Astronomy in Poland

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Polish post-war astronomy was built virtually from nothing. Currently, about 250 astronomers are employed in seven academic institutes and a few smaller units across Poland. Broad areas of astrophysics are covered and the level of astronomical research in Poland is higher than the world average. Joining ESO has created an atmosphere that is conducive to further improvements in the quality of Polish research, and it marks an important step towards the full integration of Polish astronomers into the international scientific community.

Poland is a country with a long astronomical tradition: Mikołaj Kopernik (Nicolaus Copernicus, 1473–1543) with his great work on the heliocentric system, or Jan Heweliusz (Johannes Hevelius, 1611–1687), the author of *Selenographia* and inventor of several constellation names still in use, being two examples. However, starting from the end of the 18th century Poland entered a dark period in its history. The Polish state disappeared from the map of Europe for about 120 years and wars swept Polish soil during every generation. The last one, World War II, left Poland ruined, with a devastated intelligentsia and no scientific resources.

The very few professional astronomers who survived the war started to build scientific centres in some cities, literally from scratch. These were Włodzimierz Zonn, Stefan Piotrowski and Maciej Bielicki (in Warsaw); Władysław Dziewulski and Wilhelmina Iwanowska (in Toruń), Tadeusz Banachiewicz, Rozalia Szafraniec and Karol Kozieł (in Cracow); Eugeniusz Rybka, Antoni Opolski and Jan Mergentaler (in Wrocław); and Józef Witkowski and Hieronim Hurnik (Poznań). A modern approach to research and university courses meant that their first students rapidly reached a world-class level. Prominent examples are: Stanisław Gorgolewski (in radio astronomy), Stanisław Grzędzielski (interstellar and interplanetary matter), Jan Hanasz (radio astronomy, space research), Jerzy Jakimiec (in the field of Solar flares), Tadeusz Jarzębowski (photometry of variable stars), Andrzej Kruszewski (polarisation of starlight, variable stars and extragalactic astronomy), Wojciech Krzemiński (variable stars), Jan Kubikowski (stellar atmospheres), Józef Masłowski (radio astronomy), Andrzej Pacholczyk (magnetohydrodynamics and radio galaxies), Bogdan Rompolt (dynamics of the Solar atmosphere), Krzysztof Serkowski (polarisation of starlight and instrumentation), Grzegorz Sitarski (dynamics of comets and asteroids), Józef Smak (stellar evolution, cataclysmic variables and accretion discs), Jan Smoliński (luminous variable stars), Antoni Stawikowski (stellar spectroscopy), Jerzy Stodółkiewicz (magnetohydrodynamics and dynamics of globular clusters), Wiesław Wiśniewski (stellar photometry, comets) and Andrzej Woszczyk (planetary systems and variable stars).

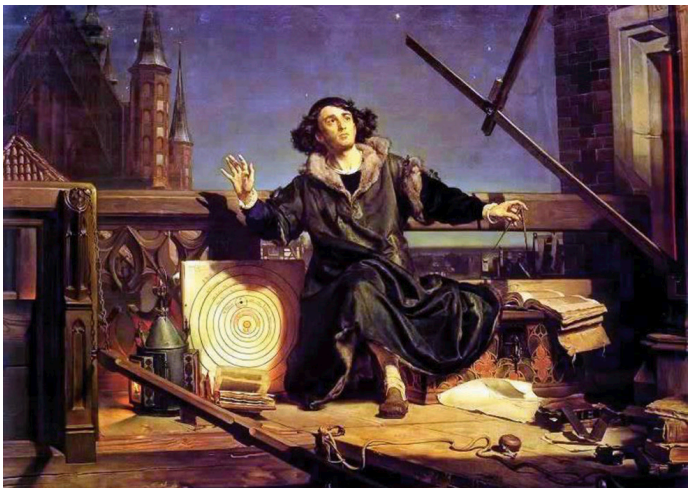

Figure 1. Mikołaj Kopernik pictured in his Frombork observatory. From the painting by Jan Matejko (1838–89).

In the mid-1950s, when the oppression of the communist system softened, the "old" professors renewed their pre-war contacts with foreign scientific institutions and recommended their best students as candidates to visit leading astronomical institutes. After returning home, the young astronomers continued to carry out world-class research and started to train the second generation of post-war astronomers. Unfortunately, the freedom to go abroad also has a dark side: Poland fell victim to a brain drain, as several brilliant Polish scientists decided to stay for good at different western academic institutions. Nonetheless, most of them preserved close ties with their Polish colleagues, e.g., by inviting them to visit abroad and carrying out collaborative research or providing support for scientific libraries. As soon as Poland achieved independence, the older emigrant astronomers frequently began to visit Poland for both shorter and longer stays. Nowadays young scientists almost always come back from abroad to their home institutions.

