Astronomy for the next generation - The Waldbröl school observatory

from Thomas Eversberg

Astronomy has a potentially special position in the core curriculum of physics. In contrast to many other subjects, theoretical aspects can be supplemented in class by practical experience. Physics, chemistry, optics, mechanics, mechatronics, computer technology - all these disciplines can be covered through observations with a modern telescope and the evaluation of the data, in the spirit of a "Studium Generale" of the STEM subjects. Schools and universities therefore buy highly mobile telescopes or even install them permanently in their own observatories. The "Waldbröl School Observatory" with its sponsoring association as a school-based place of learning takes a slightly different approach.

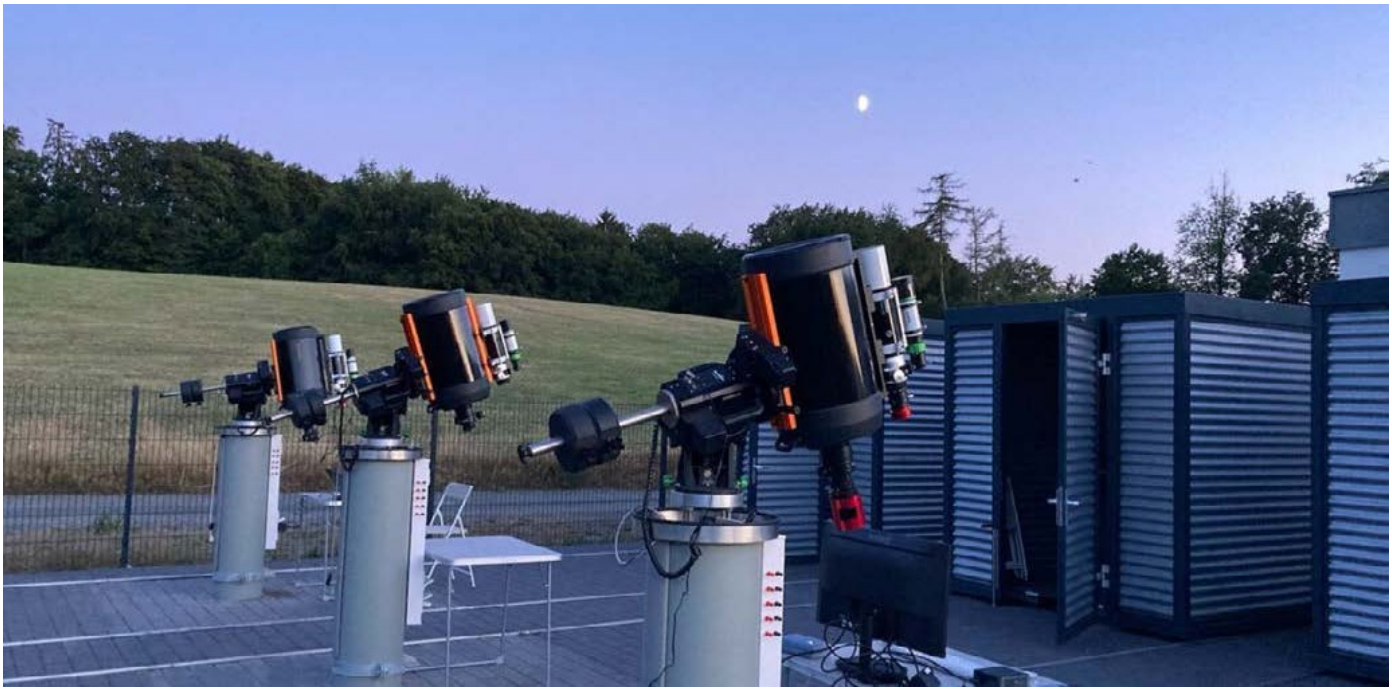
The "School Observatory" project (www.stsci.de) was initiated by the 80 cm telescope of the University of Munich on the Wendelstein in the Alps. Two physicists won the bid at its auction and brought it to Waldbröl (North Rhine-Westphalia, administrative district of Cologne). It is now the largest optical telescope in NRW. In order to make sensible use of the device in its potential range of applications, the non-profit association "Initiativ-

The "Schnörringen Telescope Science Institute e. V." (STScI) was founded to promote the next generation of STEM talent in order to provide young people with an appropriate
"Access to the sky". In addition, over the course of many years of voluntary work, smaller devices and an appropriate infrastructure of the highest standard have been created. On the one hand, young people notice very precisely what level of equipment is used and whether they are being served.

