

Excursion to the Observatorio del Roque de los Muchachos, La Palma, October 2016

Report by Manali Jeste and Hannah Zohren

In October 2016, we - that is two PhD students and eight master students of astrophysics from Bonn University - got the chance to accompany our lecturer Dr. Tim Schrabback to an observation session at the William Herschel Telescope (one of the Isaac Newton Group of Telescopes, ING) on La Palma. This took place within the framework of the course Optical Observations held at Bonn University.

The aim of the observations was to confirm candidates for very massive galaxy clusters that have previously been found in observations making use of the Sunyaev-Zel'dovich effect (namely in the Planck SZ2 catalogue). These clusters are expected to be very massive and preselected to be at redshifts above $z > 0.7$. The strategy was then to observe the cluster candidates with three filters (r, i, z) to make sure there is a galaxy cluster indeed and perform long-slit spectroscopy for the measurement of the redshift.

Our course on Optical Observations provided us with important knowledge that helped us to perform these observations at the WHT. One of our tasks in this course was to reduce data that we obtained ourselves by using the 50cm Cassegrain telescope at the AlfA (Argelander Institut für Astronomie). Thus we learned about the need for calibration frames such as BIAS (no exposure time) and FLAT (uniform illumination) frames. In addition, several exposures of the target are taken which are co-added to increase the signal to noise ratio.

Apart from that, we were taught about the physics of galaxy clusters and how it is possible to determine their redshifts. The spectra of galaxies contain characteristic features as for example the 4000Å break that is very prominent in elliptical galaxies. To estimate the redshift one has to determine how far these features are shifted towards redder wavelengths. On the one hand, we were introduced to photometric methods where the redshift is determined from the ratio of fluxes in different filters of a certain wavelength range. On the other hand, a more detailed determination can be performed spectroscopically where the entire spectrum of a galaxy is examined. Of course we also learned about all the components that influence an observation, as for example effects by the atmosphere, the influence of the moon or humidity and wind.

Finally, we got the opportunity to put all the theory we learned to practice. For that, we started the observations at the WHT close to sunset so as to take FLATS observing the twilight sky. The telescope has a primary mirror diameter of 4.2m and can observe at a wide range of wavelengths - from optical to infrared. The FLATS can also be taken during dawn, as long as one gets a uniform background. After a short introduction and instructions from Dr. Cecilia Fariña - our support astronomer - the images were taken. Here we got to control the camera and the telescope dithering. The instrument used was ACAM - the Auxiliary-port CAMera - which is mounted permanently and is important for broad-band and narrow-band imaging and also for low-resolution spectroscopy. The field of view in imaging mode is 8 arcmin and the filters available at ING can be used here. In the meantime, the telescope operator took care of the guiding star and the target was well kept in check. Images were taken in r, i, z bands and dithering was done between exposures. Once a set of exposures was completed, we reduced the data on the fly to get the colour image (which is the combination of all three bands). For all this, a software called THELI was used. We then used the colour image as a help to identify the best position and orientation for the slit to overlap with as many bright cluster galaxies as possible for the following spectroscopic exposure. The arrangement of the slit in the telescope was done by the telescope operator (Fiona Riddick and Berto Gonzalez).

The observation at the WHT was a very valuable experience for us. It gave us the opportunity to work with a big telescope, perform observations of our own and work together with experts that we otherwise would not have met. This includes the telescope operators, our support astronomer and a fellow scientist (Dr. Remco van der Burg) leading this observation run together with our lecturer Dr. Tim Schrabback. We gained insight on what an actual night of observing looks like, what kind of

images can be obtained and how to adjust the plan sometimes quite spontaneously to the conditions at hand. We got the chance to apply our previous knowledge when we operated the telescope and reduced the obtained images on the fly. All this left us with the rewarding feeling of contributing to actual scientific research.

