THE UNIVERSITY OF SYDNEY

The Dick Hunstead Fund for Astrophysics

2017 Update

The Dick Hunstead Fund for Astrophysics

"We thank you for your foresight and generosity. The impact of your giving is felt across our University, our state, our nation and indeed, the world. Your gifts are used to fulfil our mission - we are working to resolve some of the most challenging issues of our time, including disease, climate change, and powering the world in years to come."

- Dr Michael Spence AC
Vice-Chancellor and Principal
The University of Sydney

The School of Physics at the University of Sydney.

SIfA - leading the way

The Sydney Institute for Astronomy (SIfA) is a national and international leader in astronomy and astrophysics, dedicated to cutting edge theoretical and observational research.

The critical role SIfA played in the October 2017 discovery of the first gravitational waves, caused by the collision of two neutron stars, is but one exceptional recent example. This important finding was a result of a comprehensive collaboration between the LIGO-Virgo and 70 observatories, the University of Sydney and CAASTRO team - led by SIfA's Professor Tara Murphy. Professor Murphy and her colleagues were the first in the world to confirm the radio waves from the source.

SIfA also has major involvement in several high profile ongoing surveys including the Kepler K2 survey, the Galactic Archaeology (GALAH) survey of a million nearby stars, the SAMI Galaxy Survey, the OzDES galaxy survey, the FLASH survey of radio galaxies as well as the UTMOST survey of fast radio bursts.

Developing and applying new technology for the next generation of instruments and telescopes at its state-of-the-art laboratory facilities (SAIL labs) is an important way SIfA continues to make vital, novel discoveries that improve the world's understanding about the universe we inhabit.

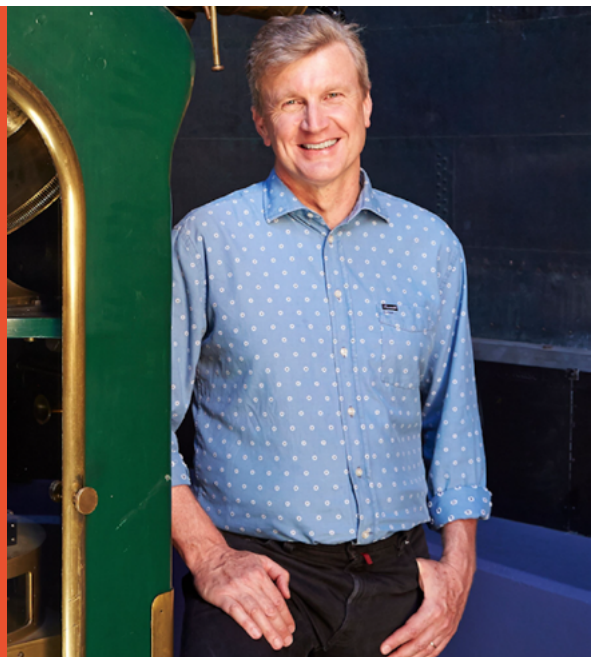
SIfA is currently engaged in developing Hector – an instrument that will build on the success of SAMI – and Praxis, an instrument that will suppress the infrared night sky to allow deep high-redshift observations. The SAIL labs were also the recipient of Breakthrough Funding from Russian physicist Yuri Milner for research and innovation to develop the next generation of small space craft for interplanetary missions.

A leader in big data science and research, SIfA is also committed to excellence in postgraduate training and research-led undergraduate training. However, these and many more achievements would not be possible without the generous support of donors.

Professor and Mrs Hunstead, your contributions towards, and ongoing interest in SIfA research are deeply appreciated. Your generosity has enabled many vital activities in support of talented up-and-coming astronomers. This report is an update on outcomes of the Hunstead Gift over the past year. It is a small way of acknowledging, on behalf of SIfA and the entire University of Sydney community, the importance and impact of your generosity.

