POSTSCRIPT

AN OVERVIEW OF POLISH ASTRONOMY

> "I was pleased to think about that simple veto right of the Polish nobleman, and how it could upset the resolution of a meeting; and then at the same time of the Pole Copernikus, who seems to have used this same right, against the resolution and appearances of other people, in its largest and most worthy use."
>
> -Neitzsche

In the Old Rzeczpospolita, astronomical infrastructure consisted of the tools in the hands of the great astronomers. In Matejko's painting of Copernicus' conversation with God, we see some of these instruments. To see them in real-life, one may go to Torun, Frombork or the Jagiellonian University's Collegium Maius. When on his deathbed, Copernicus was presented with his revolutionary work; it is said he arose from a comatose state, beheld it, and expired in a state of peace. Although Arthur Kosteler called it the 'book that nobody read,' *De Revolutionibus Orbium Coelestium* indeed was, as proven by history, and more recently, by the scholarship of Harvard's Gingreich, who tracked down every last one of the first and second editions.[1] Even so, the 16th Century would not see Copernicus' heliocentric model widely used. When Galileo employed so effectively the telescope nearly seventy years later, popularizing heliocentrism, telescopes, in general, soon began making their way around Europe. Soon a Pole studying abroad was to bring some home.

A Kaliszanin, Alexius Sylvius (called Polonus), was in 1613 studying in Belgium, and helping there in early observations of sunspots. Upon returning to Kalisz with two telescopes, he formed a small observatory to continue sunspot study. Sylvius fashioned other instruments too, before departing once again for Belgium and later Spain (where he is said to have constructed a working model of the heliocentric universe, driven by weights, in Madrid).

At the same time (the time of Wladyslaw IV Vasa), Wilno University Professor Andrzej Milewski conducted regular lectures in astronomy. Many specialized fields, such as fortification, ballistics, geodesy and cartography, demanded general astronomical knowledge. At the same time, Professor Oswald Kruger used his mathematics lectures to focus on astronomical topics, which inspired many of his students. One went on to publish a work on the recent findings of Galileo, along with descriptions of his telescope and methods. An even greater work came from another student, named Dyblinski, who published a textbook called *Centuria Astronomica* in 1639. This was a 'comprehensive, though popular, review of astronomy based on works of the

[1] Giengreich

most eminent astronomers.'[2] At Jagiellonian University, Prof. Jan Brozek popularized the heliocentric model. Near Kielce, an interesting book was written by Stanislaw Lubieniecki, called *Theatrum Cometicum*, which was an anthology containing over 400 comets known from Biblical times to the 17th Century.

In 1640, the great astronomer Jan Hevelius in Gdansk was finishing the finest observatory of the 17th Century. Built inside of, and on top, of his home (which he called *Gwiezdne Miasto* 'Star Town'). Its centerpiece was the world's largest telescope (50x mag.). Hevelius designed and built his own instruments; some based on those of his friend Tycho Brahe who was working in Prague. Sir Edmund Halley in England sent him some of his own special telescope lenses. Because nothing was standardized in this early time, astronomers themselves generally made equipment, using techniques shared with each other.

Throughout the time of Jan Kazimierz and the wars that plagued the 17th Century, Hevelius and his friends catalogued the sky, systematizing the constellations. He produced books about comets, the lunar surface, and a sky atlas- all containing precise measurements, drawings and data. Hevelius also built a solar telescope to get a better look at sunspots, by projecting the Sun's image into a dark room.

In the 1650s, Gwiezdne Miasto was enlarged, covering now three kamienicas (on today's ul. Heweliusza). In *Machina Coelestis* (1673), the rooms are described as having "three wooden walls and a canvas (or leather) curtain wall that rolls up for observing," and the room itself, "is wheel-mounted and rotatable to face a celestial object." One of his prized tools was a "quadrant made of copper, with an iron frame, engraved with portraits of Hipparchus, Ptolemy, Copernicus, and Tycho Brahe." Many of his tools were plated in gold, to guard against the salt air- so familiar to Gdansk residents.

