Ten years of astronomical Field Trips to Tenerife: challenges and rewards

[Short title: UG astronomy from Tenerife]

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Abstract

We describe an unusual undergraduate course that has been running successfully for over 10 years and is built around a 2 week Field Trip to Tenerife. The purpose of the visit is two fold: firstly to spend a week working in collaboration with students from the Universidad de La Laguna and secondly to spend a week at the Observatario del Teide carrying out astronomical observations. This paper is concerned primarily with the second of these two activities.

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1 Introduction

In the late 1980s, at the time Southampton University (SU) was establishing a new Programme of Study, Physics-with-Astronomy, it was felt to be essential to provide the students with detailed practical experience in observational astronomy. The obvious difficulties of scheduling and successfully executing observational work from the UK led to establishment of an annual Field Trip to the Observatario del Teide (OT) at Izana in Tenerife, Spain. This trip was created by, and jointly supported by staff from both Southampton University and the Universidad de La Laguna (ULL) with considerable help from staff at the Instituto de Astrofisica de Canarias (IAC).

This course is intended to:

- Provide students with an opportunity to work in a high quality astronomical environment.

- Permit student to visit professional research facilities.

- Require students to work with other students from another country.

- Promote team-based activities under intensive, time-critical schedules.

The first group of 8 students from SU travelled to ULL and subsequently up to the OT in April 1990. Since then, the course has expanded to allow 12 astronomy students and 12 space science students per year from SU to visit Tenerife every Easter vacation. Both sets of students spend the first week of the two-week visit working jointly with final year astrophysics students from ULL (see Dean & Perez-Fournon 2002 for details). The second week is spent at the OT and is the main subject of this paper. Some of the costs were borne by the EU Erasmus programme for a couple of years, but primarily the majority of the financial support has come from SU, with a modest financial contribution from each student. Considerable assistance in kind has been provided by the ULL and IAC over the 12 years the course has been running.

2 Structure & timetable

The structure of the main component of this course is built around a six night stay at the Observatario del Teide (see Figure 1 and http://www.iac.es/ot/indice.html). This observatory is run by the IAC and consists of a collection of day and night time telescopes, together with a suite of experiments studying the cosmic microwave background. It is located at an altitude of 2400m about 1 hours drive from La Laguna. The altitude has never posed a problem to any person on the Field Trip.

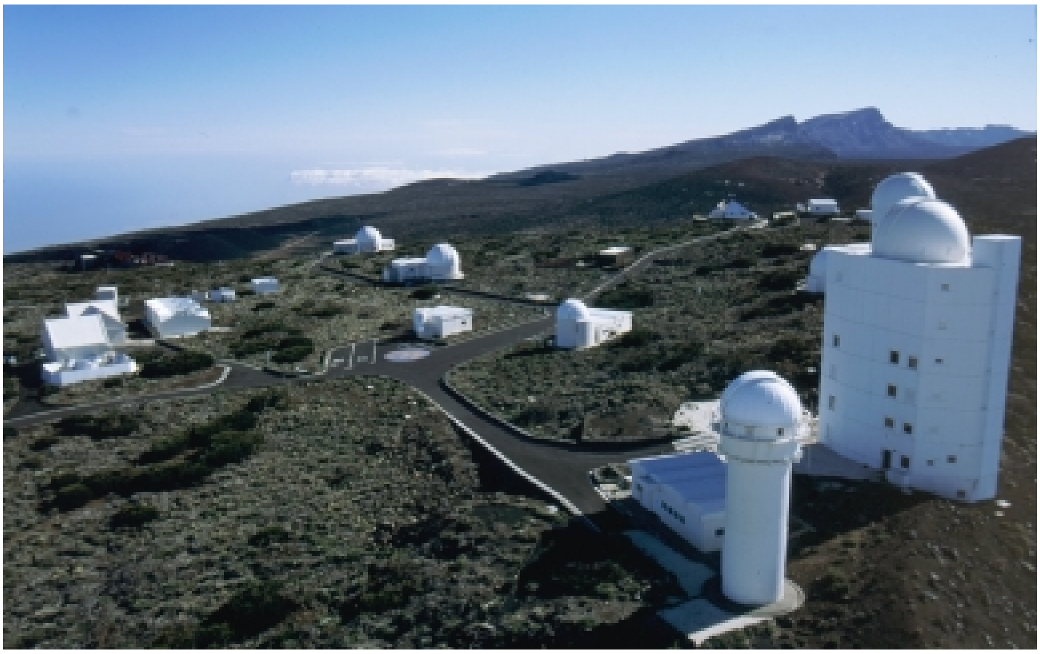

Figure 1: general view of the Observatario del Teide

Accommodation and catering is provided on-site, so the astronomical experience is a total one for the students. The course normally starts by arriving around midday allowing a period of familiarisation in day time before work will begin that night. The evening meal occurs around 7pm and the students are expected to commence work just after sunset i.e. about 8.30pm. Observations will continue, weather permitting, till dawn (around 7am) with a "night lunch" break occurring around 1am. Though the first night is normally particularly challenging as people are adjusting their body clocks to a night time schedule, students and staff quickly settle into an effective routine which will last for all 6 nights.