"The Hunstead Gift for Astrophysics is an extraordinarily generous fund that has enabled a number of remarkable and high-profile initiatives to take place at the Sydney Institute for Astronomy."

- Professor Joss Bland-Hawthorn
Director
Sydney Institute for Astronomy



Professor Joss Bland-Hawthorn

Program overview

The Hunstead Lecture Series - 2017

The annual Hunstead Lecture Series took place in November 2017 and delivered five lectures over one week on a key astrophysics topic. The lecture attracted a leading international data analyst, Professor David Hogg, to provide PhD and postdoctoral students, as well as past and present members of the School, with fresh insights on how "big data" is being addressed with powerful new software tools.

Heralding from New York University and the recently-formed Flatiron Institute, Professor Hogg is a renowned researcher with specialised interest in observational cosmology, especially approaches that use galaxies to infer the physical properties of the universe.

Professor Hogg also works on models of stars and their spectra, and on exoplanet discovery and characterisation. In all areas, he is interested in developing the data analysis systems that make these projects possible, both for his group and for the astrophysics community as a whole.

As part of the lecture series, Professor Hogg shed light on some big questions in physics such as, "how do you find important patterns in data with many dimensions?"

He also spoke about research and industry, pointing out that many of the developments are emerging from technology breakthroughs at Facebook, Amazon and Google. There was a great deal of interest in this topic, particularly among young researchers, as many are likely to look for long term employment in this sector.

Outcomes

More than 40 PhD and postdoctoral candidates attended the five consecutive lecture series, with some now working in the industry, and some now playing a key role in other University departments. For example, Madhura Killedar is a PhD graduate now employed by the University of Sydney as part of Sydney Informatics Hub.

Video links of all Professor Hogg's talks have been produced and uploaded to the SIfA site, enabling the lectures to be shared to a wider audience. The talks can be found here: http://sydney.edu.au/science/physics/sifa/hunstead-gift-lectures2017_DHogg.shtml

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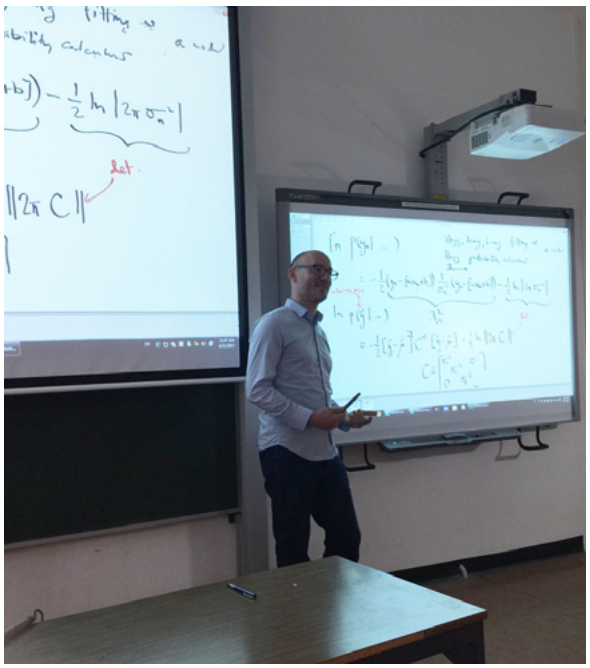


Professor David Hogg delivering the Hunstead Lecture Series in 2017.

Feedback

Participant feedback on the 2017 Hunstead Lecture Series was overwhelmingly positive, as illustrated below.

"I found David's lectures extremely relevant: they covered a topic (machine learning/statistics) that forms the core of my current work - and introduced some new perspectives - so I have direct practical applications, as do my colleagues that attended as well. This lecture series is absolutely important as it provides SIfA researchers an invaluable opportunity to learn from the international community and access a broader area of expertise. There's always more to learn beyond postgraduate study, and a few days of lectures are the ideal format for research academics."