When Jan III ascended the throne, he terrorized not only the Turk, but also ignorance of the cosmos. He was a great patron of Hevelius, and during visits to Gdansk (which was still the largest city in his realm), he was sure to stop in to the observatory.[3] The king's patronage proved especially important in 1679, when a fire destroyed the whole thing. It began anew, however, and Hevelius did not forget his master's contribution: when it fell to him to name a new constellation, he made sure that over their heads in the 17th Century (and ours in the 21st Century) will always fly *Scutum Sobiescanum*: the Shield of Sobieski.

[2] Wilno University Observatory
[3] Uranos

Hevelius died in 1687. Without him, astronomy was somewhat stagnant in the Commonwealth for the next fifty years. Even at Jagiellonian University, the Ptolemaic model continued to be used until the mid-18th Century.[4]

Interminable conflict continued into the 18th Century, and the Noble Republic went into decline. Still, in the Wettin Period, Magnates and other Szlachta supported the arts and sciences. This trend in social life played a key role in Poland's first permanent institutional observatory, envisioned by Thomas Zebrowski in Wilno. After finishing the blueprints, he presented them not to the state, but to noblewoman Elzbieta Oginska-Puzynina, who funded the construction of its physical plant. Nobleman Michal Radziwill donated the telescope, and Josephus Sapieha, Bishop of Wilno, provided other instruements.

Constructed on top of the main university building, it began operations in 1753. Zebrowski observed the Moon and those of Jupiter, and determined the latitude of the city astronomically. Later, Marcin Odlianicki-Poczobut built an extension that made the building itself into a scientific instrument: "The enlarged structure had two towers for observations and a firm sandstone wall in the plane of the meridian. It divided the premesis of the new building into two equal parts. The wall was built for the fixing of the large meridian quadrant. The front wall of the observatory was decorated with signs of the Zodiac and Latin quotations."[5] Locating asteroid, comet and planetary positions became its main fuction. A later astronomer, Lalande, used Wilno's data on the planet Mercury to make the first calculation of its exact orbit.

Some other sites became active on a smaller scale during this Enlightenment Period. Around 1760 in Poznan, the Jesuit College got an endowment of scientific equipment from Princess Maria Leszczynska, including some telescopes, which it used to found a small observatory. This operated for twenty years before being demolished, as the college itself became a barracks for the Prussian Army.

At the same time, three personal observatories were set up. One, by the enterprising N. M. Wolf, operated in Gdansk, and was passed to an organization called the Natural History Society after his death in 1785. The society used it until its deomolition in 1813. In Warsaw meanwhile, the Czartoryski family and King Stanislaw August Poniatowski set up their own observatories during these last years of the Enlightenment. But it was in Kraków that a second true center of Polish astronomy was destined to rise.

There was an atmosphere of reform in Kraków after the First Partition of 1772; the KEN affected education, especially. Refromer Hugo Kollataj chose Jan Sniadecki to be

[4] UJ Observatory
[5] University of Wilno

Jagiellonian professor of mathematics. Sniadecki went on leave to Germany, where he worked at an observatory, before making his way to Holland and finally France, where he met Charles Messier and the Encyclopedist d'Alembert. In 1776, it was decided that a new UJ Observatory would be built in the beautiful Botanical Gardens (east of the Planty on ul. Kopernika) in a building that had belonged to the Jesuit Order. Sniadecki was not exactly happy about the building, "It is more suitable for dances than astronomical observations." But there it was. During the next ten years, Sniadecki lectured in astronomy (dedicating his first lecture, conducted in vernacular Polish, to Copernicus). He then went to England, visiting William Hershel, Oxford and the Royal Society in Greenwich. After his return, the Observatory opened in 1792, containing some of the Leszczynska instruments from the defunct station in Poznan.

