

CAASTRO Newsletter Edition 9, December 2013



Introduction from CAASTRO Director

There have been many highlights to 2013 for CAASTRO. Most recent and most prominent has been our <u>annual retreat</u>, which we held last month in Torquay, Victoria. This was a spectacular success, featuring almost 90 staff and students, numerous international visitors, <u>a large number of excellent</u> <u>science presentations and discussions</u>, and a tightly contested <u>golf-cart rally</u>.

The science results continue to flow, with <u>more than 50 CAASTRO papers published</u> in 2013 and a lot more new results in the pipeline. Check out our <u>news stories</u> and <u>latest papers</u> to learn about some of our recent discoveries. We also will be greatly expanding our research capacity in 2014, with appointments of a dozen new postdoc positions now underway. This will allow us to maintain our momentum on projects such as <u>MWA</u> and <u>SAMI</u> while we also ramp up in new topics such as intensity mapping, fast radio bursts, and the <u>OzDES</u> survey.

There have been some important recent additions and changes to CAASTRO. First, it gives me great pleasure to welcome <u>The University of Queensland</u> as our seventh node. UQ bring important new capacity to CAASTRO in all three of our research themes, especially in the area of theoretical cosmology that is becoming a growing part of our efforts. UQ's <u>Tamara Davis</u> has been a member of CAASTRO since inception, but now becomes a CAASTRO Chief Investigator.

Meanwhile, our "Dark Lord" Brian Schmidt has agreed to take on an important new role within CAASTRO as Chair of CAASTRO's new gender action committee. I am very appreciative of all Brian's efforts to ensure that the research within our "Dark Universe" theme is internationally competitive, and look forward to working with him in his new role. Correspondingly, Tamara Davis will now join the CAASTRO

executive as the leader of the Dark Universe research theme: please welcome our new "Queen of Darkness"!

We also welcome three new theme scientists, who will assist the theme leaders in managing and overseeing the research activities and strategic plan within each theme. CAASTRO's new theme scientists are <u>Lisa Fogarty</u> (Evolving Universe, U. Sydney), <u>André Offringa</u> (Dynamic Universe, ANU) and <u>Michael Childress</u> (Dark Universe, ANU) - they are keen to find out what people have been up to, so CAASTRO members can all expect emails and phone calls from them soon. I offer huge thanks to our three outgoing theme scientists, Emil Lenc (Evolving), Steve Tremblay (Dynamic) and Chris Springob (ICRAR/UWA), who all took on these roles with enthusiasm and professionalism.

I offer my best wishes for a restful holiday break to the entire CAASTRO team and to our many partners and collaborators. We will be undertaking some exciting new initiatives in 2014 - I look forward to seeing these take shape.

Bryan Gaensler CAASTRO Director

RESEARCH UPDATE

Prospects for the Detection of Fast Radio Bursts with the MWA

Fast Radio Bursts (FRBs) are bursts of radiation observed at radio frequencies that last only a few milliseconds. The physical mechanisms for generating FRBs are unclear, but there are a lot of intriguing suggestions. What is clear is that these are very energetic events, and their short durations suggest that these are the hallmark of extreme events in the Universe, e.g. collapses, explosions, or collisions involving compact objects.

The frequency-dependence of the pulse arrival time suggests that FRBs are extragalactic, prompting a flurry of theoretical discussion about the potential sources of these highly-energetic events. After <u>the discovery of four FRBs</u> with the Parkes radio telescope (by a large team including members of CAASTRO), Curtin University's Cathryn Trott, Steven Tingay and Randall Wayth <u>have published a paper</u> predicting the rate of FRB detections for the Murchison Widefield Array (MWA). The MWA's low radio frequencies and large number of small antennas allows it to monitor a huge fraction of the sky; the MWA is thus an excellent instrument to survey the Universe for FRBs, with the expectation of several events per month. Crucially, because the MWA is an array of antennas and not a single dish, it has the ability to accurately localise any detections. This will in turn provide key information on the host galaxies, origins and nature of FRBs.

In just its first few months of observing, the MWA has the potential to provide the first census of this new and exciting population. Conversely, if the MWA fails to detect the expected number of FRBs, this will place strong constraints on the underlying source population, informing our knowledge of the progenitors of these energetic events.

Expected number of detections per day per z=0.01 redshift bin for the MWA, using an incoherent combination of signals from each of the 128 tiles. Rates are shown for three values of the source spectral index, alpha.



