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TWO EXAMPLES OF ASTRONOMY PRACTICE IN AN AERONAUTICS AND SPACE ENGINEERING SCHOOL: THE MAJOR PROJECT AND THE INTRODUCTION TO RESEARCH AND INNOVATION COURSE

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Abstract. IPSA is an aeronautics and space engineering school based in Paris and Toulouse, France. Astronomy is taught mainly through lectures in the preparatory cycle. In the engineering cycle, astronomy and space more generally is taught through projects such as mission analysis. Technical associations complete the training of engineering students by proposing projects that will result in scientific publications. In this article, we present two examples of how astronomy is practised at this school in partnership with the Société Astronomique de France (SAF).

Keywords: research, education, photometry, spectroscopy, citizen science

1 Class sessions based on practical astronomy

The first example of a practical course is the Major Project in the second year of the engineering school's preparatory cycle. The teacher is in charge of a group of 20 students who divide into groups of 3 or 4 and then choose a participatory astronomy topic. These subjects are either obtained via observatories that can be remotely controlled, participatory astronomy websites or the participation of volunteers from the Société Astronomique de France (SAF), in particular Patrick Wullaert (Figure 1) and Jean-François Coliac.

Fig. 1. The group of students from IPSA and Patrick Wullaert (SAF) at the Sorbonne Observatory.

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This major project was divided into 5 sessions, each lasting 4 hours, with a report and presentation in the final session. There were 6 different subjects: astrometry of double stars at the Sorbonne Observatory (Paris), a light curve of an eclipsing binary with Jean-François Coliac at OABAC (Marseille), a light curve of an exoplanet transit via ExoClock, a group working on the spectra of the STAROS database and two groups working on the participatory photometry project using Python HOYS at Las Cumbres Observatory (LCO). The students benefited from the help of members of the STAROS project, staff from the LCO network and Jean-François Coliac from the SAF, as well as Patrick Wullaert (chairman of the Double Star Committee at the SAF).

The second example of practical astronomy is a first step towards research called the 'Introduction to Research and Innovation Course' (CIRI in French), for students in the engineering cycle. There were 30 students in groups of 3 or 4. They were able to work on data sets obtained in a professional observatory (light curves from variable stars or exoplanets). During this 2024 session, the students were able to respond to a call to observe a kilonova following a KilonovaCatcher alert. This course always ends with an introduction to the spectroscopy of planetary nebulae with the 2spot association and a hands-on session with the telescope they have in Chile, during a videoconference session. The students present their results orally and in a written report.

2 Students results for each course

Each group in the major project was able to talk to an astronomy professional or use professional facilities to obtain a result or a measurement. Two nights were spent at the Sorbonne observatory with Patrick Wullaert, chairman of the SAF double star commission, and a pair of binary stars was observed, Castor A and B.

The teams working with Jean-François Coliac obtained light curves from Coliac's observatory, OABAC. They were able to compare two light curves of an eclipsing binary obtained in two different filters, blue and red.

The teams who worked remotely with the spectroscopic database project team, with calls for observations during campaigns (`https://staros-projects.org/`), were able to obtain low-resolution and even high-resolution spectra, thanks to the DEMETRA software (Figure 2).

However, the two groups that were able to carry out actual citizen science projet in astronomy, were the two that used the Python codes for the LCO's HOYS (Hunting Outbursting Young Stars) project (Figure 3). They were able to add their measurement points to a light curve that had been in the making for months, with students and pupils from all over the world.

Unfortunately, this privileged small-group relationship could not take place with the large class of 30 engineering students. However, despite the limited number of students, each group was able to carry out a rewarding task: taking part in and responding to an astronomical alert using the Kilonova Catcher programme. Although in the end the alert was a false alarm, its implementation was tried and tested and the result was positive: the IPSA students were mobilised to observe the professionals' targets. These students, who are nearing the end of their studies rather than the beginning, are very sensitive to this 'mini-researcher' aspect that they were able to carry out in this course.