The Jagiellonian Observatry was tasked with measuring the positions of the Sun and Moon, observing the Jovian Moons and their eclipses, as well as the transits of planets over the solar disc, and the occultations of stars by the Moon. Sniadecki himself was interested in comets and variable stars, "in the last, he was ahead of his time."[6]

In imagining the cosmos meanwhile, Michal Dymitr Krajewski from the Rus Wojwodship, was a kind of Polish Jules Verne, preceding Verne himself. His *Podolanka* (1784) criticizes humanity's ongoing subordination of nature, as the later Fedorov would do in his philosophy of Russian Cosmism, while in *Wojciech Zdarzyński* (1785), he depicts a Pole who, traveling in a balloon, goes to the Moon and finds there a kind of utopia. Krajewski was a reformest and a priest, who was still a 'friend of science.'

The Partitions of Poland put its centers of astronomy in different empires. Kraków went to Austria and Wilno to Russia. The Austrians reorganized Jagiellonian University along the empire's centralized educational structure. Things became unhappy for Sniadecki, who soon left Kraków for the West, and finally to Wilno, where he took over the observatory in 1807, succeeding Paczubut. UJ astronomy began a long thirty-year transition period, where not much was accomplished.

In Wilno, things did not look as bad. Sniadecki and assistant Piotr Slawinski continued observation on all kinds of celestial bodies: the planets, moons, asteroids, comets, and of course the Sun. They determined geographical coordinates and shared data with the observatories of Berlin, Greenwich, Königsberg, Paris, and of course its overseer- the Russian station at St. Petersburg- Pulkovo. Slawinski wrote the first Polish language astronomy book in 1828.

In Warsaw, the old capital (now that of the temporary Congress Kingdom), a new university was founded in 1816. Under rector Franciszek Arminski, an observatory opened there

[6] UJ Observatory

in 1825. It contained, among other things, a heliometer for measuring the Sun, a comet-finder, and three clocks made by 'Gugenmus of Warsaw.' But neither this facility, nor its university, were to last.

During the November 1830 Uprising, the Russian Army advanced on the city. In the aftermath, Tsar Nikolai decreed the closing of Polish universities, which included Warsaw and Wilno. In Wilno, activity at the Observatory continued under Slawinski, but was now overseen by the *Imperial Academy of Sciences*. Russian astronomers from Pulkovo wound up replacing most of the Polish staff, bringing with them some new instruments: a photoheliograph, photometer and spectroscope. In Warsaw, the Observatory was temporarily dismanteled by Arminski, who later reconstituted it when the atmosphere allowed it. His successor Jan Baranowski translated *De Revolutionibus* into Polish for the first time, while astronomer Jan Kowalczyk catalogued the coordinates of 6,041 stars during twenty years of observations. Also during this time, astrophysict Adam Prazmowski discovered that light from the Sun's corona was polarized. Steadily, however, Russian astronomers replaced their Polish counterparts here as well. At the same time, some Poles found success in Russia. Marian Kowalski studied in St. Petersburg before taking a post at the Observatory in Kazan. While there, he discovered how the Milky Way Galaxy rotates, accurately described the orbit of newly-discovered Neptune, as well as how binary stars 'dance' with each other- findings he presented in his *Recherches astronomiques de l'observatoire de Kasan* of 1859.

The January Uprising of 1863 came and went, but because the Warsaw and Wilno facilities were now Russian, they were not damaged. Wilno in fact was developing into a fine Solar Observatory, where nearly a thousand photographs of the Sun, along with new spectroscopic and photometric measurements, were obtained. In 1876, however, a fire broke out, and there were no funds to restore the damaged building. After a century of use then, it was closed, its instruments sent to Pulkovo, its books to Russian libraries.