The students are divided up into groups of 3-4 individuals and will spend a whole night working at one of several observational locations. These locations have varied over the years depending upon astronomical circumstances (availability of comets, planets etc). The following have been, and hopefully will continue to be used:

1. The Mons telescope (see Figure 2 and http://www.iac.es/telescopes/mons.html**)** has provided the core of our programme. This is a 0.5m f/16 Cassegrain system (focal length 750cm) upon which we mount a SBIG ST-6 CCD camera with BVRI Johnson filters. This configuration gives us a field of view of approximately 5 arcmins, a plate scale of ~1 arcsec/pixel and permits observations of both extended objects (e.g. stellar clusters, galaxies & nebulae – see Figures 3 for images taken by students of different kinds of astronomical objects using this facility). The filters permit quantifiable results to be obtained and this is strongly encouraged in general on this course. By using standard Johnson filters the students are able to obtained Hertzsprung-Russell diagrams of open and globular clusters, colour studies of different types of galaxies and compare their results directly with the published literature. In addition to imaging, the system has been used to record time-dependent activities such as that from an eclipsing binary system.

Figure 2: the 0.5m Mons telescope

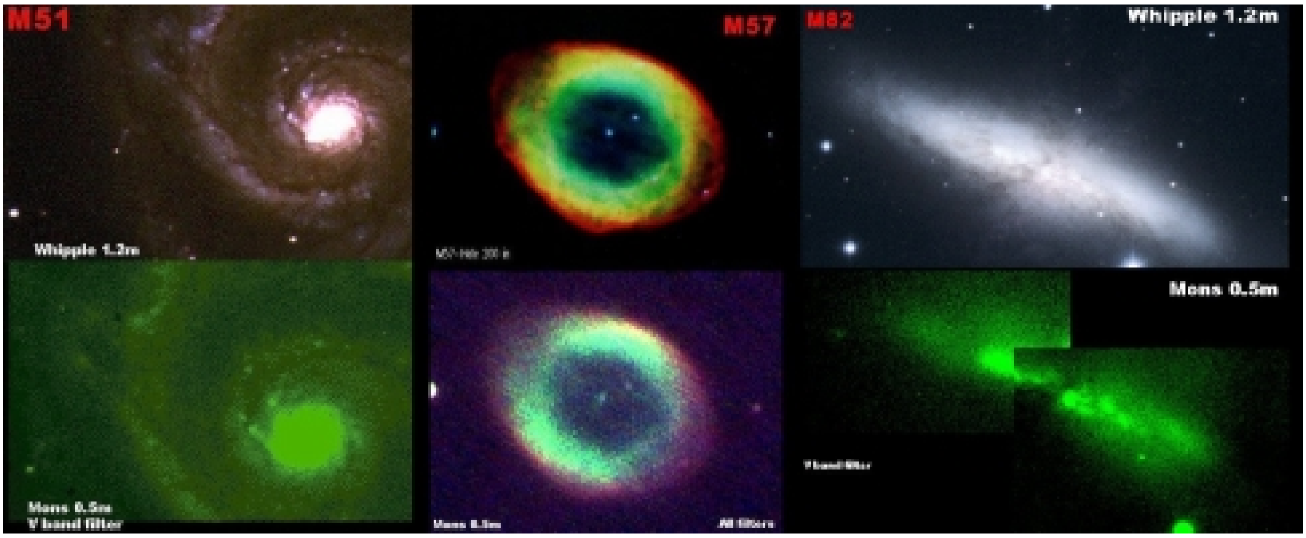

Figure 3: examples of images obtained by Southampton University students using the Mons telescope compared to images taken by the larger telescopes.

2. The Vacuum Newtonian Telescope (0.4m vacuum tube telescope normally used for solar observations) provides an excellent facility for planetary work due to its exceptionally long focal length – 35m! This very long focal length is achieved by passing the light through a network of connecting tubes located around the barrel of the telescope. The design of this telescope mount (see Figure 4 and http://www.iac.es/gabinete/oteide/vnt/vnt1.html) only permits observations within 20 degrees of the plane of the ecliptic so is ideal for detailed studies on Jupiter, Saturn and the moon. The students carry out photographic work using 35mm cameras mounted on this system with the objectives of recording Jovian moon

rotation, as well as high quality images of all of these systems (to record, for example, the rotation rate of Jupiter by following the Red Spot).