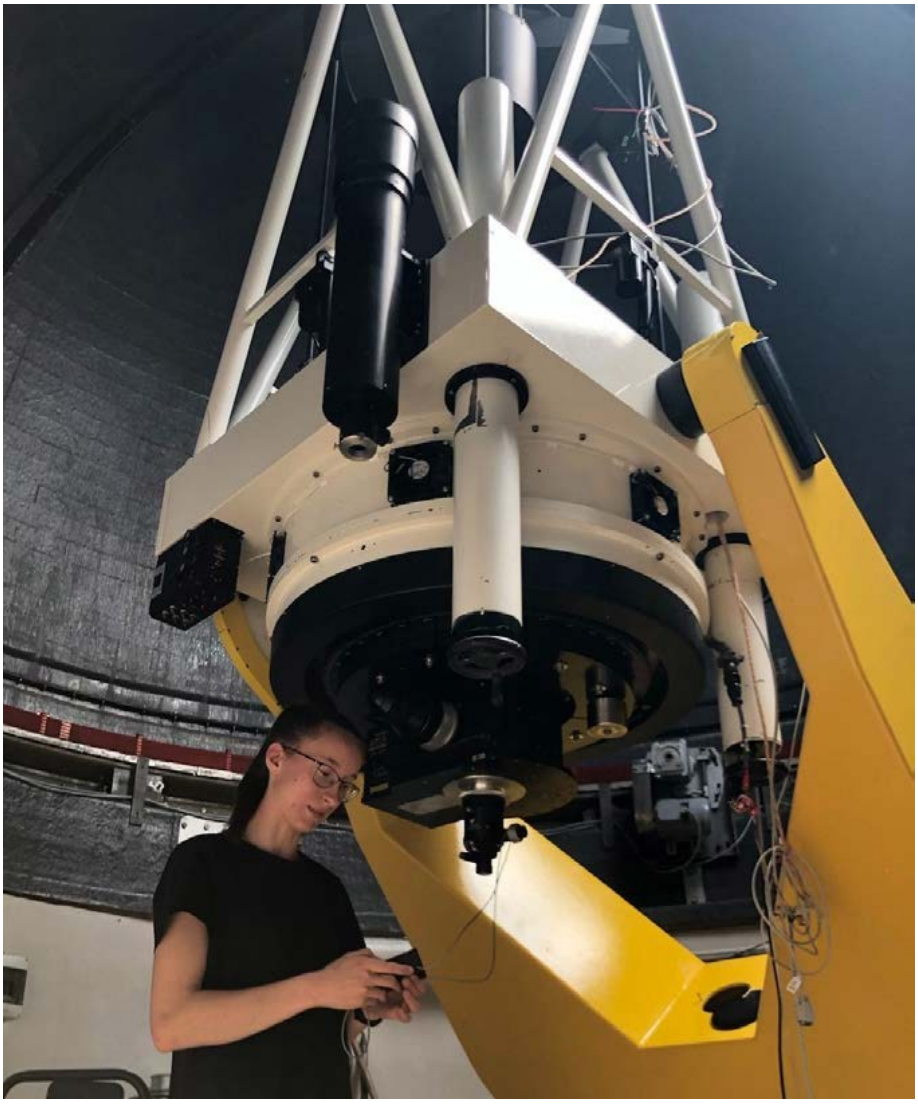
therefore takes seriously. On the other hand, it is important to "mirror" modern technology (electronics, analytics, IT, etc.) with appropriate equipment and thus create a connection to today's world. Telescopes are no longer set up with graduated circles. The result is a complex that is better equipped than many professional observatories in the 1 m class. This equipment is intended to introduce young people interested in technology and science to STEM subjects in a didactically appropriate way. Pupils in astronomy clubs or in independent astronomy classes can also use the equipment.
groups, but also interested students, can make exclusive use of the observatory. **(Image 1)**