- Madhura Killedar
Research Engineer, Sydney Informatics Hub

"The Hunstead Lectures are highly relevant since they allow SIfA people to get in touch with (and have ample time to talk to) high-profile researchers who otherwise would be 'unreachable'. Professor Hogg's lectures were as inspiring as they were useful, since the topics he discussed are applicable to a wide range of problems in and out of astrophysics!"

- Dr Thor Tepper Garcia
5-year Theoretical Research Fellow

"I loved David Hogg's lectures. I found them really helpful and it was interesting seeing a whole new approach and context for data analysis and coding."

- Kathryn Ross
1st year PhD student

"I thought the Hunstead Lectures both this year and last year were excellent. I particularly liked the science versus technical balance and think that should be encouraged in the future."

- Shourya Khanna
2nd year PhD student

"The Hunstead Lectures were an extremely interesting lecture series that explored the many sides of studying astrophysical processes with large data sets. David Hogg had an amazing energetic way of teaching which sparked a lot of interesting discussions, both in real-time with the audience and also during individual meetings afterwards. The lecture series was perfectly balanced between thorough explanations of complex statistical methods and their astrophysical application to Kepler Photometric data and abundance measurement with the Cannon method."

- Dr Jesse van de Sande
5-year SAMI Research Fellow

The Hunstead Visitors Scheme

Since its establishment in 2015, the Hunstead Visitors Scheme has hosted some 13 high profile guests across three days in Sydney. Each guest meets with SIfA students and gives a keynote seminar. In 2017, five international visitors attended.

February
Lars Hernquist (Harvard University)
Next Generation Cosmological Simulations: Galaxy Assembly and Evolution

March
Hans-Walter Rix (Max Planck Institute for Astronomy)
How the Milky Way Shaped Its Disk

August
Garth Illingworth (University of California, Santa Cruz)
Galaxies at Cosmic Dawn: Exploring the First Billion Years with Hubble and Spitzer. Implications for JWST

November
Raffaella Morganti (Netherlands Institute for Radio Astronomy)
The Life Cycle of Radio Galaxies

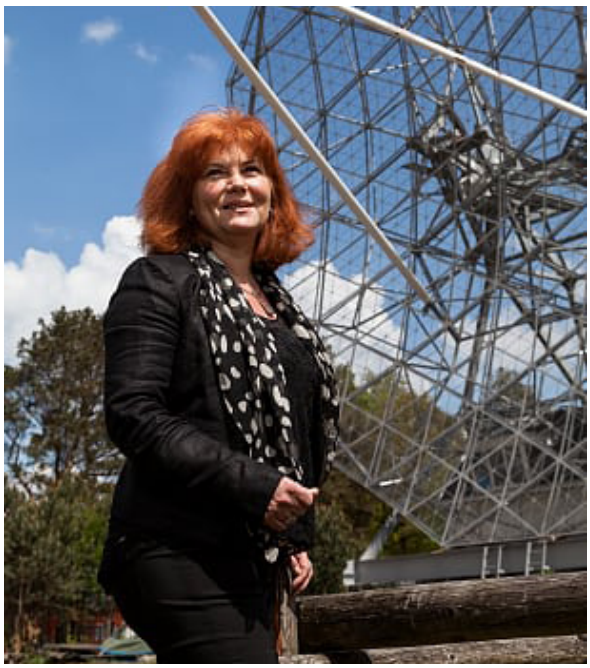
December
Alice Quillen (University of Rochester)
Visco-elastic Interactions and Exoplanets

Enduring relevance: Visitors Scheme

Participating in the scheme in August this year, world renowned Australian astronomer, Garth Illingworth, comments on the importance of this annual event:

"One of the most challenging aspects of running an active university department is to support an active visitors program. It can be extremely hard to find the needed funding. Yet the returns from a visitor program are extraordinarily valuable for students, postdocs and faculty. The Hunstead Visitors Scheme is a wonderful asset for the astrophysics program at the University of Sydney. I was personally helped by the support of the program in my visit to the department. I greatly appreciated the support from Dick and Penny."