There are currently about 250 professional astronomers (with 155 International Astronomical Union members among them) in Poland, most of them working in six separate university institutes and two institutes of the Polish Academy of Sciences. A few individual astronomers hold positions in other institutions, mostly within institutes of physics. According to data from Science Watch — a newsletter published by the Thomson Institute — 1777 papers on space science were published in the years 2009–2013 with at least one author affiliated in Poland (2.66 % of world production). These papers were cited 11.83 times on average, as compared to 9.61 for the world average, showing that the quality of Polish research in astronomy is high. In the Astronomical Data System (ADS) database, we found six papers cited over 1000 times and nine more papers cited between 800 and 1000 times with Polish astronomers as authors/coauthors (but not necessarily affiliated in Poland at the time of writing).

Figure 2. Two (of four) automatic telescopes from the Solaris telescope located at the South African Astronomical Observatory (SAAO), South Africa.

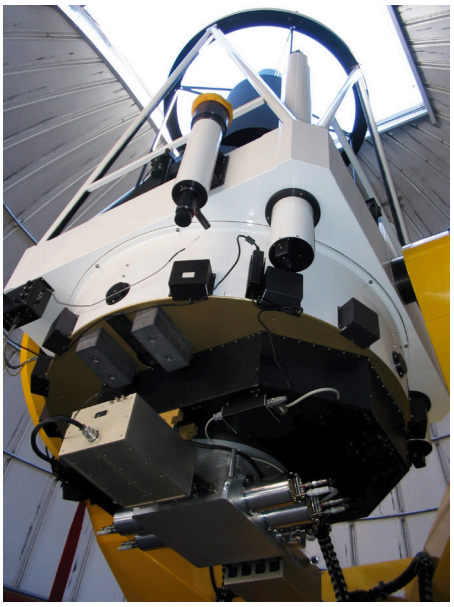

Figure 3. The Warsaw Observatory's 1.3-metre telescope in Las Campanas, equipped with the 32-chip CCD camera built in Warsaw, one of the largest in the world, and used for the OGLE survey.

We describe the six astronomy institutes, their staff complements and areas of expertise in the following sections.

Nicolaus Copernicus Astronomical Centre of the Polish Academy of Sciences

The Nicolaus Copernicus Astronomical Centre of the Polish Academy of Sciences (NCAC PAS[1]) is the largest astronomical institute in Poland. It is located in Poland's capital Warsaw, with a branch in the city of Nicolaus Copernicus's birth, Toruń.

The history of NCAC PAS started in the 1950s, when the idea of building a national astronomical observatory was first formulated. The failure of the first idea led Bohdan Paczyński and J. Smak to suggest that a theoretical astrophysical research institute should be established instead. This idea gained important support from the American National Academy of Sciences, as a result of preparations for the celebrations of the Nicolaus Copernicus Quincentennial (1973). The USA provided financial support for the creation of the institute. The Centre was finally opened in 1978 and immediately started vigorous research activity across a broad range of subjects in astrophysics. Currently these include: observational and theoretical aspects of stellar astrophysics (e.g., astroseismology), stellar systems (globular clusters, dwarf galaxies), nuclear matter, physical processes around compact objects (accretion discs, jets and outflows), circumstellar matter, structure and evolution of active galaxies, cosmology and extrasolar planetary systems.

NCAC PAS employs more than 40 full-time scientific staff (including postdocs), and runs a postgraduate programme for about 25 students. Each year there are openings (on a competitive basis) for three- and five-year positions at NCAC. The positions for three years are open to young researchers who have just completed their PhDs. Positions for five years may lead to a permanent position.

The most important contributions of NCAC scientists to modern astronomy and astrophysics include papers on stellar evolution and accretion disc theory by B. Paczyński and J. Smak. The other important topics are helio- and astroseismology (led by Wojciech Dziembowski), variable stars (Janusz Kałużny, Joanna Mikołajewska and Romuald Tylenda), nuclear matter physics and high energy astrophysics (Paweł Haensel and Andrzej Zdziarski).

The researchers are involved in a number of large international projects and collaborations.

Projects involving international cooperation are concentrated around the Cherenkov Telescope Array (CTA) and the High Energy Stereoscopic System (H.E.S.S.) working in the high-energy gamma-ray domain, and the South African Large Telescope (SALT), with a diameter of ten metres. NCAC astronomers are also members of teams involved in cosmic experiments, such as INTEGRAL, Herschel or BRITE-PL (a project for the observation of stellar pulsations with six photometric nano-satellites). The centre operates the ground communication station for the constellation of astroseismology satellites BRITE — a joint project involving Austria, Canada and Poland and headed by Aleksander Schwarzenberg-Czerny. The new programme Solaris (involving Maciej Konacki), aimed at accurate spectroscopic observations of binaries with four small (50-centimetre) automated telescopes distributed around the world, is also worth mentioning (see Figure 2). This

programme aims to determine accurate parameters of binary stars, and to search for planets around them.