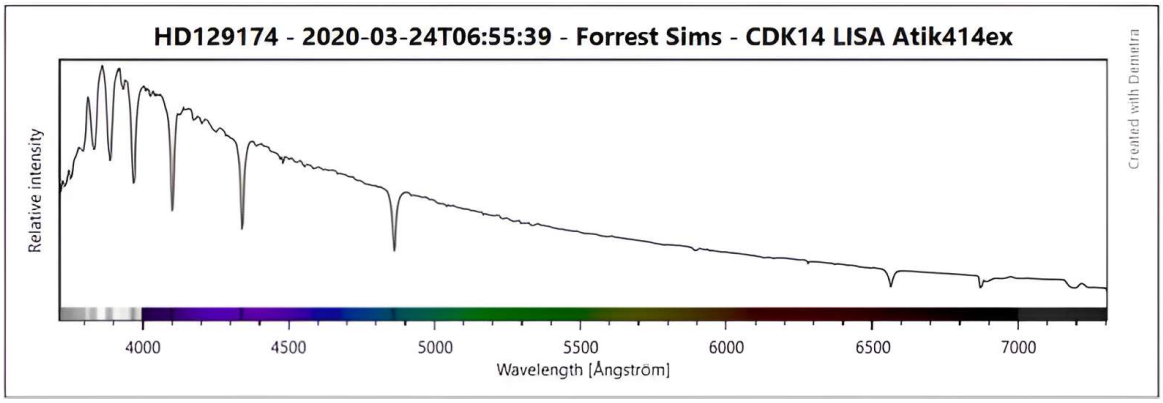

Fig. 2. Spectrum of the star HD129174 obtained by the students using Demetra.

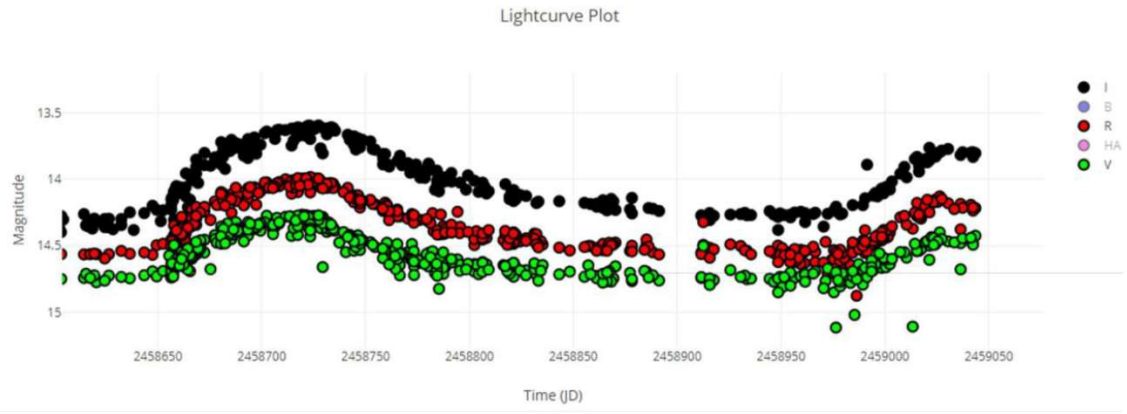

Fig. 3. Lightcurves obtained by students for the HOYS project with the Las Cumbres Observatory (LCO).

3 Feedback from these practices and conclusion

There were many problems, not least the very bad weather in Paris in the spring of 2024. We had to use remote telescopes such as those in the LCO network, old observations or data taken from public databases (STAROS, ExoClock).

The other major negative point that was noted was that the students arrived with a disparate level of knowledge of astronomy. Some don't even master the basics of astronomical instrumentation (setting up and taking down a telescope), which can sometimes have an impact on their understanding of what they are doing on site at an observatory or at a distance.

The students' lack of time is also an important factor to take into account: in 5 sessions, you can deal with the data once you've obtained it, but analysing it and drawing a scientific conclusion from it is more complicated.

On the other hand, what the IPSA students particularly appreciated was the availability of astronomy enthusiasts, especially those from SAF, who accompanied them in their process of becoming 'mini - researchers' for several months. The students found this 'mentoring' approach, mixed with practical lessons and theory from time to time, very valuable and enjoyable. They are not used to this type of course and will remember it fondly.

There is a real enthusiasm among the engineering students for research, particularly in astronomy, when they handle telescopes, when they produce their own data and can put it to good use, and when they are supported at every stage by amateurs as part of an amateur-professional collaboration or as part of a participatory astronomy campaign. The project-based teaching approach was very much appreciated, and direct application of the course on plasma physics, for example, was possible with the 2spot team and Lionel Mulato, who came to lend a hand by talking about planetary nebulae and their spectroscopy.

One of the recommendations made by the students at the end of 2024 was that the teacher, Anica Lekic, should be able to propose new subjects for the following year in conjunction with amateurs and, why not, astronomy professionals. They have also proposed monitoring certain targets over several years using photometry or spectroscopy.

It is therefore entirely possible to use new astronomy practices, in particular participatory campaigns, to train future engineers (particularly from IPSA) in their future profession. The major project or CIRI can and should be highlighted on their CVs.

Thank you to the Staros project's team (`https://staros-projects.org/`), to the 2spot association (`https://2spot.org`), to Jean-François Coliac and Patrick Wullaert from SAF.