Very early on, a
didactically sensible approach. As a result, the "school laboratory" with three identical observation stations offers an astronomical introduction for the next generation. All of them house a reflector telescope with an aperture of 28 cm and a small lens telescope. In one station

1 The Waldbröl school observatory. On the left is the tower of the 80-cm main telescope with service building, on the right the student laboratory, behind it the upper secondary station with 3.5-m dome, next to it the storage container. The lower secondary station with a 2.7 m dome is located behind the service building.



2 The school laboratory with three identical 28 cm telescopes. The sliding steel 'cubes' can be used as heated control rooms.

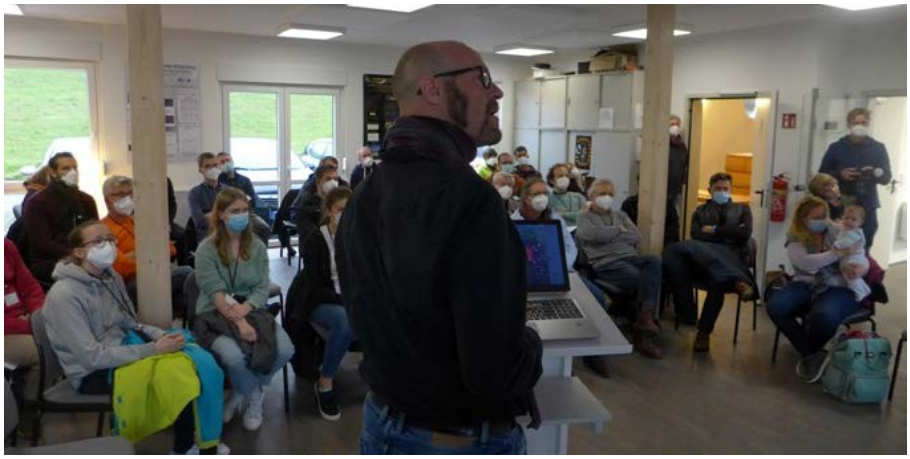


3 Club member *Sophia Wick* at the 80-cm main telescope under the 6-m dome.

a special solar telescope is also installed. Each station is digitized and has a mini PC with a large screen. Three movable steel structures (the 'cubes'), which can also be used as electrically heated control rooms, serve as weather protection. It is therefore possible to control and record images and data from the 'cube' or work directly on the device. Interestingly, the latter is preferred by young people, even in the cold. Obviously, direct experience and haptics play a role that should not be underestimated. In the student laboratory, three groups can each be provided with their own observation station. Instead of just being shown a telescope and learning very little, you can learn how to use the technology in practice. And if you get stuck, just ask the neighboring group. After an observation evening, everyone knows how to do it. All stations are fully equipped (eyepieces, DS-LR and CCD cameras, filters and low-resolution spectrographs) and all can even be controlled from the control room in the service building. Even operation via the Internet is possible. However, we are not aiming for this for didactic reasons and it is also difficult to implement in view of the remote support required for voluntary work. **(Image 2)**

The new knowledge can later be used to 'explore' the two side stations. One station with a 2.7 m dome houses a telescope like the one in the school laboratory, but with a slightly larger aperture of 35 cm. In addition to the complete equipment already mentioned, a high-resolution slit spectrograph can be used here and real research can already be carried out.[1] Another station is a special feature. Under a 3.5 m cupola is a large-field telescope with an aperture of 35 cm, which can image a field of view of around 2.6° on the detector chip. With this device, photometric images can be taken with professional filters in accordance with the 'Sloan Digital Sky Survey' is possible. Real research with photometric techniques is therefore also possible here. Apart from this, the device is also very fast due to the extreme F-number of f/3. The very large field of view at this light intensity enables not only the classification and age determination of open star clusters, for example, but also cosmological history through the investigation of extended tidal tracks of colliding galaxies.