- Professor Garth Illingworth
University of California, Santa Cruz



Raffaella Morganti participated in the 2017 Hunstead Visitors Scheme.

Dr Jesse van de Sande, 5-year SAMI Research Fellow, was part of a team that organised a mini-workshop for Professor Illingworth as part of the scheme. He shares his insight into the experience below.

"We organised a mini-workshop for our Hunstead visitor, Garth Illingworth, where we highlighted the latest results coming out of the SAMI Galaxy Survey.

It was great to share our work with a high-redshift galaxy expert, who has extensive experience with the Hubble Space Telescope and the James Webb Space Telescope. The meeting was a great success and exposed high-quality Australian science to a leading figure in the American astronomical society."

- Dr Jesse van de Sande
5-year SAMI Research Fellow

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The Hunstead Merit Award for Astrophysics

The *Hunstead Merit Award for Astrophysics* was established in 2015 to provide a top-up (valued at $5,000 per year for three years) to PhD students enrolling at SIfA.

Aiming to attract top students to undertake cutting-edge research, the award is available to students who did not undertake their undergraduate studies at the University of Sydney.

A maximum of two awards are made annually with the key criteria based on merit. One award each year is reserved for women and other underrepresented groups within the astronomical community.

Award outcomes

The inaugural recipient of the *Hunstead Merit Award for Astrophysics* in 2017 was Harry (Hao) Qiu.

Harry finished a Bachelor of Science in Astronomy at China's Nanjing University midway through 2017. His undergraduate research project focused on searching X-ray astrophysical transients in the XMM-Newton X-ray Catalogue. He discovered a rare Symbiotic X-ray binary - the results being published in the well-known international journal, *The Astrophysical Journal*. He also received a university first grade thesis award for this work.

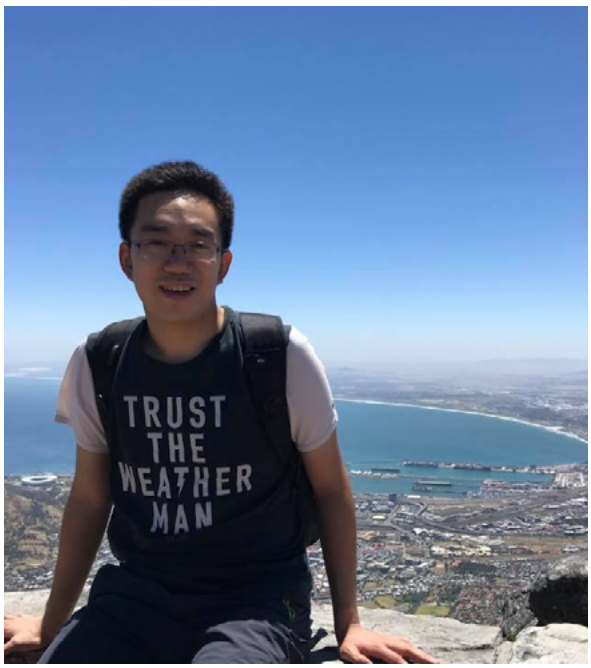
After visiting Sydney during a vacation research exchange program run by the University of Sydney's School of Physics in 2016, Harry became interested in SIfA research.

His current project, exploring the dynamic radio sky with ASKAP, is focused broadly on radio transients and is supervised by SIfA's Professor Tara Murphy.

Words of gratitude - Harry Qiu

Harry has provided the following message of thanks for your generous support of his research.

"I have been interested in space since a very young age. I spent my early childhood in Adelaide, where I began watching Star Trek video tapes from the state library at the age of four. My father also had the chance to visit NASA's space centre in Florida, bringing back a set of Apollo 11 models. I was very inspired by fellow Adelaide-born astronaut, Andy Thomas, and this inspiration gave me huge excitement and a hunger to learn more about the universe.