In mid-century, Maximilian Weisse revived the UJ Observatory in Habsburg Kraków, with instruments from his native Vienna. He conducted the measuring of orbits, magnetism and meterorology, as well as published a 63,000 star-cataglogue (for comparison, on a starry night, one can see about 2,000 with the naked eye). In 1862, successor Franciszek Karlinski conducted an inventory: 96 instruments, 10 clocks, 941 books and 100 pieces of furniture. During his forty-year directorship, Karlinski gave many Polish junior-scientists an opportunity to work and train with him. He also standardized astronomical observations using digital code, which modified later, is still used by the International Astronomical Union. The main function of the UJ

Observatory, however, was to serve an imperial puropose: as meteorological station for the Province of Galicia.

At the end of the 19th Century, UJ physicist L.A. Birkenmajer calculated the orbits of binary stars and planetary moons, sought to find the shape of the globe, and studied its magnetic field. In 1902, Karlinski retired and Prof. M.P. Rudzki stepped in, bringing with him great plans for new grounds outside Kraków city, but these went unrealized, smoted out by WWI. Rudzki proposed a new method of determining the shape of the Earth, recalling it in his first book, "*Physics of the Earth*" (1909) before writing his more well known "*Theoretical Astronomy.*"

In the meantime, Lwow, capital of Austrian Galicia, became a center of astronomy under D. Zbrozek in 1877. A large telescope was installed from Vienna in the 1880s, and by the time of WWI, many kinds of telescopes were being used, including photographic and equatorial. Astronomy classes have been held at Lwow University since 1900.

Within the vicissitudes of official action, one should not forget successful amateurs. In the village of Plonsk northwest of Warsaw, Jan Jedrzejewicz observed double stars, sunspots, lunar occultations, and the positions of 16 comets. He then wrote an astronomy handbook called "*Kosmografia*" in 1886. After his death, his equipment and material was brought to Warsaw, where it was taken over by the Society of the Sciences in Mokotow, and used to observe comets and nebulae.

Gdansk continued to play some role in astronomy as well, seeing one observatory open, and another re-open, in the later 19th Century. The Natural History Society re-inaugurated its defunct station in 1868, and joined to the School of Navigation. It had around five telescopes, one of which could take pictures. The new one, and the last to open during the Partition Period, was set up down the road at the Sts. Peter and Paul High School. In 1904 it used Zeiss equipment to photograph and study the Sun, meteors, asteroids, comets and the Galilean Satellites.

At the turn of the century, another Polish science fiction writer emerged, Jerzy Zulawski, a teacher who moved on to travel and write full time. Critiquing his '*Lunar Trilogy*' (1901-11) Stanislaw Lem professed that reading it constituted for him one of those life-changing experiences, eventually inspiring him to be a 'writer of the fantastic.' In the story, a heroic group goes to the Moon, stays there as the generations pass before descendents eventually restore the original spacecraft, allowing them to return to Earth, the home of their ancestors. Also notable from the period is Antoni Slonimski's *Dwa końce świata*, a dystopian novel. Unfortunately, to ponder dystopianism in the early 20th Century was not far wrong.

The World War ushering in the calamitous 20th Century, the one named by William S. Lind and a growing number of others as the beginning of the end of Western Civilization, did

bring the Polish state back for twenty years. Many new projects and renewals appeared in the II Republic, including the refounding of the University of Wilno in 1919, just as Pilsudski brought the city into Poland again. The Obervatory was in sorry condition (after the 1876 fire), and declared unsuitable for astronomical work by Wladyslaw Dziewulski, who made the decision to move it to the outskirts of the city (today's Vingis Park). Under Dziewulski, by the end of the Interwar Period, Wilno became the most modern observatory in Poland, researching astrophysics, spectroscopy, and variable stars, and publishing the *Bulletin de l'Observatoire astronomique de Wilno*.