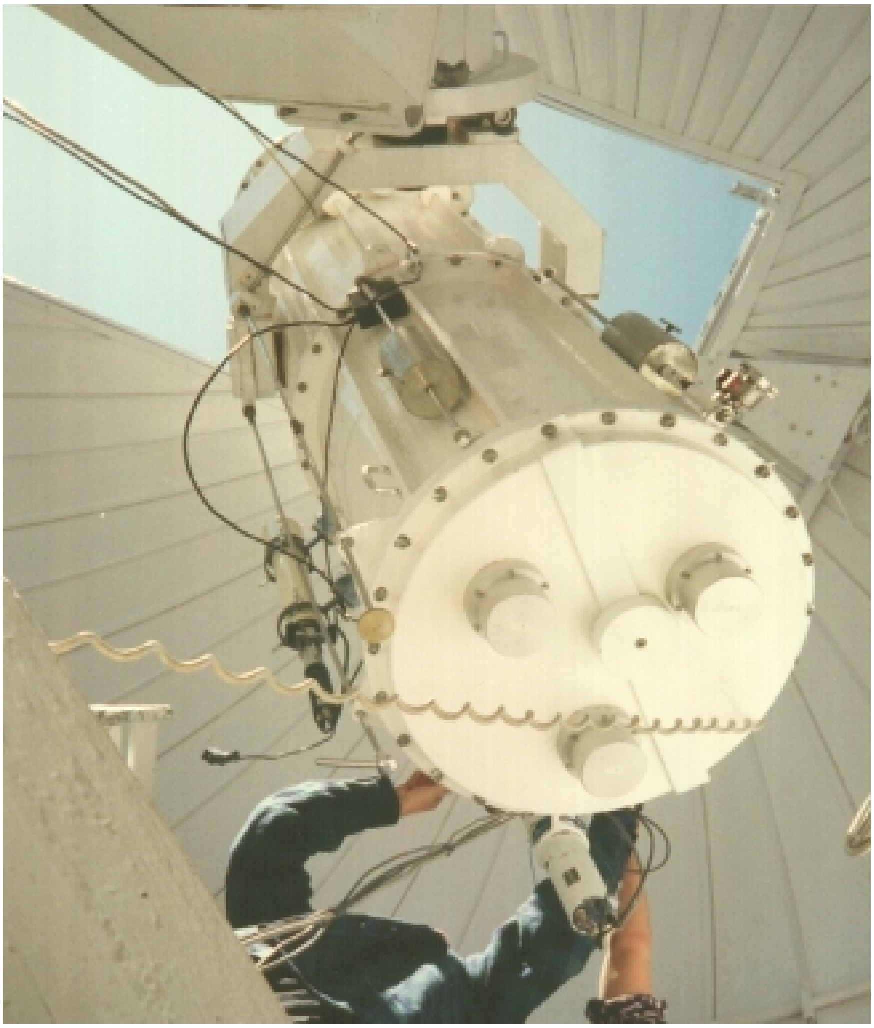

Figure 4: the 0.4m Vacuum Newtonian Telescope

3. A portable Meade LX200 telescope has provided a third location ideal for more general familiarisation of the sky and wide-field photographic imaging. This telescope has tracking in both axes as well as an on-line data base of objects. Mounting of 35mm cameras on the back is straightforward. This telescope is combined with sets of binoculars to permit rapid progress across the sky by all students simultaneously when, for example, sets of stellar clusters wish to be identified.

4. In recent years, some access to one of the professional telescopes has been permitted under the direct control of an astronomer. This telescope is the IAC80 operated directly by the IAC (http://www.iac.es/telescopes/iac80/iac80_presentacion.html) - an 80cm Cassegrain facility with a 1024 x 1024 CCD instrument. A full set of research grade filters are available. This represents a true professional experience for the students, but it is not always popular with the ones that enjoy the more direct hands-on involvement of some of the other telescopes. This telescope has mostly been used for studying

binary modulation in a variety of short period systems and it produces high quality data.

5. In addition to night time work, the students are able to spend late afternoons (4-6pm so as not to interfere with sleep patterns) carrying out solar studies (see Figure 5). The LX200 is used with a Thousand Oaks Type 2+ glass solar filter, together with a focal reducer to produce images of the whole sun. The objectives are to photographically record sunspot locations, sunspot development and differential solar motion by taking images over several days and pooling the data from all groups.