Harry Qiu

I moved to Nanjing with my parents when I was eight and continued my education there. Nanjing is home to the Purple Mountain Observatory – the oldest national astronomical observatory in China, as well as Nanjing University, which has one of the most prestigious Astronomy departments in the country. I took the opportunity to study astronomy at Nanjing University and started my journey in astrophysics.

The title for my thesis itself is very broad, aiming at radio transients, an exciting field in radio astrophysics. At the moment, our project is focusing on using the Australian Square Kilometre Array Pathfinder (ASKAP) to study a specific kind of radio transient event known as fast radio bursts (FRBs). These bursts are energetic events occurring throughout the universe. Around 25 FRBs have been officially recorded since the first discovery ten years ago, with the Parkes radio telescope discovering most of them. I have had a long-time interest in FRBs since I visited the Parkes radio telescope four years ago, when they detected a FRB just before my visit.

Professor Tara Murphy told me about this project around June 2017, and I was very excited to join the team! ASKAP is a survey telescope with huge observing efficiency, and we have been able to find so many FRBs in our first year – outperforming every other telescope in detection rate. The main problem we are trying to tackle right now is to improve the ability of real-time detection accuracy, which will enable us to catch FRBs right after they appear, allowing us to perform even more detailed observations.

Our final aim is to get a good localisation of the burst, so we can pinpoint where the event is occurring and follow up with other telescopes to further study this kind of phenomena. This is a completely new field in radio transients, and we still know so little about these energetic bursts.

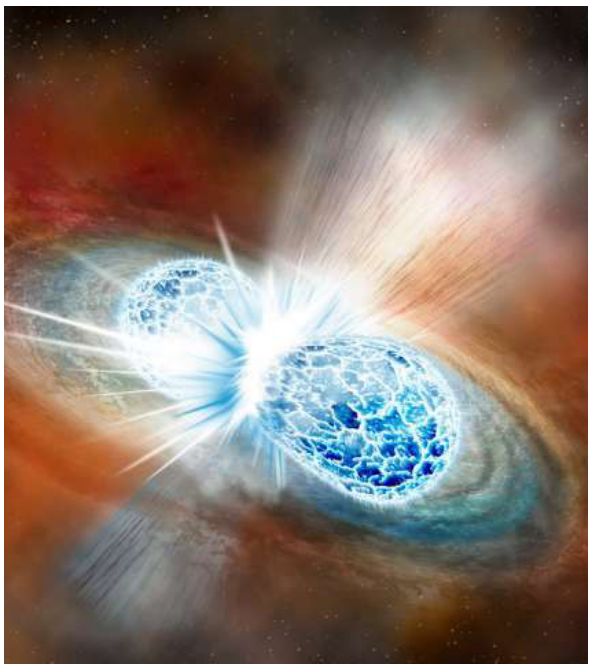
Moving to Sydney was hard in many ways – especially finding affordable accommodation! The support from the *Hunstead Merit Award for Astrophysics* has relieved some of the pressure. It will definitely make life easier for students like me that are not from Sydney. I will be able to afford accommodation and have a substantial amount of money left for my living costs.

By receiving support from the award, I was able to arrange my living needs and focus solely on my studies. This award is a great encouragement and recognition for my previous research achievements.

I expect to continue my studies in astrophysics and hopefully become a leader in my field. I would also like to pass down the support provided to me by the amazing people from the School of Physics such as Dick Hunstead, Tim Bedding, Tara Murphy and Joss Bland-Hawthorn, so we can continue to provide help and inspire future students interested in astronomy and physics.

Finally, I would just like to thank Professor Dick Hunstead for this amazing contribution to the School of Physics. Dick is an amazing astronomer and a wise mentor. I have heard about how different it was decades ago when he first started research. His support makes me cherish the research environment I have today. It motivates me to dig deeper to make an impact in astrophysics and aim to inspire and support future generations with their research.

Thank you once again."