Two Populations of Gamma-ray Burst Radio Afterglows

Massive stars undergoing core collapse will sometimes create powerful bursts of gamma-rays. These gamma-ray bursts (GRBs) are some of the most powerful explosions in the universe. After the short lived burst of gamma-rays, there is typically a longer lived X-ray and optical afterglow that can last for a few hours to a few days, followed by a radio afterglow that can last for months after the burst. The X-ray and optical afterglows are routinely detected with space based X-ray telescopes (95% detection rate), and ground based optical telescopes (70% detection rate). However, radio afterglows are detected only about 30% of the time. The cause of this low radio detection rate has previously been attributed to limited observing sensitivity. Paul Hancock, Tara Murphy and Bryan Gaensler have used a stacking process to test this idea, and conclude that the low detection rate is instead due to two intrinsically different populations of GRBs: radio-bright and radio faint. They show that the radio-bright GRBs are also brighter in the gamma-ray, X-ray and optical wave bands, confirming the existence of two physically distinct populations. Hancock et al. suggest that the cause of the difference between the two populations is the efficiency with which a GRB produces gamma-rays, with more efficient gamma-ray production leaving less energy for the production of an X-ray, optical and radio afterglow. Future observations will detect a greater number of radio bright GRBs but will not detect radio afterglows from more than 70% of detected GRBs. The existence of radio-faint GRBs hints at a population of relativistic supernovae that bridge the gap between the most energetic supernovae and the lowest luminosity GRBs. Future radio and optical surveys should be able to detect these supernovae, leading to a better understanding of both supernovae and GRBs.

The Giant Lobes of Centaurus A Observed at 118 MHz with the Murchison Widefield Array

CAASTRO PhD student Benjamin McKinley and collaborators <u>have published widefield</u> <u>observations of our nearest neighbouring radio galaxy Centaurus A</u> at low radio frequencies with the Murchison Widefield Array 32-tile prototype. They found that the structure of this source at 118 MHz matches closely with previously published higherfrequency maps, apart from an extra peak in the southern lobe at 118 MHz. This extra peak provides tentative evidence for the existence of a southern counterpart to the wellknown northern middle lobe of Centaurus A. They also conducted a detailed analysis of the spectral behaviour of Centaurus A's giant radio lobes and found significant spatial variation of the spectra across the extent of each lobe. Both the spatially-changing spectral behaviour and the morphology at low radio frequencies support a scenario of



multiple outbursts of activity from the active galactic nucleus of the host galaxy NGC 5128.

Centaurus A at 118 MHz with the MWA (greyscale and red contours), overlaid with the smoothed 1.4 GHz Parkes image. Negative contours are shown in a lighter shade.

CAASTRO OUTREACH PROGRAM

On the 18 October 2014, we took <u>CAASTRO in the Classroom</u> into Chinese schools! Organised by Fang Yuan (ANU), Jamie Farnes (USyd), Shane O'Sullivan (USyd), and Xiaohui Sun (USyd), it was a great success. In this one hour session, we reached students and teachers from Beijing Huijia Private School, Hangzhou Senior High School, and Akesu High School in Xinjiang province, northwestern China, who were excited to learn about Cosmic Engines in the Early Universe.





Students participating in CAASTRO in the Classroom from Akesu High School, Xinjiang province

For National Science Week (10-18 August 2013), we partnered up with the popular science news website <u>ScienceAlert</u> to host <u>"Memes, blogs and videos: how social</u> <u>media has transformed the way we communicate science"</u> – an expert panel discussion in Canberra with Henry Reich (<u>MinutePhysics</u>), Phil Plait (<u>Bad</u> <u>Astronomy</u>), Chris Cassella (<u>ScienceAlert</u>), Elise Andrew (<u>I F***ing Love Science</u>),

Destin Sandlin (<u>SmarterEveryDay</u>), and Gregory Brown and Mitchell Moffit (<u>AsapSCIENCE</u>).

The first Science Education research thesis in CAASTRO was submitted in early November by Honours student <u>Hannah Feldman</u> at Curtin University, under the supervision of the CAASTRO Education & Outreach team Wiebke Ebeling and Steven Tingay. Hannah's <u>"Hands-on Teaching Tool"</u> uses the MWA to communicate wave physics and interference to high school students.

In the lead-up to the CAASTRO Annual Retreat, we offered a full-day workshop on "Writing clear science for grant and job applications" for our students and early career researchers.



CAASTRO Education & Outreach Honours student Hannah Feldman, testing her "MWA Teaching Tool" at the Curtin Institute of Radio Astronomy, Perth

Telescopes in Schools Astrophotography Competition

CAASTRO is a proud supporter of Melbourne's <u>Telescopes in Schools</u> program. This year, the program featured an astrophotography competition. The Melbourne Planetarium at Scienceworks in Melbourne hosted the Award Ceremony on 26 Oct 2013 and is exhibiting the prize winning images for the next few months. The category awards were sponsored by CAASTRO and each winner received a book on astronomy or astrophotography. The student prize was won by Madhooshi Senarath from Pascoe Vale Girls College, while the overall prize was awarded to Louise Ankers, a physics teacher also from Pascoe Vale Girls College.







A selection of student photos from the exhibition; for more <u>click here</u>.

