# Fellows at ESO

## Katharina Immer

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I do not exactly know when I started to be interested in astronomy. For as long as I can remember, I have watched the night sky and the beautiful coloured images of astronomical objects from the Hubble Space Telescope and other telescopes. When I was a teenager, I got a little reflecting telescope with which I observed stars and the Moon.

In high school, I was particularly interested in physics and mathematics and thus it was a natural step to decide to study physics at the University of Bonn. Since I already knew at that time that I wanted to be an astrophysicist at the end of my studies, I chose astronomy as my minor subject. The introduction to Galactic astronomy, as well as lectures about microquasars and the interstellar medium, were particularly interesting. During my studies, I had several opportunities to visit the 100-metre radio telescope in Effelsberg. Standing in front of this huge telescope was very impressive. Since this telescope operates in the radio wavelength regime, it can even observe through heavy clouds and rain.

In 2008, I started my Diploma thesis at the Max Planck Institute for Radio Astronomy (MPIfR) in Bonn, one of the hubs of radio astronomy in Germany. I worked with Karl Menten on Very Large Array (VLA) observations of the dust ridge clouds in the Galactic Centre in the search for H II regions and thus ongoing star formation in these clouds. Since we did not find any radio sources in the clouds, we could exclude the existence of stars with spectral types earlier than B0.5. I also worked on data from the infrared spectrograph onboard the Spitzer Space Telescope with Frederic Schuller. From the slope of the spectra and the detected emission lines, we sorted the observed sources into young stellar objects and late-type evolved stars. By the end, we could derive a star formation rate for the Galactic Centre.

For my PhD, I decided to stay in Karl Menten's group in Bonn. In 2010, I went for a year to the Harvard–Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts, as a predoctoral fellow to work with Mark Reid on VLA observations of DR21 and Submillimeter Array observations of W33. In addition, I am part of the Bar and Spiral Structure Legacy Survey, led by Mark Reid, which determines the trigonometric parallaxes of star-forming regions in the Milky Way. That year was one of the best of my life, learning a lot about interferometry, submillimetre and radio observations, as well as high-mass star formation, meeting some of my closest collaborators and friends, as well as my boyfriend, travelling along the East coast of the US and having a wonderful time.

After I moved back to Bonn, I became one of the visiting observers for the Atacama Pathfinder Experiment (APEX) telescope in Chile. During my time at the MPIfR, I went to APEX for four runs. Here, I learned how to observe with a single dish telescope and gained insights into all kinds of science projects that were conducted with this telescope. The experience that I gained helped me to improve my observing proposals significantly.

After finishing my PhD in 2013 and a short-term postdoc at the MPIfR, I started at ESO in Chile in 2014. I decided to come to ESO because I liked the duty and science combination of the fellowship. Since I wanted to stay in contact with APEX, but also get to know the Atacama Large Millimeter/submillimeter Array (ALMA), I chose the commissioning and Science Verification of the Band 5 receivers at both APEX and ALMA as my duties. This is a very interesting project, giving me insights into the workings of a new instrument and the different problems and quirks that come with it at the beginning. The Science Verification of these receivers brought me into contact with cutting-edge science in very different astronomical fields, from star formation to evolved stars to extragalactic projects, and I learnt a lot about many topics outside of my own field. I am now also involved in the ongoing commissioning and Science Verification for the Band 9 receiver at APEX.

For my science, I am still mostly focused on high-mass star formation, trying to understand the chemical evolution of the molecular clouds during the star formation process as well as the kinematics in the clouds. While I have started several projects with colleagues within the star formation group, the multi-science environment at ESO also sparked new ideas and collaborations outside of my field of expertise, which is both challenging but rewarding.

I am looking forward to continuing with research on high-mass star formation and the work with submillimetre and radio telescopes of this and future generations like APEX, ALMA, the Jansky Very Large Array (VLA), or the Square Kilometer Array (SKA), during my remaining time at ESO as well as in future positions during my career.

Evelyn Johnston

## Evelyn Johnston

I was always interested in science as a child, but growing up in Belfast in Northern Ireland, with the light pollution and regular wet and cloudy weather, meant that I was lucky to see any stars at night. But when we went on holiday and found clear, dark skies, I would often be amazed at the number of stars that would appear. I loved trying to identify new constellations, looking at the planets through binoculars, and wondering what else was out there that I couldn't see. As early as nursery school, my favourite song was "Twinkle twinkle little star", although it was only later, when a teacher told us that the Sun is a star, that I started to really wonder about the Universe.

I never really considered astronomy as a potential career until I started university, but I did know as a teenager that I wanted to go to university and become a scientist. At college I met very enthusiastic physics and maths teachers who picked up on my interest and helped me widen my knowledge beyond simply what I needed to know to pass my exams. Maybe it helped that, during those years, I skipped classes to watch two partial solar eclipses with my teachers, and ended up explaining what was happening to the crowds of interested students who joined us.

