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Small Observatories, Large Research

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Small telescopes in the hands of enthusiasts are becoming part of global science. The EASST Foundation coordinates the activities of professional and amateur astronomers, demonstrating that space exploration can be a shared adventure.

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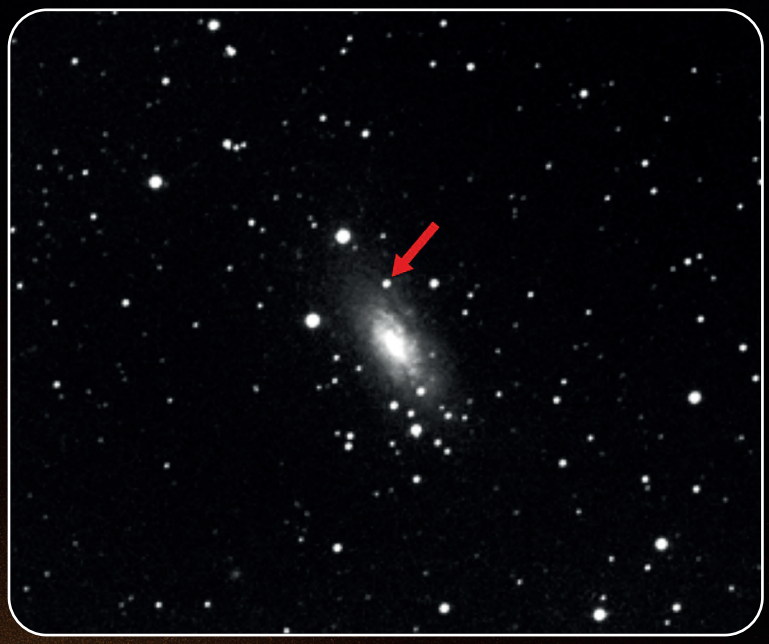
A new star has appeared in the constellation Lacerta. Earlier observations of the same region of the sky showed only a charming spiral galaxy, but the latest measurement from the sky-scanning space mission Gaia revealed that a new object had begun shining right next to it. This was most likely a supernova explosion – the death of a massive star and the birth of a black hole. As Gaia continued its



A typical monochrome photo taken with a small 40 cm diameter telescope, showing a galaxy at the center with the new supernova SN2024ggi marked by an arrow

The map of the Milky Way created by the Gaia space probe, revealing the structure of our galaxy in unprecedented detail

ESA/GAIA

journeys across the sky, an alert about the new supernova was automatically sent by a system operating at the University of Cambridge The alert reached scientists studying supernova and black holes. Information about this intriguing object was then forwarded to the BHTOM.space system and, through it, to a network of small telescopes scattered around the globe. Among the first to respond were the school observatory in Bolęcin, in the Silesian Voivodeship, and the Skinakas observatory on the Greek island of Crete, which sent the first images of the supernova. Soon, they were joined by other observatories – both professional and amateur – that had clear, cloudless skies that night and over the following days. In this was a complete picture was formed: how the new supernova changed its brightness and color over time. This ultimately lead to a scientific publication describing its evolution and the newly formed black hole. Such a situation took place in 2024. This story shows that cooperation between the scientific community and enthusiasts brings tangible results.

On the one hand, professional astronomers possess specialized knowledge and clearly defined observational needs. On the other hand, amateur astronomers are increasingly equipped with high-quality telescopes and ready to engage in research collaboration. The European Astronomical Society of Small Telescopes (EASST) Foundation was established to harness the potential of collaboration among enthusiasts of exploring the universe. Therefore, the foundation's mission goes beyond science popularization. Its goal is to make the experience, knowledge, and tools accumulated over the years of scientific work available to people who are not professional astronomers, yet wish to take an active part in the exploration of space.