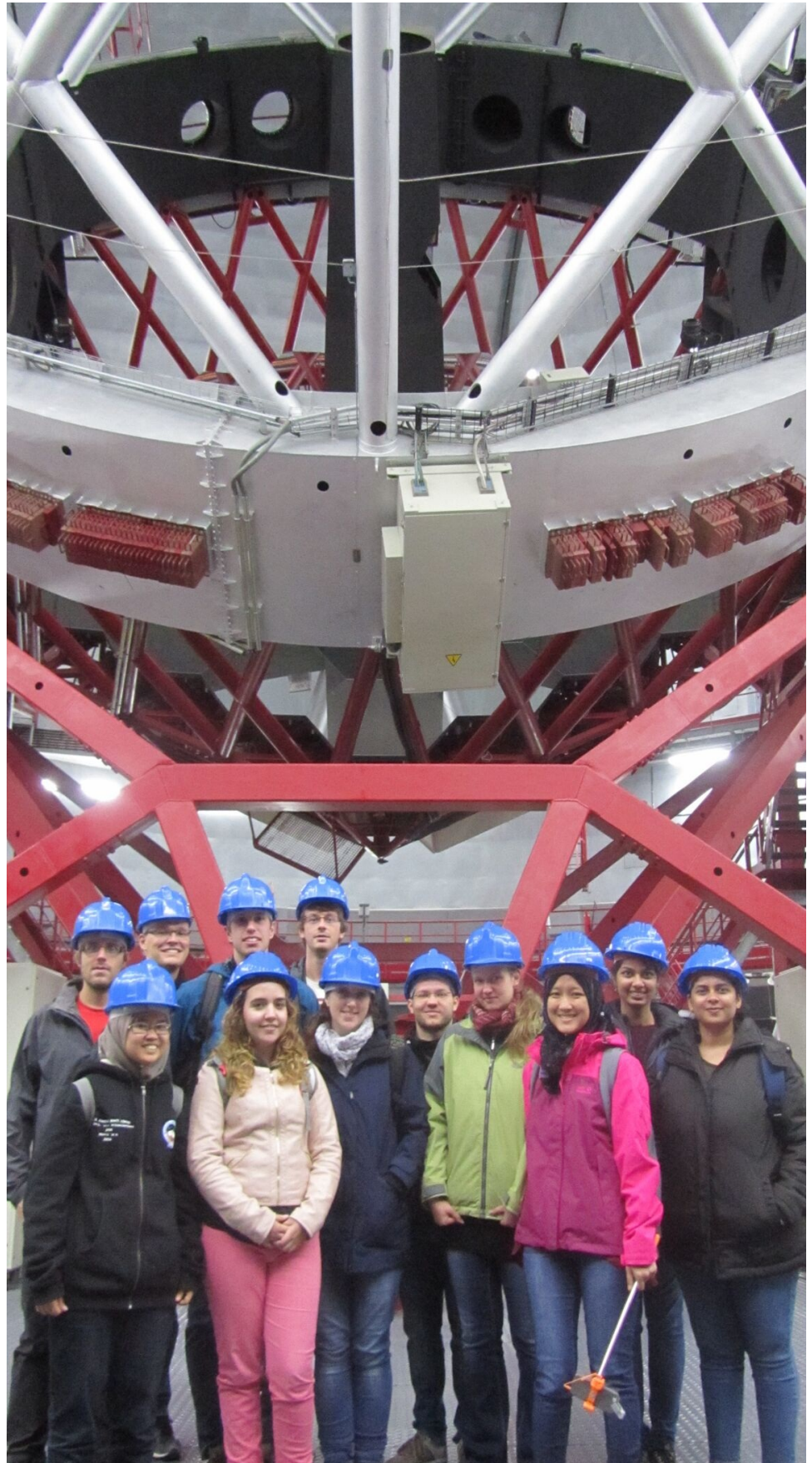
Before the observations, we visited the neighbouring telescopes like the Nordic Telescope and Gran Telescopio Canarias (GTC) where a small introduction of each was given along with an opportunity to see the ongoing observations at night at the GTC. Other than all the work, there is also a lot to explore of the island of course. We visited the Volcano San Antonio where we saw the crater along with relevant geological information as well. Our visit to the island came to a close by enjoying the evening at the beach, relaxing and swimming.

At this point, we want to thank our lecturer Dr. Tim Schrabbach again for making this trip possible. We would also like to thank the Bonn-Cologne Graduate School of Physics and Astronomy for travel support, as well as Bonn University for support via Qualitätsverbesserungsmittel. We hope that many other students will get the opportunity to experience astrophysics as closely as we did.

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Participants and instructors of the excursion at the top of the Roque de los Muchachos. From left to right: Manali Jeste, Dr. Tim Schrabbach, Vyoma Muralidhara, Hannah Zohren, Felix Siebeneicker, Alya Azman, Silvia Nösel, Beatriz Hernandez Martin, Dr. Remco van der Burg, Nils Linz, Jan Luca van den Busch, Fatimah Raihan. The 4.2m William Herschel Telescope (WHT) is visible in the background in the very left (picture credit: Tim Schrabbach).



Participants and instructors of the excursion in front of the central part of the primary mirror of the Gran Telescopio Canarias (picture credit: Manali Jeste).