In October 2017, SIfA played a critical role in discovering the first gravitational waves, caused by the collision of two neutron stars (image source: phys.org)

The Hunstead Summer Scholarships in Astronomy

Andrew Curzons - recipient update

The 2016 *Hunstead Summer Scholarship in Astronomy* was awarded to Andrew Curzons from the University of Adelaide. Below, Andrew shares what the scholarship has meant, and his current PhD research direction.

"Receiving the *Hunstead Summer Scholarship in Astronomy* was a great honour. It felt like the hard work I had put in during my undergraduate degree had been recognised and paid off. The scholarship enabled me to travel to a new city and live comfortably while undertaking my research project over the summer. If it weren't for this support, I wouldn't have had the experience I did at the University of Sydney.

I was also fortunate enough to work with Professor Joss Bland-Hawthorn. Joss led me in a project which involved modelling the optical emission from the Magellanic Stream – a huge arc of gas that extends over a large portion of the sky. Our work involved ruling out potential sources of this emission as they were too weak, and concluding the best explanation was the centre of the galaxy went through an active period sometime in the past.

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This active period would have likely involved a cone-shaped ejection of high energy particles from the galactic centre, directed towards the Magellanic Stream. These high-energy particles would have then interacted with the gas in the stream and caused the emission we see.

Although I have not continued this work with Joss, I was included as a co-author on two papers in *Astrophysical Journal* and gained many important skills that continue to be useful through the scholarship opportunity. I was introduced to what research actually involves; reading papers, making models and testing whether they fit observations. Most of all, my time as part of the *Hunstead Summer Scholarship in Astronomy* introduced me to the important skill of coding, particularly in the language Python.

My current research project at the University of Adelaide involves modelling the diffusion of high-energy particles from supernovas and the processes these particles undergo when they interact with gas to produce radiation across the whole electromagnetic spectrum. This is heavily programming based, so my time learning Python was of the highest assistance.

I would like to sincerely thank Dick and Penny Hunstead for their generosity in making this scholarship opportunity possible."

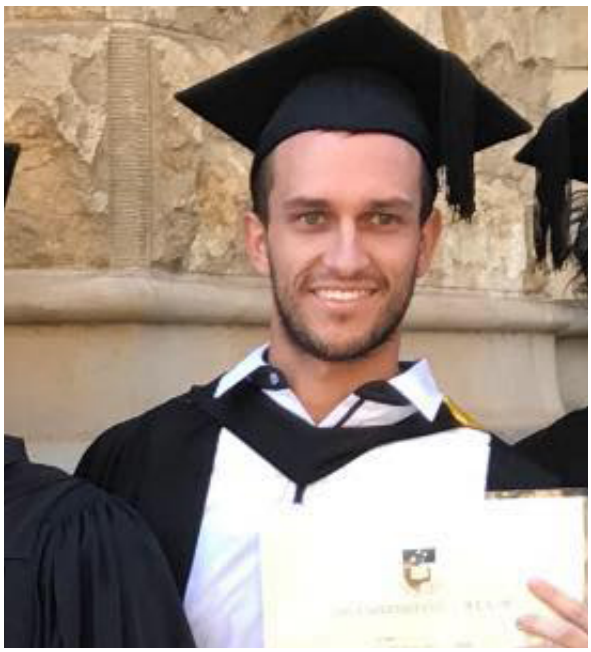
The Hunstead Workshop

In 2017, the Hunstead Workshop ran on 4 and 5 December. The theme was physical processes that take place within galaxies. The workshop involved 40 talented scientists across Australia as well as four visiting international professors including;

- Raffaela Morganti (Netherlands Institute for Radio Astronomy)
- Lars Hernquist (Harvard University)
- Alice Quillen (University of Rochester)
- Vardha Bennert (California Polytechnic State University)

Graduate students were are also invited to attend, giving them a chance to interact with more established scientists. The meeting concentrated on the big surveys led by Australians and their instruments, with one third of the guest speakers from the University of Sydney, and a third of these female.