Astronomy has long been a pioneer in the field of the so-called citizen science (see the text addressing this topic on pages 38–41 of this issue of *Academia* – editor's note). A good example is the Galaxy Zoo project, which has been running since 2007, where thousands of participants analyzed images of galaxies after brief training, contributing to scientific publications. The EASST Foundation takes this a step further by inviting telescope owners – private individuals, schools, and educational institutions – to collaborate and by coordinating their activities. The Foundation aligns the needs of scientists studying temporary or long-term phenomena with the capabilities of those

HORTEN VIDEREGÅENDE SKOLE

An amateur observatory at a high school in Horten, Norway, actively participating in observations coordinated by EASST

owning private telescopes and small professional telescopes. In this way, a passion for observing the sky becomes a source of data used in the search for black holes, the study of supernova, and other phenomena of the ever-changing sky.

New Technical Capabilities

Until recently, amateur astronomers were largely limited to observing the Moon, planets, or nebulae. Many telescopes purchased in supermarkets were unsuitable for serious observation and quickly ended up in attics. To make matters worse, higher-quality equipment was expensive and complicated, often requiring specialist knowledge to operate. Now the situation has changed. The technological revolution – particularly the development of affordable, sensitive CMOS cameras (complementary metal-oxide-semiconductor technology that converts light into an electrical signal), the same technology that revolutionized smartphone photography – combined with autonomous telescopes controlled by artificial intelligence algorithms, has opened access to astronomy on an unprecedented scale. Equipment has become more affordable and easier to use, while still enabling the collection of scientific-quality data. Among small telescopes, technological development has blurred the line between professional and amateur equipment.

The Foundation naturally cooperates not only with private telescope owners but also with smaller professional telescopes. In the 20th century, hundreds of observatories equipped with mirrors about one meter in diameter or smaller were built across Europe and the USA. For decades, all astronomical research was carried out on these instruments; today, they are primarily used to educate new generations of observers.

However, although the most spectacular discoveries today require giants with mirrors 8 to 10 meters in diameter, smaller instruments remain extremely valuable. They enable long-term monitoring of selected phenomena – lasting hours, weeks, or even years – providing unique data that the largest observatories cannot collect due to limited observation time.

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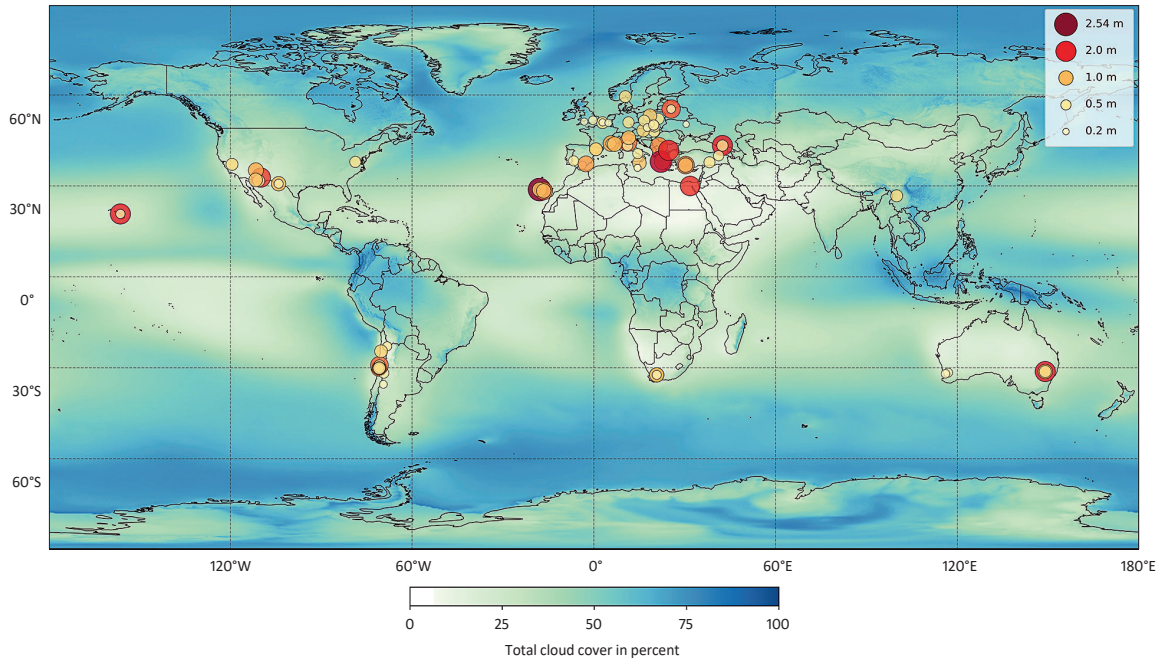
The University of Wrocław telescope in Białków, a member of the EASST small-telescope network