Astronomers from NCAC are active in collaborations with scientists at several institutes and universities around the world, such as: Stanford University, Harvard University, the University of Durham, the Institute d'astrophysique (Paris), the Institute of Space and Astronautical Science (Japan) and the Ioffe Institute (St. Petersburg). NCAC is an active participant in The European Laboratory "Astronomie Pologne–France", a collaborative programme formed by the Centre national de la recherche scientifique (CNRS) in France and the Ministry of Science and Higher Education in Poland.

Warsaw University Observatory

The Warsaw University Observatory[2] is a part of the Faculty of Physics. It offers astronomical study programmes at undergraduate and graduate levels and has the right to award PhD degrees in astronomy and the degree of doctor *habilitatus*.

Recent research in observational astronomy concentrates on two large photometric surveys: the Optical Gravitational Lensing Experiment (OGLE) and the All Sky Automated Survey (ASAS). Both were initiated by B. Paczyński, who was the first to point out the importance of microlensing as a new tool for stellar astronomy investigations. OGLE has been in operation since 1992 and is currently led by Andrzej Udalski. First observations were obtained with the Swope 1-metre telescope at the Las Campanas Observatory (LCO). Since 1996, the OGLE survey has used dedicated 1.3-metre telescope, owned by the Warsaw University Observatory, and located at the LCO (Figure 3). Presently, it is equipped with a large CCD camera containing 32 chips with 268 million pixels. The total sky coverage of OGLE is about 3000 square degrees and 1.3 billion sources are monitored every night. OGLE has been, and remains, a real mine of important discoveries. The first microlensing event was observed in 1993. Since then, over 15 000 of these events have been recorded. About 500 000 new variable stars were detected by OGLE. Fifty exoplanets have been discovered so far using transit and microlensing techniques and several new Kuiper Belt objects have been identified. The programme continues and we hope for many exciting new discoveries.

The other survey, ASAS, uses four small telescopes placed in two stations: in the north in Hawaii, and for the south at the LCO. ASAS is led by Grzegorz Pojmański. Over 20 million stars over the range 8–14 magnitudes are being monitored. Several hundred observations per star have already been collected. More than 40 000 new variable stars have been detected (in addition to the ~10 000 already known). All data from both the OGLE and ASAS programmes are publicly available and are continuously used by astronomers from all over the world.

Several astronomers led by Grzegorz Pietrzyński are involved in the large international observational programme Araucaria. Its principal aim is to provide an improved calibration of the local extragalactic distance scale. So far, the distance modulus to the Large Magellanic Cloud (LMC) of 18.493 magnitudes has been determined with an unprecedented accuracy of less than 2 %. Warsaw University astronomers are involved in a number of other international projects: H.E.S.S., the CTA, the Laser Interferometer Gravitational-Wave Observatory (LIGO) and the VIRGO interferometer, Planck and Gaia.

Theoretical research is also conducted and is concentrated on Solar and stellar oscillations, and evolutionary models of binary stars.

Astronomical Observatory of the Jagiellonian University

The Astronomical Observatory of the Jagiellonian University[3] is a part of the Faculty of Physics, Astronomy and Applied Computer Science. A number of small radio and optical telescopes are located at the Fort Skała Observatory on the outskirts of Cracow. The main scientific programmes include high-energy astrophysics, the investigation of active galactic nuclei, galactic magnetic fields and radio astronomy (led by Marek Urbanik, Michał Ostrowski and collaborators). The observatory is involved in exploiting the large facilities H.E.S.S., the CTA, the LOw Freqeuncy ARray (LOFAR) and SALT.

There is another small group of astronomers in Cracow, employed in the group associated with the Chair of Astronomy within the Institute of Physics at the Pedagogical University, and led by Jerzy Kreiner. They have a small observing station with a 60-centimetre optical telescope located in the Western Carpathian Mountains, 1000 metres above sea level. The main research activities concentrate on observing variable stars (pulsating and eclipsing binaries).

Centre for Astronomy of the Nicolaus Copernicus University

The Centre for Astronomy of the Nicolaus Copernicus University[4] is a part of the Faculty of Physics, Astronomy and Informatics. It is located in Piwnice village, 15 kilometres north of Toruń. The site contains a 32-metre radio telescope, and a few optical instruments, among them a 90-centimetre Schmidt–Cassegrain telescope and 60-centimetre photometric telescope. The optical telescopes are used mainly for student training and modest research projects. The centre is involved in international collaborations such as the Very Long Baseline Interferometry (VLBI) network, H.E.S.S. and SALT.