MEMBERSHIP UPDATE

CAASTRO now has 148 members. We welcome our latest team members: Dr Holger Baumgardt, University of Queensland Ms Manisha Caleb, Australian National University Dr Weiguang Cui, ICRAR University of Western Australia Dr Jason Dossett, University of Queensland Prof Michael Drinkwater, University of Queensland Mr Fabian Jankowski, Swinburne University of Technology Dr Simon Johnston, CSIRO Dr Anna Kapińska, ICRAR University of Western Australia Dr Evan Keane, Swinburne University of Technology Ms Sarah Leslie, University of Sydney Ms Aina Musaeva, University of Sydney Dr Richard Newton, ICRAR University of Western Australia Dr David Parkinson, University of Queensland Ms Clare Peter, ICRAR University of Western Australia Mr Samuel Richards, University of Sydney Dr Signe Remer-Sorenson, University of Oslo Dr Ashley Ruiter, Australian National University Mr Adam Schaefer, University of Sydney Dr Paul Scott-Taylor, ICRAR University of Western Australia Dr Ivo Seitenzahl, Australian National University

CAASTRO MEMBER PROFILES



Dr David Parkinson, University of Queensland Affiliate, Dark Theme

David has worked at UQ since 2010. Following his PhD from the Institute of Cosmology and Gravitation, University of Portsmouth, he was a postdoctoral researcher at the Astronomy Centre, University of Sussex.

David's research is in the area of cosmology, in which he attempts to answer the big questions about how the Universe was created and how it has subsequently evolved into its present form. One of the most important of these questions is the nature of the mysterious "Dark Energy" that is causing the universe to speed up in its expansion. David's speciality is developing theories that might explain this acceleration, such as alternative theories of gravity, and testing them against current observational data.

Ms Clare Peter, University of Western Australia Administrative Officer

Clare joined CAASTRO in August 2013 as an Administrative Officer and provides admin support to the Deputy Director. Clare has 13 years of administrative experience, but many aspects of her role in CAASTRO are unique and challenging, which she is thoroughly enjoying!





Mr Adam Schaefer, University of Sydney PhD Student, Evolving Theme

Adam grew up on a banana farm under the clear skies of Mullumbimby on the far north coast of New South Wales, where he attended Mullumbimby High School. For his undergraduate studies he moved to the University of Sydney to study a Bachelor of Science majoring in physics and mathematics with honours in physics. He is currently enrolled in the postgraduate program at Sydney, where he is studying the



environmental dependencies of spatially resolved star formation in the SAMI galaxy survey under the supervision of Scott Croom and James Allen.

CAASTRO MEMBERS RECOGNISED

Our Director, Professor Bryan Gaensler has won the <u>2013 Scopus Young</u> <u>Researcher Award</u> for the Physical Sciences. The award was presented to him on 13 September 2013 at the Australian Research Management Society conference in Adelaide.

On 13 November Professor Steven Tingay, CAASTRO's Education and Outreach Leader, was awarded the <u>Curtin Vice-Chancellor Award for Excellence & Innovation</u> in Research Development (Paul G Dunn prize).

Upcoming Visitors to CAASTRO

- Ravi Subrahmanyan, RRI, India. Visiting ANU & UWA, Apr 2014, to work on all-sky reionisation experiments
- Julius Donnert, INAF, Italy. Visiting UWA & USyd, Feb/Mar 2014, to work on simulations of the cosmic web

Events and Workshops

The workshop <u>"The Ephemeral Universe with Widefield Low Frequency Arrays"</u> was held in Perth over 12-14 Nov 2013. The meeting attracted 48 participants from around Australia and from the USA, UK and the Netherlands. Three themes emerged from the meeting:

1. The interchange between theory and observations, particularly pertaining to puzzles that have existed since the 1960s and 1970s and which have still not been resolved.

2. The observational properties and reality of fast radio bursts, and the need to explain their various characteristics. There was spirited discussion on the scintillation properties of pulsars off the Galactic plane, which may relate to the Galactic latitude dependence of FRB detections. It became clear that the verification and localisation of FRBs is a pressing issue, and is one that feeds directly into requirements for the SKA.

3. Desirable specifications for SKA1-low as a pulsar and transients detection machine, including discussions on the optimal frequency range, configuration, station size, signal buffer and signal processing chain. The presence of Robert Braun, Andy Faulkner, Peter Hall and Jan Geralt bij de Vaate, and the virtual presence of Rob Fender, all made this discussion worthwhile.

In all, the meeting was extremely lively, with all talks generating a great deal of discussion.



Nearly 90 staff and students attended the third Annual CAASTRO Retreat, held in Torquay, Victoria, over 20-22 Nov 2013. Our international guest speakers were Prof Philipp Podsiadlowski (University of Oxford), Prof Carlton Baugh (Durham University), Dr Claudia Lagos (ESO) and Prof Marc Davis (UC Berkeley).



Participants of the 2013 CAASTRO Annual Retreat in Torquay, Victoria

Upcoming Events

- SkyMapper: Everything you Need to Know to Use the Terabytes, Canberra, 7-9 April 2014 Supernovae in the Local Universe, Coffs Harbour, 11-15 August 2014
 CAASTRO Annual Retreat, south-east Queensland, 19-21 November 2014
 ADASS XV, Sydney, 26-30 Oct 2015

Contributions from CAASTRO members are welcome for future editions; please contact <u>Kylie Williams</u> if you have stories or suggestions. Past editions of the CAASTRO newsletter are available at <u>www.caastro.org/newsletters</u>.