I moved to Sheffield in England to do a degree in Physics and Astronomy. During those years, my interest in astronomy grew, and for my Masters year I was lucky enough to be offered the chance to carry out my research project while working as a student support astronomer at the Isaac Newton Telescope (INT) in La Palma. This position gave me my first opportunity to experience life as an astronomer at an observatory, and while the job was hard, I thoroughly enjoyed the experience. The INT is a rather hands-on telescope, where visitors have to do everything themselves, including refilling the cryostats, pointing the telescope, opening and closing the dome, etc. As a result, it gave me a real feel for how astronomical observations are really carried out, the preparation that has to go into planning the night, and a true appreciation of the work by the whole observatory team to build and maintain the precision of such impressive machinery.

My experience in La Palma convinced me to do a PhD in astronomy, so I returned to the UK for my PhD at the University of Nottingham on how the star formation in spiral galaxies shuts off to transform them into lenticulars. I quickly became interested in understanding the star formation histories within different components, such as bulges and discs, and the role those structures play in the evolution of the galaxy as a whole. As part of my PhD, I developed a technique to apply bulge–disc decomposition to long-slit spectra along the major axis of a galaxy in order to separate the spectra of these two components. From their independent spectra, I was able to study their individual stellar populations and star formation histories.

I found that the lenticular galaxies in the Virgo and Fornax clusters experienced a final episode of star formation within the bulge region once the discs had already started fading. These young stellar populations within the bulge region suggest that at some point during the transformation, small amounts of gas were funnelled into the inner regions of the galaxy, where the gas eventually became dense enough to trigger a final episode of star formation. I am now working to further develop my spectroscopic bulge–disc decomposition technique to apply it to integral field unit (IFU) datacubes to make full use of the spectral and spatial information. I hope to be able to determine whether this final central episode of star formation activity occurs throughout the bulge or only at the centre of the disc, and which processes are most likely to trigger it and the dependence on environment.

During my PhD I only had one opportunity to go observing, since all the data I needed had already been collected. During that time, I found that I missed the observing side of astronomy and wanted the opportunity to experience a new culture again. So, after my PhD, I moved to ESO in Chile, and now have duties on Unit Telescopes 1 and 4, particularly working with the Multi-Unit Spectroscopic Explorer (MUSE). Carrying out observations with IFU spectrographs, such as SINFONI, KMOS and MUSE, helps me better understand the limitations of my own plans with such data. I am enjoying contributing to the running of such a large observatory and learning more about the instrumentation at Paranal from the various specialists I work with there. I also love learning my way around the southern skies when I get a few free minutes to stargaze, and I hope that by the end of my fellowship, my Spanish will be good enough to talk people through the constellations at local outreach events.

## Wolfgang Kerzendorf

I have always been fascinated with science. As a kid in elementary school I was very interested in biology. From experiments with growing tadpoles to

catching various critters in the Mediterranean Sea, I always wanted to know how things work and live. Astronomy was also an early passion of mine. I remember that I was fascinated by the planetarium at the Deutsches Museum in Munich. This must have inspired my parents to Xerox a star map (laser printers didn't exist then) to A3 format at the local library. I cut self-adhesive phosphorescent tape to the different sizes of "stars", representing the different "magnitudes", and this would illuminate my bedroom at night.

During high school I started to become more interested in physics. In particular, I remember one project where our physics teacher built air-pressure powered rockets with plastic soda bottles and we would try to gauge how high things flew. In the later years of high school, I became very interested in computing and helped to set up the computer labs. My *Facharbeit* (end of high school thesis) was a Java program that would calculate and visualise the electric field of a radiating dipole (created with the help of a Professor of Physics in Würzburg).

Despite my strong interest in computing, I wanted to study physics and selected a university in Germany that did active research in astrophysics. Thus, I started studying physics at Heidelberg University in the autumn 2002. My first serious contact with astronomy came with my advanced laboratory course in physics that involved obtaining photometry of a globular cluster and subsequently fitting isochrones. My lab partner and I were one of the few who were actually able to obtain the required photometry on a cold December night. After many nights configuring my computer to run Linux and installing IRAF (a difficult endeavour even in 2004), we were finally able to obtain the photometry with DAOPhot and fitted an isochrone. Despite the rather difficult and arduous nature of this lab, I was excited: finding out the age and distance of a star cluster was definitely a highlight of my undergraduate studies.

After two and a half years of study, I started to be interested in doing a semester abroad. My tutor Rainer Wehrse had his colleague Mike Bessel visiting him and he encouraged me to meet him.