In Warsaw, astronomy lectures were continued but observations were not, because the equipment was taken to Rostov when the Russians left the city in 1915. That did not stop physicist Czeslaw Bialobrzeski from being able to determine the importance of radiation inside stars. Meanwhile, Michał Kamieński, an expert in cometary orbits, who had worked in Russia and Japan, led the observatory's renewal, aided in no small part when its instruments were returned by the Soviets in 1925. Positions of asteroids and comets, occultations and variable stars were studied. Also in 1925, Warsaw Polytechnic began its own observations, while a few years later in 1931, at Piaseczno just south of the city, variable stars, colorimetry, and planetary surfaces were studied in a small facility begun by the short-lived 'Free University of Poland.'

In Poznan, Bohdan Zaleski, who had experience at St. Petersburg- Pulkovo, began setting up a new Adam Mickiewicz Univeristy Observatory, which opened in 1922 with a telescope, astrocamera, meridian circle and books donated by an astronomer working in Germany, Kazimierz Graf. Poznan Observatory measured and published 486 star declinations throughout the 1920s. Later studies consisted of eclipsing binaries, micrometric observation of asteroids and comets, occultations, and the time service.

Studies in Lwow continued as well, especially on eclipses, asteroids, comets, lunar occultation, and, again, the time service. In 1935, an inventory found two telescopes, a photometer and an astrocamera. Work began on a stellar catalog and the photography of variable stars. To the west in Czestochowa, an amateur observatory with two telescopes was built at Park Staszyca in 1931, which studied variable stars.

Wladyslaw Dziewulski, so important in re-establishing Wilno, began his career in Kraków. His early departure from there opened the way for the long tenure of Prof. Tadeusz Banachiewicz, a noted astronomer who worked in Russia, Germany, and Warsaw. He furnished the Jagiellonian Observatory with updated instruments and made it an international center of research in eclipsing binaries (when one star in a multiple star system moves in front of the other), while publishing the scientific journal "*Acta Astronomica*," and personally publishing over

200 papers in celestial mechanics. Today, scientists use the *Banachiewicz-Olbers* method of determining parabolic orbits. He also developed '*Cracovian Calculus*,' still used today in celestial mechanics. The first orbit of Pluto, discovered in 1930 by Percival Lowell using a blink microscope, was determined at UJ Observatory. Banachiewicz also pioneered radio astronomy in Poland. He was a member of Polska Akademia Umiejetnosci, and for at time, served as vice-president of the International Astronomical Union (IAU).

Soon the impact of city lights became clear. After the invention of electric light by Thomas Edison and the illumination of European cities, it made no sense to have observatories in the center of all this light pollution. Better skyviewing was to be had on the outskirts of town or in the countryside, preferably at the tops of high peaks. Before the end of the II Republic, two new observatories were opened further afield.

Tadeusz Banachiewicz was responsible for the first. He sought to establish a 'National Institute of Astronomy,' and center it on a new observatory that all astronomers would have access to. At the same time, because modernist Kraków was growing and its lights became brighter at night, he chose a site outside of the city. So in 1922, on the 922m high on Mt. Lubomir (Lysina) 30 km south of Kraków, the new observatory was built. It monitored solar eclipses with a self-styled 'chronocinematograph,' determined the exact distance between the Earth's continents, and looked at variable stars. Astromers here discovered two comets, in 1925 and 1936. The second, comet Kaho-Kozik-Lis, was co-discovered by the facility's janitor (Lis).

The other major Interwar observatory, Pop Iwan, was even more remote. On a 2020m peak near Czarnohora in the Eastern Carpathians, it was to be used for meteorology and astronomy, financed by the Polish Army in conjunction with Warsaw University. An astrograph and a telescope were installed, and the observatory opened in 1938. It did not last long.

During the Soviet invasion in 1939, Pop Iwan Observatory was completely destroyed and never rebuilt. After Poland was split, arrests were made on both sides. In Nazi controlled Poznan, many UAM Observatory employees were arrested, their positions filled by Germans. Banachiewicz was arrested in Kraków, along with many other Jagiellonian professors. His brainchild, Lubomir Observatory, was set ablaze and destroyed in 1944 during fighting over Beszczady. Warsaw Observatory functioned during the war until the Warsaw Uprising of 1944, when, during the razing of the city, German panzer fire on the observatory obliterated it (including its library).