The Hunstead Workshop in 2018 will be led by the Australian National University's Simon Murphy - SkyMapper Postdoctoral Fellow.



Andrew Curzons

Feedback

The Hunstead Workshop received extremely positive feedback. Below are selected highlights from participants' comments.

"I thought the workshop was great! As there were a number of international experts visiting, it was great to get people from across the country together to discuss recent results and showcase some of the work we're doing here. It was also immensely useful that there was funding available to have Professor Raffaella Morganti over for a visit. We had a very productive few days and made a lot of progress on a number of papers and projects we're working on together."

- Dr Elizabeth Mahoney
DECRA Fellow

"The event was an impressive line-up of speakers, most of which are at the top of their respective field which is not common for 'small' meetings like this. I'd suggest that next time we have a more guided discussion, similar to what you did at our gas accretion workshop. I think it is a great idea if the meeting ends with pointers to what the open questions are, and which problems might be worth addressing first."

- Dr Thor Tepper-Garcia
5-year Theoretical Research Fellow

"The Hunstead Workshop had an ideal mix of observers and simulators who all aim at connecting Milky Way results to extragalactic galaxies at different wavelengths. I had numerous fruitful discussions with the workshop participants that led, amongst other things, to a collaboration on a project comparing simulations and observations with Professor Lars Hernquist from Harvard Unversity."

- Dr Jesse van de Sande
5-year SAMI Research Fellow

"I think it was really helpful having such a casual setting where everyone was open to discuss the talks. I really enjoyed the whole program. It was useful meeting other researchers in different areas but with similar interests and being exposed to new concepts that I wouldn't normally get."

- Kathryn Ross
1st year PhD student

"The workshop served as a nice interdisciplinary review of galaxies and I enjoyed that very much."

- Shourya Khanna
2nd year PhD student

Other activities supported by your gift

Conferences

The fund provides vital support for a range of other activities in the field of astrophysics, including participation in conferences across Australia.

The support for conferences typically enables a SIfA representative to be on the Science Organising Committee plus another representative at the meeting.

This year, the fund supported three meetings across Australia - the Dark Energy Survey meeting chaired by Dr Chris Lidman (held in Brisbane in November 2017) as well as meetings at the Australian National University and Macquarie University.

The Hunstead Gift also provides support for people who fall on hard times or face challenges in furthering their studies. For example, in 2017 the support was used to assist Aina Musaeva, a single parent, during the write-up phase of her PhD research.

Industry workshop

A special workshop on public speaking led by ASTRO-3D research fellow, Caroline Foster, will be held in early 2018 in place of the Early Career Researcher workshop, which ran in 2016 but not 2017. Planning work for the event is already underway.

Words of thanks: Professor Joss Bland-Hawthorn

"The past year has been a particularly pivotal period for the Hunstead Fund. For the first time, and in a strong show of support, senior scientists have contacted SIfA in relation to various Hunstead events and programs – requesting to be invited or to participate.

The funding has also enabled some key events in SIfA's calendar year – notably the 2017 Hunstead Lecture Series delivered by Professor David Hogg and the 2017 Hunstead Workshop on Galaxian Processes, honouring four visiting senior international professors (Vardha Bennert, Lars Hernquist, Raffaela Morganti, Alice Quillen).

These and other programs will continue to be developed further in future years, but already they have had an enduring and positive impact on SIfA, for which we are profoundly grateful."

Thank you

Professor and Mrs Hunstead, on behalf of the School of Physics and the entire University of Sydney community, thank you once again for your foresight, partnership, and support.

We look forward to continuing to work together and to providing you updates on future SIfA initiatives and achievements made possible by your generosity and philanthropic vision.

For more information
Julia Tauber | Director of Development
Division of Alumni & Development
T +61 2 9351 1907 | **E** julia.tauber@sydney.edu.au
sydney.edu.au

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