Many of the above activities are supported by a photographic darkroom. The students are trained before arriving in Tenerife to carry out developing and printing of black and white photography. They then enhance these skills by processing their own films and printing up their results during the week. In some cases it is essential to develop films almost immediately to provide the necessary feed-back on the correct exposure times required. Though this kind of imagery is rapidly diminishing in popularity at all levels, it nonetheless provides a rigorous and scientifically demanding test of their skills. The results can be very rewarding both scientifically and aesthetically (see Figure 6 for an example).

Figure 5: solar observations with an LX200 telescope

Figure 6: 30s black & white film exposure of the Orion constellation over Mount Teide.

On return to Southampton the students are set two objectives to encourage the analysis and interpretation of their data under more considered circumstances. These objectives are, firstly, to produce an A1 poster for presentation at an in-house conference, and secondly to write an essay discussing some other aspect of their work. To facilitate both of these activities the university runs a half day course on electronic image processing to explain to the students the steps required to process such data and extract scientific information. The poster presentation normally occurs 3-4 weeks after the Field Trip, and the essay is submitted a further week later.

3 Climatic considerations

Though the weather at the observatory is not always photometric, there are very few nights that are not practical for the students to carry out their work. Over 10 years of visiting no more than a total of 10% of the nights have been completely unusable, and at no stage has a whole visit been at serious risk. This is clearly one of the great advantages of running a course like this at a professional astronomical site. The enormous investment in time and money in transporting a group of students and staff to a location should not be underestimated, nor put at risk by choosing an inappropriate location.

In addition, there are serious health and safety issues that need to be addressed before proceeding. The environment on a mountain top is always subject to dramatic changes, often producing extremely cold and difficult conditions. It is important that all participants are made aware of such hazards and that they come suitably equipped for handling adverse weather conditions. Working outside all night in sub-zero temperatures and a brisk wind will always be a challenge, but in the wrong clothes it could be very hazardous.

4 Learning outcomes

After participating on this course it is expected that our students should be able to:

- work in small teams with each member having a specific responsibility, and know how to interact positively with other members of a close team
- devise a solution to a complicated problem in a relatively short period of time
- work closely with people from a different country and background
- employ practical skills in operating complex equipment under difficult e.g. extreme weather conditions
- operate a telescope and find their way around the sky in celestial co-ordinates
- process data using image processing programmes on PCs.
- present the results of their work verbally, illustratively and in writing.

5 Assessment methods

A wide variety of assessment methods are employed over the duration of this course. The majority of their marks (70%) come from direct continuous assessment by the staff running the experiments at the observatory site. Since the groups of student rotate round all the experiments spending at least one whole night at each location (often two nights), then the staff member supervising that experiment will have 10-11 hours of continuous contact with the 3-4 students. This provides a very firm basis for assessment of each student's performance.

The next 15% of the assessment comes from the poster presentation at the "conference". In this case, between 4 and 6 members of staff act as conference attendees and circulate asking the students about their work. Each member of staff provides a mark on each student.

Finally, the remaining 15% is allocated for the essay presentation. Again several members of staff will read the essays and each will provide a mark on each student.

6 Feedback

This type of intensive course is excellent for obtaining feedback on student progress and learning. Contact between the staff and students is extensive and prolonged, and there are many opportunities to observe student progress and to spot difficulties in the learning process. It is also often very straightforward to adapt the process in real time so as to bypass the cause of any serious difficulties. The details of the course have evolved on many timescales, but there have been many examples of major improvements being made because of the close observation of the students at work.

More formally, we issue all students a standard questionnaire at the end of their course to obtain more balanced reflective feedback. The results of these questionnaires have always revealed an exceptionally high rating for this course and considerable student satisfaction with what they have achieved. They find a lot what is required of them to be extremely demanding, but they enjoy the unusual challenges presented by a course that is so different to all their other traditional laboratory or lecture based programmes.

7 Costs

The details of the costs vary from year to year depending on air fare prices and accommodation arrangements. It is certainly true, that by selecting a major tourist destination for this work there is a great deal of scope for different kinds of travel packages. In general, the cost of the whole course (including the first week's activities described in Dean & Perez Fournon 2002) works out at about £600 per student. Most of this amount is met by SU, but each student is required to make a contribution of £100 to the costs.

8 Conclusions

This course has proved an exceptionally successful way of teaching practical astronomical observation techniques to undergraduates. It has stimulated many of them to pursue the subject in much greater depth than they had previously planned, including inspiring many to study for PhDs in this area. Variations on this course are being actively explored, or have already been established, by several other universities.

Acknowledgements

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References

Dean AJ & Perez Fournon I 2002 Eur.J.Phys (submitted)