After the change in borders in 1945, professors and scientists from the former eastern territories, who survived, moved nearly wholesale to new universities in the west. From Wilno they went to Torun, and from Lwow to Wroclaw. In the latter case, the personnel from Lwow

found in Wroclaw the historic Breslau Observatory, dating back to 1790, which thrived during the 19th Century before being refitted and moved to the city's outskirts in the Interwar Period. However, the instrumentation and the library were destroyed, except for a lone telescope, which was refitted in 1952 and used to observe the magnetism of stars. Later the facility would specialize in sunspot measurements. Some 'antique' finds occurred here as well- including a 100 year old telescope made in Konigsburg, which was brought to the Jagiellonian Museum. Also inherited from Germany was an out-of-town station located 70 km north of Wroclaw, in Bialkow. This facility was built in 1932, but its instruments were also either damaged or looted. The other Breslau Observatory station was not retained because it was located in Windhoek, German Southwest Africa.

The Adam Mickiewicz facilities in Poznan came through the war in the best shape. With only minor repairs, they were functioning normally again. When the Cosmic Era began in 1957, the communist authorities required a new kind of 'observation', that being a satellite tracking system, and one was installed here. In 1964, a station in nearby Borowiec was also abrogated by UAM, in conjunction with PAN. Borowiec now specializes in celestial mechanics and geodynamics, including monitoring small variations in the Earth rotation. Borowiec is one of twelve permanent gravimetric stations worldwide. In 1994, the station completed refits for Geodynamic GPS.

Warsaw Observatory meanwhile, reopened in 1950, in accordance with Boleslaw Beirut's Six-Year Plan, which incedentially did not legislate for instruments. Wlodzimierz Zonn and Stefan Piotrowski worked throughout the next decades to make Warsaw Observatory a well-known astrophysics center, focusing on extragalactic astronomy, Einstein's Theory of Relativity, and cosmology. In the 1970s, a new UW Observatory was installed at Ostrowik, 35 km southeast of the city.

After the war, Torun took its place as a great center of Polish and European astronomy. The new Nicholas Copernicus University, opened in 1945, largely employed the faculty from Wilno, including W. Dziewulski. The campus was built on the northwest outskirts of town, and the new observatory 12 km to the north, in Piwnice. Harvard University lended a 19th Century telescope to UMK, used to begin observations in 1949. A decade later the facility was completed, crowned in 1977 with a powerful modern radiotelescope, with a 15 m radio dish that studies the sun, the satellites of Jupiter, interstellar plasma, the cosmic sources of radio waves and conducts radio interferometer measurements.

From the end of the war through the time of Gierek, as we have seen, the new stations all appeared outside of major cities. Along with Piwnice (Torun), Ostrowik (Warsaw), Borowiec

(Poznan) and Bialkow (Wroclaw)… Skala (Kraków) also emerged, in the hinterlands of Malopolska.

Just after the War in 1947, a telescope from UJ Observatory was moved to a new observing station built at Przgorzaly, where a castle-like structure was constructed during the war as a Luftwaffe officers' retreat, on a beautiful hill overlooking the Wisla. This was a precursor for a much more extensive project, carried through by Banachiewicz. In 1953, he obtained from the government an old Austrian fort located 10 km north of Kraków, in Skala. In 1964, on the 600th Anniversary of the Jagiellonian University, the Copernicus Observatory at Fort Skala opened. Consisting of five domes and workshops, it conducts spectroscopy, astrometry, and visual observations, solar and radio astronomy. UJ also authorized another installation in 1976, this one a small outpost station, placed near romote Cisna, in 'a wild forest area of Bieszczady' (southeast Poland).