A Real Need to Support the Gaia Mission

The origins of the network created by EASST go back to 2010, when the Institute of Astronomy at the University of Cambridge was developing an alert system for the Gaia space mission. The Gaia space observatory was designed to scan the entire sky and report new phenomena – such as supernovae or other transient objects – as quickly as possible. Łukasz Wyrzykowski, then a research staff member at the institute and co-author of this work, was personally involved. He was puzzled by one question: what is the point of generating alerts if no one confirms them from Earth? This thought led Wyrzykowski, even before the mission had been launched, to begin constructing a network of telescopes that would respond to signals from space. Over the 11-year period of Gaia's operation, a global network of about 130 telescopes was established. Initially, these were mainly university telescopes, but over time, instruments belonging to amateurs began to join.

The Gaia mission concluded its observations in January 2025, having accumulated tens of thousands of alerts. Among them were particularly valuable candidates for black holes in our galaxy. Searching for these objects using the gravitational microlensing method



Map of the 130 telescopes involved in the operations of the EASST network. The background shows average cloud cover

required years of observation to detect unusual brightening of stars caused by the gravitational field of black holes. In this endeavor, small telescopes scattered around the world proved irreplaceable.

Dynamics and Communication

Today, a new field of astronomy is emerging: the study of the changing sky. Space- and ground-based telescopes search for exotic gamma-ray flashes, X-ray bursts, or signals in gravitational waves, and the network of small telescopes on Earth must respond quickly and flexibly. Many instruments in multiple locations are needed to keep up with phenomena that appear and vanish in the blink of an eye.

The EASST Foundation's telescope network employs a unique practical tool. Individual observatories communicate via a dedicated portal called BHTOM.space, where they can find information about currently interesting objects and upload their data, which is then automatically analyzed. As a result, the time between requesting observations and receiving scientific results has been significantly shortened.

Polish scientific institutions have played an important role in this initiative right from its very beginning. As early as 2012, the development of the telescope network was included in the European OPTICON grant, run by the University of Cambridge with the University of Warsaw as a partner. Subsequent stages of funding were provided through European Commission programs, including Horizon 2020 and Horizon Europe. Currently, the BHTOM project is carried out primarily at the Astrophysics Department of the National Center for Nuclear Research in Warsaw, with support from the European ACME grant.

The potential of the EASST telescope network extends beyond basic research. The rapid development of the space industry has resulted in millions of pieces of space debris orbiting the Earth. These need to be monitored regularly to prevent collisions, including those that could impact the International Space Station. In addition, active satellites and potentially Earth-threatening asteroids must also be tracked. Small telescopes are well suited for these tasks, and the Foundation is working on adapting astronomical instruments so they can perform these functions as well.

In Search of a Clear Sky

In the course of its operation, the telescope network also faces several challenges. The first is light pollution. The glow emitted by cities reduces contrast even under clear skies, rendering faint objects completely invisible. The second is fickle weather and unpredictable cloud cover. The solution to these obstacles is an extensive network of telescopes spread across many countries. Although weather is usually better in warmer climates, the opposite can also occur. When skies were overcast in Spain and Italy, observations were carried out by telescopes in Poland or even Scotland. The third challenge is atmospheric turbulence, which causes star images to lose sharpness. The Foundation is conducting research on improving image quality using artificial intelligence and machine-learning methods that can compensate for the effects of unstable air.

Citizen astronomy is not only about science and technology. Observing the night sky offers a unique existential experience. Looking at the stars inspires humility and provides a fresh perspective. It makes us aware of how small humans are compared to outer space and how special the Earth is. It is also a way to relax and care for both physical and mental health – a benefit widely recommended by specialists. ■

Further reading:

EASST Foundation website: https://easst.eu/