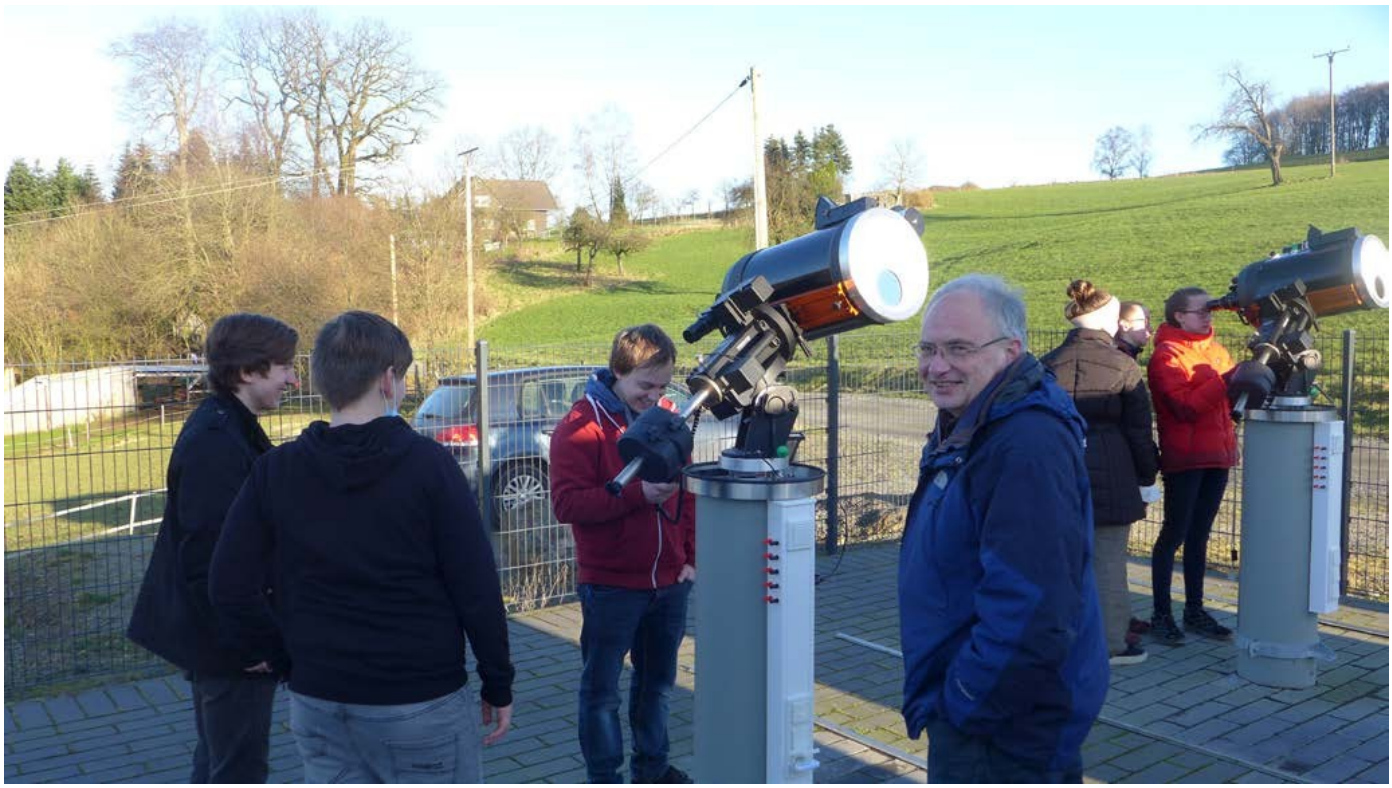
In addition, we have some large refracting telescopes that we can attach to the mounts as required.