The old UJ Observatory from 1792 meanwhile, which is also the oldest functioning astronomic facility in Poland, has been quite significant in the postwar period; for example, it was here that Prof. Kazimierz Kordylewski discovered 'space-dust' gathered at certain points in front of and behind the Earth in its orbit, called Trojan Points. In these places, there is a gravitational equilibrium where matter accumulates. Today, they are called 'Kordylewski's clouds.' Also at UJ, the Sun is observed on a daily basis, through radio, while extragalactic radio sources and distant galaxies are mapped. Kraków and its outpost sites, it might be added, had at this time become a center of the deepest form of space study: extragalactic astronomy and cosmology, much through the influence of Prof. Konrad Rudnicki. His work, culminating in *The Cosmological Principles*, has outlined five principles, both historic and modern. They include: Ancient Hindu, Classical Greek, Genuine Copernican, Generalized Copernican, Perfect and Anthropic.

Science fiction meanwhile, containing visions of the cosmos within stories and discussions of the human condition, have been prolific in Poland as well. The truly great name is of course Stanislaw Lem, whose Solaris is only his most famous work- many of which are now rediscovered and translated into other languages.

In the 1980s, another Kraków institute of higher education became a 'space power,' this being the Kraków Pedagogical Academy. Prof. Jerzy Kreiner successfully made the case for a state of the art facility in a good climate, at a high elevation. The Academy agreed that such a facility would be good for both research and teacher training. Many spots were looked at and finally, the 1,009 m peak of Mt. Suhora, 60 km southeast of Kraków, was selected. Happily, a chair lift at the villge of Tobolow helped in transportation of people and material. Opened in 1987

to the words, "*Let this place represent a vision for the 21st Century*," it is equipped with a powerful telescope, advanced photometers, and specializes in variable stars. In 1991, Mt. Suhora became part of the International "Whole Earth Telescope," allowing uninterrupted observations of variable stars.

If by now the reader suspects that Poles today should be quite active in conducting astronomical projects around the world and at home, he would be correct. The remarkable Bohdan Paczynski from Warsaw University now possesses the Spitzer Chair in Astrophysics at Princeton. He has developed our modern understanding of the life cycle of stars. Other contributions range from developing the technique of microlensing to discover illusive deep-space objects, to investigating enigmatic cosmic explosions called Gamma Ray Bursts. This famous astronomer teamed up in 1992 with Prof. Andrzej Udalski and Warsaw University on a project called the Optical Gravitational Lensing Experiment (OGLE). A special telescope was made in Poland and transported to one of the driest places on Earth: the Atacama Desert in Chile. OGLE has been critical to our understanding of dark matter, and has discovered a large number of planets orbiting other stars.

Another Polish project garnering worldwide acclaim is the All-Sky Automated Survey (ASAS). Paczynski and Grzegorz Pojmanski of Warsaw Observatory initiated the project, which began in 1997. As you read this, it continuously measures the exact brighness of 10 million stars, and has discovered two comets. ASAS is also located under the clear skies of the Atacama Desert. Pojmanski and his staff at UW Observatory monitor it remotely from Warsaw, using the Internet, whilst the crew of OGLE does physical on-site work that is periodically needed.

At another faraway location, the Great Karoo of South Africa, the South African Large Telescope (SALT) is jointly run by Polish and international authorities... and it really is large: the largest optical telescope in the southern hemisphere. Because facilities located in the north never have access to half the sky, the sky of Centaurus, the Southern Cross and the Magellanic Clouds, this facility, like that in Chile, is especially valuable.

Another remarkable circumstance has been the recent discovery of well over 200 planets around other stars. The discoverer of the very first extrasolar planet (1990), which must go down as one of the most important and epoch-making findings in the history of science, was Polish astronomer Aleksander Wolszczan, working at the Arecibo Observatory in Puerto Rico. Another Pole meanwhile, Maciej Konacki, discovered the first planet located in a star system with three

suns (like that of our nearest neighbor, Alpha Centauri). He was using the Keck I telescope in Hawaii.[7]

If the observatory is, for the astronomer, a place to observe, catalogue and discover new things about the cosmos, so the planetarium is the tool that brings to the masses the education and excitement of space-studies. Indeed, in Chapter IV of *Tsiolkovsky's Imperative*, the planetarium was referred to as the ultimate teaching tool, whose capability goes beyond even presentation of astronomical and space-studies content.

