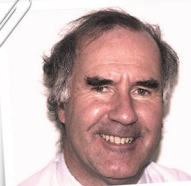


John Hearnshaw

62 years old, born in Wellington, New Zealand

Place of work: University of Canterbury (Dept of Physics and Astronomy and Mt John Observatory), Christchurch, New Zealand

Website: http://cosmicdiary.org/blogs/john_earnshaw/



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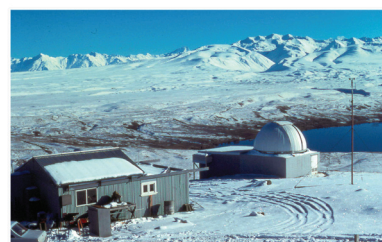
John is a natural communicator. He has made a successful career out of both scientific research and education, working as an observatory director, lecturer and author. His passion for astronomy is undeniable, and his expertise is greatly valued by all who work with him. John certainly has interesting stories to tell!

The astounding images of the Universe that captivate so many, and the science that comes from them, are produced at observatories. These iconic institutions are instantly recognisable, with their large telescopes scouring the heavens. Join John Hearnshaw as he takes us on a tour of observatories, revealing how they are vital to modern astronomy.

Life at an Observatory

I really am the luckiest of astronomers. I've now been an astronomer for over 40 years, and during this time I have been able to indulge in my cosmic passions more or less as I have chosen. For the last 32 years I have been working at Mt John Observatory, much of that time as the observatory director.

So why am I lucky? Because Mt John is surely one of the world's most beautiful observatories. I have seen many observatories in many countries, but none are as scenic as Mt John. It is sited in the centre of New Zealand's South Island, surrounded by high mountains and lakes. Lake Tekapo is just below the observatory, 25-km in length, and is a most extraordinary turquoise-blue colour. What a sight on a fine day! Mt John, at 44° south, is also the world's southernmost optical observatory (except perhaps for small instruments at the South Pole). This makes Mt John invaluable for variable star campaigns that need round the clock observations, and also for monitoring far southern objects. Where else can one observe the Magellanic Clouds every month of the year?



Astronomers may have to brave difficult conditions, especially if working on site for a long time. This is definitely the case when snow and ice are present! This photograph shows Mt John Observatory in winter with the Southern Alps in the background. Image credit: John Hearnshaw.

Small is beautiful

All my astronomical life I have been working with small telescopes, mostly less than two metres in aperture. I have no regrets that I did not sign up to the big telescope league and join the rat race applying for observing time on telescopes like Gemini and Keck. First, New Zealand is a small country (just four million people) with limited resources. Investing in small telescopes, and doing this well, make sense. Small telescopes with great instruments can often outperform large telescopes with mediocre instruments, especially if one has regular access to the equipment.

At Mt John there are four telescopes, two with 60-cm aperture, a 1-metre telescope and a 1.8-metre. The last of these was built by the Japanese, with whom we have a major collaboration on gravitational microlensing to find extrasolar planets.



Observatories are usually surrounded by other buildings which contain additional equipment, supplies, and housing for astronomers. Here Mt John Observatory can be seen, with Lake Tekapo beyond. Image credit: Tim Rayward.

When I came to Mt John in 1976, we just had the two small reflectors and very poor instrumentation. Immediately I borrowed a small Cassegrain spectrograph from friends and colleagues at the University of Florida, and was able to start New Zealand's first stellar spectroscopy programme that year. At the same time we started building the first Cassegrain échelle spectrograph in the southern hemisphere. It had first light in 1977. I obtained the design from the Harvard-Smithsonian Center for Astrophysics where I had been a postdoc fellow. With our échelle I was able to get superb high resolution photographic spectra of bright southern stars using a 60-cm telescope!

Later we used an image tube which allowed us to reach fifth or sixth magnitude, and then in the 1980s we got a linear diode array, our first electronic digital detector. This was followed by our first CCD in the 1990s. By the way, an échelle spectrograph uses a special kind of diffraction grating for dispersing the light into its component colours. The light falls on the grating at a large and oblique angle, which promotes high dispersion.



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Observatories are built in locations where cloud is a rare sight. Observing time is valuable, after all! Visible here is the dome of the 1.8-m MOA telescope on Mt John at dusk. Image credit: Fraser Gunn.

Revolutionary instruments

Now I must mention one of our best projects at Mt John, the 1-metre McLellan telescope. We designed and built it ourselves in our university's workshops in the Department of Physics and Astronomy. We started in 1980 and did the optics, the mechanical design, the electronics, the control system and the dome. It was a big project and took us six years. Our 1-m McLellan telescope (named after a former Professor of Physics) had first light in early 1986. It has now seen 22 years of continuous service and very few nights have been lost due to technical problems.

Another big project at Mt John which deserves mention is our 1.8-m MOA telescope. MOA is "Microlensing Observations in Astrophysics", and is a joint NZ-Japan collaboration. The telescope was installed by Nagoya University in 2004 and is dedicated to finding extrasolar planets, using the deflection of light rays from a distant source star by the gravitational field of a perfectly lined up lens star. This lensing action magnifies the source star's brightness for a while,

perhaps a few weeks. Planets orbiting the lens star induce perturbations in this magnification process which can be detected using high time resolution CCD photometry. We have contributed to five such discoveries so far. The MOA telescope, too, has a large CCD, in fact with 80 million pixels, from a mosaic of 10 chips at prime focus, and we measure the small changes in brightness of over 10 million stars in the Galactic Bulge every clear night throughout the winter months.

Promising projects

The McLellan telescope revolutionised stellar spectroscopy in New Zealand. In 2001 we designed and built Hercules, a large fibre-fed vacuum échelle spectrograph for precise radial-velocity measurements and other studies of variable and binary stars. It is one of the best high res instruments on a small telescope anywhere. This was my baby and I am really pleased with how the instrument has performed. Hercules is the "High Efficiency and Resolution Canterbury University Large Echelle Spectrograph". It now has a 16-million pixel CCD and can get the spectrum on a ninth magnitude star from ultraviolet to far red in an hour.

We are now in the process of improving the performance of Hercules by adding an iodine cell and a fibre double scrambler. The iodine cell superimposes a large number of fine absorption lines on a stellar spectrum, so as to give the velocity zero point, while the scrambler stabilises the image of the end of the fibre, as the light emerges into the spectrograph, and this gives a remarkably stable instrumental profile. Together these changes will allow radial velocity precisions of around 1 m/s. We expect these improvements will permit the search for Earth-like planets orbiting Solar-type stars. The Earth induces a velocity wobble in the Sun of only 9 cm/s; this means that 10 000 or so observations, each with 1 m/s velocity precision, of a Sun-like star over a few years might suffice to detect an Earth-like planet in a 1 A.U. orbit.



Comet McNaught from Mt John Observatory, January 2007. Image Credit: Fraser Gunn.

Pressing problems

There are big issues at Mt John still to tackle. One is ensuring a steady flow of keen young students who will do their training and research at our telescopes. Another is keeping light pollution in check. We still have some of the world's darkest and least polluted skies, but the nearby Tekapo village is expanding. Our lighting ordinance came into force in 1981, but we still have to be vigilant. And thirdly, there's the ever present problem of funding. Astronomy is expensive and running telescopes at a remote site with four resident technical staff consumes our resources. Finding ways to support Mt John financially will be a challenge for the future.

This feature article was written as part of the Cosmic Diary Cornerstone project for the International Year of Astronomy 2009. To find out more, check out www.cosmicdiary.org and www.astronomy2009.org.