The major research activities are concentrated on radio astronomy (led by Andrzej Kus), interstellar matter (Jacek Krełowski), stellar astrophysics, exoplanets and celestial mechanics. Among the most significant achievements of recent years are the spectroscopic observations of red giants conducted by Andrzej Niedzielski and Aleksander Wolszczan with the Hobby–Eberly Telescope in Texas, within the Pennsylvania–Toruń Planet Search, which has led to the detection of 20 exoplanets. Theoretical investigations by Krzysztof Goździewski and his collaborators have enabled the determination of the orbital parameters and masses of several exoplanets.

Astronomical Observatory of the Adam Mickiewicz University

The Astronomical Observatory of the Adam Mickiewicz University[5] is a part of the Faculty of Physics of the university. The main areas of work include the dynamics of artificial satellites and small bodies in the Solar System, including non-gravitational effects (work of Sławomir Breiter and Agnieszka Kryszczyńska), as well as the investigation of the physical properties of asteroids (under Tadeusz Michałowski).

Not long ago, observational astrophysical research was started at the Observatory. Recently, a new, small robotic telescope went into operation at the University of Arizona. It is equipped with a spectrograph and it supplements a small double telescope located near Poznań. Together they make up the Global Astrophysical Telescope System project.

Astronomical Institute of Wrocław University

The Astronomical Institute of Wrocław University[6] is a part of the Faculty of Physics and Astronomy. Research is concentrated on two main subjects: investigation of Solar activity (by J. Jakimiec and his group) and of pulsating stars (led by Mikołaj Jerzykiewicz and Andrzej Pigulski). Heliophysicists carry out observations of dynamical phenomena in the Solar atmosphere using a coronagraph located near Wrocław, but they also extensively use satellite observations. Observations and pulsation modelling of β Cephei-type variables (among them DD Lac, which has been investigated in Wrocław for the last 50 years) and δ Scuti-type variables have resulted in an accurate determination of the basic parameters of several of these stars.

Institute of Astronomy of the Zielona Góra University

The Institute of Astronomy of the Zielona Góra University[7] is a young institute, founded in the year 2000, and is part of the Faculty of Physics and Astronomy. Research is concentrated on the magnetospheres of pulsars, neutron stars, high-energy astrophysics and celestial mechanics. The physical parameters of neutron stars, their magnetic fields and internal structure are modelled, based on the analysis of radio emission of pulsars (started by the late founder of the institute, Janusz Gil, and continued by Giorgi Melikidze). The properties of binary compact objects and the dynamics of planetary systems are also investigated.

Space Research Centre of the Polish Academy of Sciences

The main body of the Space Research Centre (SRC) of the Polish Academy of Sciences[8] is located in Warsaw and its two divisions in Poznań and Wrocław. Some of the research areas cover astronomical targets: the dynamics and physics of planets and the small bodies of the Solar System (Marek Banaszkiewicz and Hans Rickman with their collaborators), interplanetary space and the heliosphere (S. Grzędzielski and his colleagues) and Solar physics (Janusz Sylwester and his group). All the Polish instruments that have flown on a variety of space missions, e.g., Cassini, Herschel, Integral, Rosetta and Solar Orbiter, were built at the SRC and Polish scientists coauthored the papers describing the achieved results. The first two Polish scientific satellites, Lem and Hevelius, which are part of the international programme BRITE, have also been built there. The SRC will face important new tasks in instrumentation resulting from Poland's recent entry into the European Space Agency (ESA).

As Poland joins ESO we are very optimistic about the future of Polish astronomy. The talents and competence of the young generation of astronomers, supplemented by access to modern instrumentation and the wide range of possibilities that have opened up for international collaboration, will certainly soon result in numerous exciting discoveries, deepening our understanding of nature.

Acknowledgements

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Links

[1] Nicolaus Copernicus Astronomical Centre of the Polish Academy of Sciences: http://www.camk.edu.pl
[2] Warsaw University Observatory: http://www.astrouw.edu.pl
[3] Astronomical Observatory of the Jagiellonian University: http://www.oa.uj.edu.pl
[4] Centre for Astronomy of the Nicolaus Copernicus University: http://www.ca.umk.pl
[5] Astronomical Observatory of the Adam Mickiewicz University: http://www.astro.amu.edu.pl
[6] Astronomical Institute of Wrocław University: http://www.astro.uni.wroc.pl
[7] Institute of Astronomy of the Zielona Góra University: http://astro.ia.uz.zgora.pl
[8] Space Research Centre of the Polish Academy of Sciences: http://www.cbk.waw.pl