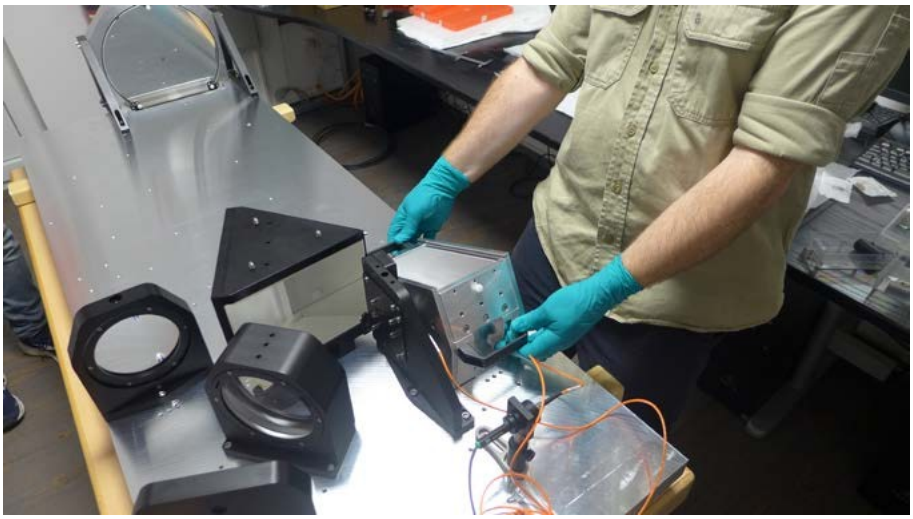
4 Association member and German/Latin teacher *Frank Bohlscheid* at the "Oberberg Astronomy School Network" seminar.

the sky. Last but not least, the offspring can use some Dobsonian telescopes, which are aligned by hand to look at the sky. These are very popular because they allow you to "hold the sky in your hands" without the need for obscure digital technology. Haptics also play a role here.

The goal of all students is, of course, to make observations with the large telescope from professional astronomy. Its position-stabilized optics with a temperature-stabilized focus is supported by a heavy Ga mount. This telescope can be used to take images of the sky with a large CCD detector, but its main use will be for high-resolution spectroscopy. For this purpose, a so-called echelle spectrograph was developed by Macquarie University in Sydney for the student observatory ([1], [2])[2] . The 240 kg device is located one floor below on a table under the telescope and is fed by the telescope via a fiber optic. As with the other spectrographs, the basics of geometric optics (prism) and wave optics (opti-