In 1955, two years before the Space Age began, Poland's first planetarium opened its doors. Still the largest in the country and one of the larger in the world (22 m dome), Silesian Planetarium also contains a small observatory. It has hosted shows continuously for over fifty years, and has even been featured on a PRL stamp. Another notable planetarium was installed in a special place:

> It was embedded in an octagonal tower belonging to the fortifications around the gothic cathedral in Frombork, the small town on the Baltic Sea where Copernicus lived for nearly 30 years. From his rooms in another of the old towers, Copernicus could just see the humble houses of fishermen, the small port, and the sea at the horizon. Here, in what he called, 'the remotest corner of the Earth,' Copernicus prepared the six volumes of *De revolutionibus*.[8]

Named for Wladyslaw Dziewulski and uniquely placed in a 19th Century storage tank in the center of town, the planetarium in Torun is very popular. It shows programs in both Polish and English, and stands as a clear example to other cities of a facility fulfilling a role as educational tool for the entire community, as well as a special place for schoolchildren. Today, there are also planetariums (besides Chorzow (1955), Frombork (1973) and Torun (1994), in Grudzadz (1972), Warsaw (1972), Olsztyn (1973), Oksywie (1975), Gdynia (1979), Komorowo (1980), Piotrkow Trybunalski (1981), Lodz (1984), Jarocin (1993),) and Kielce (2005). Other facilities with variable showings exist in Poznan and Szczecin. Because there are so few, not much demand comes in for media programs generated specially for this medium. However, foreign productions are easily translatable and narrated in Polish, while native programs can be demanded and commissioned by the educational authorities.

The power of the planetarium is spelled out by Cicylia Iwaniszewska of UMK:

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[7] This material was gathered from public domain sources and compliled with no intention to present an exausive whole- merely to present a snapshot of how important astronomical investigaton has been in Poland, and how the discoveries and thought emenating from the Polish lands has contributed to Western and universal understanding of the cosmos.

[8] Planetarium site

> My colleagues and I have found that competition (among school classes hosted by the planetarium) not only can enlarge children's astronomical knowledge, but also can give them general ability to express themselves. The improvement has been especially visible in the case of very young children, who can take part in successive years.[9]

It is never too early to plant the cosmic vision. Prof. Iwaniszewska also relates what form astronomy takes today in Polish schools:

> Some basic astronomy notions are introduced in geography and physics lessons in elementary school. In secondary school, astronomy was once a separate subject in the last year, but the introduction of school-free Saturdays 20 years ago reduced the total number of school hours, and the astronomy lessons were discontinued.[10]

Chronologically, the future comes no matter what. What kind of future it will be, however, is up to us. Considering the long tradition of Polish astronomy, only crudely presented here, it seems time to bring back not only the lessons, but also rethink and renew a comprehensive philosophy of astronomy. One that can be experienced best using that new and superb format of presentation: the planetarium. From the universities running programs for Polish schoolteachers, to planetarium construction in regional centers (first) and then at local levels, to coordinated programming, to a much desired pan-European focus in the service of a core curriculum of history-culture-space studies, a real educational advancement can be made. The goal of placing a mentality of achievement back into students today can be realized. Many cities (even some with large university populations) still have no planetarium. The best example is Kraków- a good place to start. Maybe Hungarian scientist Dennis Gabor, inventor of the hologram, said it best when thinking of the role of human action in making a better tomorrow: “The future cannot be predicted. But futures can be invented.”

[9] Planetarium site
[10] Iwaniszewska