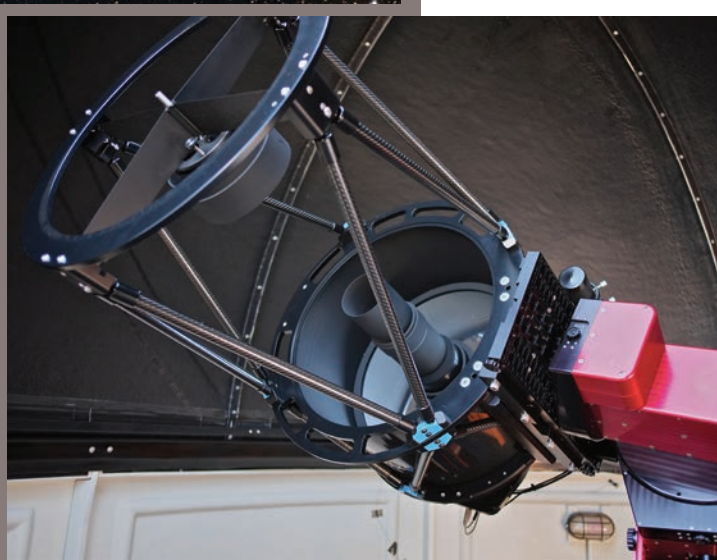
Despite the increasing light pollution caused by Perth's burgeoning population, the SPIRIT telescopes continue to impress with the quality data they produce. From an engagement perspective, first-time student users are able to marvel at distant objects, such as galaxies containing billions of stars, though images taken remotely by them in real time in just a few seconds. From there, these same students can embark on a variety of supported activities, from astrophotography to spectroscopy and participate in 'real science'.

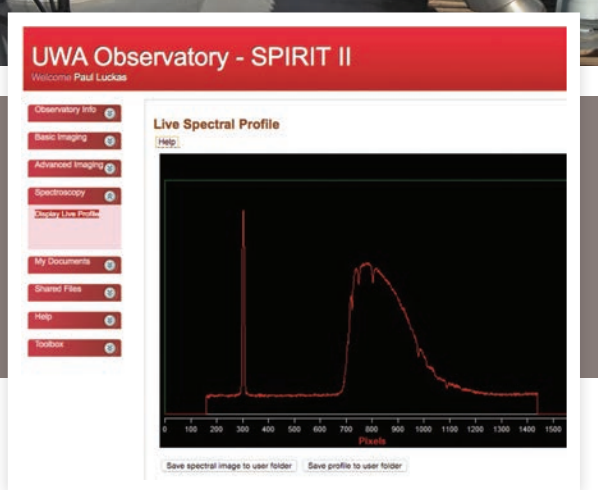
Recently, students from Iona Presentation College in Perth used SPIRIT to undertake observations of RR Lyrae stars, analysing and preparing light curves of these short-period variables for publication in the Variable Stars South (VSS) monthly circular. Further afield, students at a school in Japan successfully determined the rotation period of minor planet (15552)

Above and left: **Images of the Trifid Nebula and the first quarter moon, taken by students using SPIRIT II.**

Below: **The SPIRIT II Telescope is a PlaneWave CDK17 telescope on a Paramount ME mount, equipped with a FLI ProLine CCD camera.**







Above: **The SPIRIT observatories are located on the increasingly crowded roof of the School of Physics at The University of Western Australia.**

Right: **Students get to do real science with SPIRIT II. This screen shot shows a real time spectral profile of a bright type-A star.**

Sandashounkan in 2015, after an extensive observation program using SPIRIT. Their results (together with those of other budding SPIRIT astronomers) appear in the IAU's *Minor Planet Center* publications.

A recent and novel addition to SPIRIT is the *SPIRIT Bright Star Spectroscope*. This instrument is mounted to the top of SPIRIT II and comprises an 80mm refracting telescope, a 100 lines/mm transmission grating and a video camera. It produces a real time, low-resolution spectral image of bright targets with a spectral dispersion of approximately 10 Angstroms per pixel. The entire visible spectrum — from ultraviolet to infrared — is contained on a single image taken by the camera.

Images from the spectroscope are processed and presented on the SPIRIT web interface as a spectral profile in real time. The spectral image can also be downloaded for calibration and analysis off-line using stand-alone software. In this way, students are able to extend their 'photometric' knowledge of the universe into the realm of spectroscopy, learning about the temperature profiles and chemical signatures of stars, and reproducing the foundational work of those such as Edward Pickering and his team at Harvard in the early 20th century.

Multi-purpose facility

SPIRIT is managed and run by the International Centre for Radio Astronomy Research (ICRAR) at UWA's Crawley campus (**spirit.icrar.org**). A full life-cycle of student activities and resources is made available through the program's website, which also provides the portal for booking and accessing the telescopes. With its home at ICRAR, SPIRIT also benefits from an extended outreach program that introduces other aspects of contemporary astronomy, most notably that associated with the Australia's participation in the international Square Kilometre Array (SKA) project.

Together with outreach, SPIRIT also forms an integral part of teaching and research at UWA. As part of third-year astrophysics coursework, students at UWA use data acquired with SPIRIT to produce colour magnitude diagrams of stellar clusters. In addition, a number of postgraduate students have used SPIRIT for data acquisition, including both masters and PhD candidates studying the educational benefits of robotic telescopes in the classroom, among more conventional astrophysics research. The list of usage scenarios is on the increase, with new projects appearing each year.

SPIRIT remains unique in Australia with its multi-mode of operation and real time student web interface. Above all, ICRAR's supporting outreach program and the fact that the initiative remains largely free for educational use distinguishes it as a truly valuable resource for the many hundreds of students and teachers who have accessed SPIRIT over the years.

The success of SPIRIT provides a blueprint for similar initiatives in Australia during this critical time in science education. While our leaders continue to espouse the need for (and promise of) STEM education initiatives, programs such as SPIRIT continue to bear the brunt of funding pressures on educational authorities, stakeholders, universities and schools. We are all responsible for supporting the next generation of astronomers and scientists, so here's to another seven years of SPIRIT for all. ✦

Paul Luckas passionately runs the SPIRIT Telescope Initiative from his desk at ICRAR in Perth. His research interests include the spectroscopy of exotic stars, and on most clear nights he can be found at the end of a high-resolution spectrograph while simultaneously remotely monitoring SPIRIT operations.