5 Association member and chemistry teacher *Günter Dombrowski* with pupils in the school laboratory.



6 Setting up the spectrograph for the main telescope.

grid) can be learned and applied directly. **(Figure 3)**

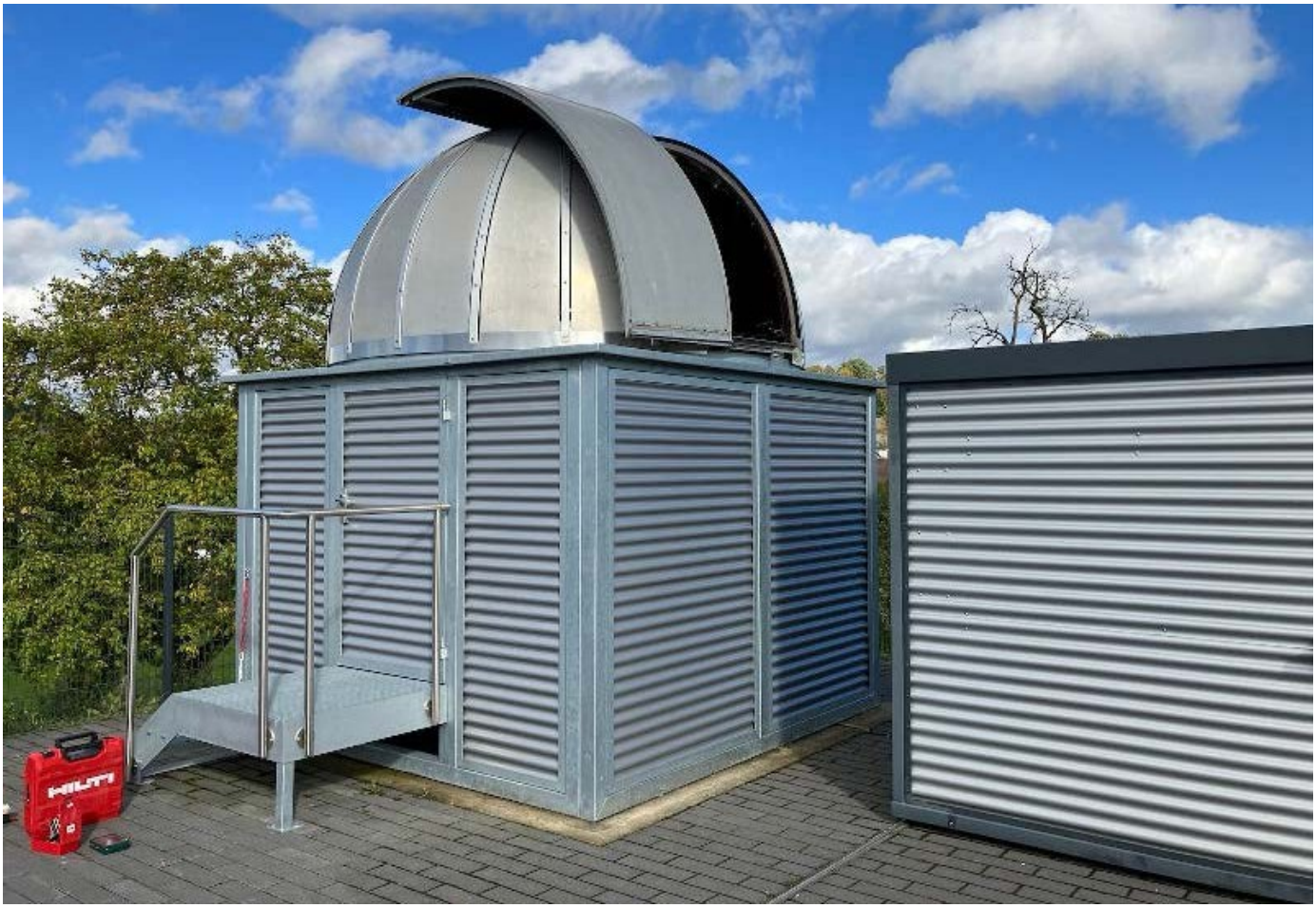
In order to successfully ori-

In order to be able to carry out didactic work in an effective manner, an appropriate infrastructure is of course required. A large seminar room with a kitchenette, a

A full range of media equipment, a library, eight beds in two dormitories and a sanitary area allow observers to stay comfortably for longer periods. And for larger groups of students, we have a further 16 mattresses - "*the sleepers*".

We prefer to sit together in the seminar room anyway". Energy is supplied by a photovoltaic system on the roof. And the firewall-protected digital environment (glass fiber connection, server, storage) and suitable software provide users with a secure IT environment and meet all the needs of scientifically oriented work.

In order to put an extracurricular place of learning on a broad foundation, the environment and its boundary conditions must also be taken into account. For this reason, the "*Oberberg Astronomy School Network*" was initially established together with schools in the region. Its communication takes place via an online forum where all participants can exchange ideas and support each other. This means that teachers with a head start in knowledge can pass this on to colleagues at other schools or work together or bring entire astronomy clubs together. Or pupils from one working group can act as mentors for other working groups. **(Image 4)**



7 The main telescope

Of course, the offspring will first want to take beautiful astro images. After that, however, they can also carry out observation and even small research programs for technical papers. The experts at the observatory will help with this (there are physicists, engineers and teachers in the association). Or they can start their own programs and evaluate the data themselves (e.g. astrophotos with a cell phone). **(Image 5)**

This also applies to astrophysical investigations with spectrographs. You start with low resolution in the student laboratory and can then learn line profile analysis with a high-resolution slit spectrograph and carry out real research. This is topped off with the echelle spectrograph on the large telescope, with which line profile analysis can be carried out in the entire visual spectral range. These are, of course, applications in the professional field, but you learn not only atomic physics but also the pitfalls of data reduction, its interpretation and evaluation. All of this includes fundamentals that are important in a professional technical and scientific environment - working accurately, a critical attitude and the ability to engage in discourse. In reality, this work teaches you various car- dinal virtues. **(Figure 6)**