Wolfgang Kerzendorf

Mike suggested contacting a young professor named Brian Schmidt at his home institute, Mount Stromlo Observatory. Brian was very enthusiastic about my applying for a summer scholarship and working with him over three months at the end of 2005. I departed for Australia in December 2005, not knowing that would be the start of a ten-year journey outside Germany.

As my first task, Brian instructed me to work on a tool that would help the observing astronomers at the 2.3-metre telescope in Siding Spring Observatory select the right instrument set-up when a new gamma-ray burst (GRB) alert triggered a Target of Opportunity observation. With my training in physics, I also started attending astronomy courses for the first time and learned about the rather strange units that are commonplace in astrophysics.

After three months, I was still excited about working in astronomy and decided to extend my stay for a further three months. During this time, the then PhD student Anna Frebel told me about an opportunity to switch from a Masters in physics to a PhD in astrophysics at Mt Stromlo Observatory. With the help of Brian, Rainer Wehrse and Penny Sackett (then director of Mt Stromlo Observatory), I applied for a PhD at the Australian National University (the parent university of Mt Stromlo). I started this PhD in February 2007 with Brian as my primary supervisor on Type Ia supernovae.

My main research task was to find surviving companion stars of these objects in ancient supernova remnants. Over the course of my PhD I tried and failed to locate these companions in three different ancient remnants (SN 1006, SN 1572 and SN 1604), thus contributing to an important result — Type Ia supernovae likely work differently than described in current astronomy text books.

For my second project, I tried to automatically fit the spectrum of Type Ia supernovae with a sophisticated radiative transfer code. This technique would allow us to reconstruct the structure of a supernova by analysing subsequent spectra. This meant optimising a function in a high-dimensional and complex search space. After some initial failures using the techniques I was taught in my physics classes, I started working with a friend of mine in computational neurobiology who taught me several nature-inspired optimisation algorithms that are ideally suited for such problems, but rarely used in astrophysics. This collaboration introduced me to the power of interdisciplinary work, that to this day is one the core themes of my research.

After finishing my PhD in the middle of 2011, I started as a postdoc working with Marten van Kerkwijk at the University of Toronto. Marten was not simply a boss, but a mentor who guided my independent research. During this time, I started working on my own radiative transfer code for Type Ia supernovae (having used

someone else's during my PhD). This was the start of the TARDIS collaboration[1] that I am now leading. TARDIS is built to be a modular code that allows us to experiment with different physical approximations, built on modern software development techniques and uniting researchers with very different backgrounds (computer science and statistics), to work on an astrophysical problem. Part of this success was through a programme called the Google Summer of Code that allowed me to recruit smart and enthusiastic undergraduates from several fields of study to work with us for three months.

At the beginning of 2014, I heard the great news that I had been selected for an ESO Fellowship. This would not only allow me to build on my current research, but also start close collaborations with the supernova researchers at ESO. I started my fellowship at the end of 2014 and was very quickly introduced to my duties: testing new algorithms to obtain better results in data processing and analysis.

Now almost one and a half years into my fellowship, I have expanded on my research of analysing Type Ia supernova spectra with several results to be published soon. The ESO Fellowship is an exciting step forward for me in my career and I'm keen to see what the second half of it will bring.

Links

[1] TARDIS spectrum synthesis code: http://tardis.readthedocs.org

# Personnel Movements

Arrivals (1 April–30 June 2016)

| Europe | |
|---|---|
| Bhardwaj, Anupam (IN) | Student |
| Cheffot, Anne-Laure (FR) | Student |
| Palla, Federica (IT) | Assistant to the Data Reduction Manager |
| Puglisi, Annagrazia (IT) | Student |

| Chile | |
|---|---|
| Acuña, Andrea (CL) | Executive Bilingual Secretary |
| Bartlett, Elizabeth (UK) | Fellow |
| Iglesias, Daniela (CL) | Student |
| Pérez Sánchez, Andrés Felipe (CO) | Fellow |
| Sbordone, Luca (IT) | Operation Staff Astronomer |

Departures (1 April–30 June 2016)

| Europe | |
|---|---|
| Grunhut, Jason Harley (CA) | Instrument Scientist |
| Karabal, Muhammet Emin (TR) | Student |
| Noethe, Lothar (DE) | Head of the Optical Engineering Department |

| Chile | |
|---|---|
| Acuña, Margarita (CL) | Administrative Technician |
| Gonzalez, Oscar (CL) | Fellow |
| Marsset, Michaël (FR) | Student |
| Muzic, Koraljka (HR) | Fellow |
| Rodriguez, Paula Valentina (CL) | Team Leader Public Outreach Vitacura |

Image on page 59: Artist's rendering of the design of the telescope and dome of the European Extremely Large Telescope (E-ELT). The ACe Consortium, consisting of Astaldi, Cimolai and the nominated sub-contractor EIE Group, signed a contract with ESO for the construction of the dome and telescope structure on 25 May 2016. See Release eso1617 for more information.