With this high-end equipment pupils and students are introduced to astrophysical research and motivated to write their theses and dissertations. However, this also applies generally and largely independently of the subject area. At least in astrophysics, corresponding research campaigns have already been successfully realized ([3], [4], [5]). In addition to spectroscopy, photometric filters offer the opportunity to carry out nebula and galaxy research (here, too, there are contacts with professionals). And, of course, practical work can also be carried out that has to do with technology in general ("*Have you ever soldered?"*). Teachers are supported in courses for their didactic work. In order to be able to implement this strategy realistically and in a way that conserves energy in view of the purely voluntary work, it is necessary to act in a staggered manner. This means that for astronomical practice, teachers must first use the tools themselves can. They can then use this knowledge to work with their groups. This is ensured with appropriate practical courses - the observatory initially only provides the working environment, the association members cannot act as teachers. However, we also offer a Girl's Day and a pre-reading evening.

The relatively dark location in the Ober- bergisches Land comes at the price of geographical distance. The drive is a disadvantage that should not be neglected compared to a stern guard at your own school. Due to the high workload and poor school conditions for study groups and other activities, only teachers who are really passionate about astronomy are reached. As an extracurricular place of learning, the observatory only fits into the curriculum to a limited extent. These obstacles are a serious problem for school operations, but also for the observatory in Waldbröl. Special efforts are not adequately compensated for with teaching hours. This is to be tackled creatively by visiting interested classes in person and offering seminars and telescope courses on site. The observatory's website provides extensive didactic material and an online teachers' forum enables exchange within the school network. Last but not least, teachers themselves must also enjoy their AGs and be relieved of the workload of the core physics curriculum. Those responsible at the observatory repeatedly emphasize that they too are still learning how best to organize practical operations at the observatory (the observatory was only opened in 2023). Dialogue with teachers is therefore essential in order to develop good concepts together. With this in mind, a doctorate is currently being supervised at the Chair of Didactics of Physics at the University of Siegen. The aim of this work is to develop a concept on the subject of 'Astronomy and Didactics' using the Waldbröl school observatory as a practical example.

Public lectures and occasional open evenings are also part of the portfolio of this place of learning in order to consolidate its integration into the regional educational landscape in the general public. This has the side effect that pupils can Students learn how to present their own knowledge and results in free speech. In view of the rhetorical requirements in the professional world, this is a side effect that should not be underestimated - *"If you can't explain it, you haven't understood it."* However, films can also be shown with a high-quality media system and a science cinema for unusual and entertaining documentaries is planned. And since the next generation should be picked up where they stand, graffiti surfaces can be hung up for the next generation of sprayers for corresponding competitions ("*Spray me a Gala xis or Captain Kirk.*"). The central aim of all activities is to have fun as a group. Young people don't want to hang around on their own. That's why one of the observatory's slogans is: "*Here you can observe, program, calculate - and grill sausages!*"

Acknowledgments:

It is impossible to thank all the more than one hundred supporters of our observatory individually at this point. They can be found on our website. However, I would like to emphasize that our project would not have been possible without the continued support of enthusiastic helpers in and around the region. Be it financially, materially or in the form of personal time. The Waldbröl school observatory, as an extracurricular place of learning, therefore belongs to the Oberberg region in an ideal sense and represents a hope for the future of the next generation.

Literature and sources:

[1] [2] STScI website https://kurzlinks.de/w7nx
[2] Proc. of SPIE, Vol. 10702, 107026I https://kurzlinks.en/5148
[3] SuW, 12/2009 https://kurzlinks.de/r8j5
[4] SuW, 1/2013 https://kurzlinks.de/zxw2
[5] VdS Journal No. 50 https://kurzlinks.de/kiuw

Notes

1 The STScI has carried out a research campaign with such a measuring device together with amateurs and professionals at the Teide Observatory on Tenerife.
2 The first exopla- net was discovered with a device of this type, for which a Nobel Prize was awarded.

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