10 YEARS OF POLAND IN ESA

Ministerstwo Rozwoju i Technologii

POLSA


ERIDANUS
FORNAX
PHOENIX
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CAELUM
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PICTOR
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CHAMAEL
CANIS
MAJOR
CARINA
PUPPIS
VELA
PYXIS
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10 YEARS OF POLAND IN ESA

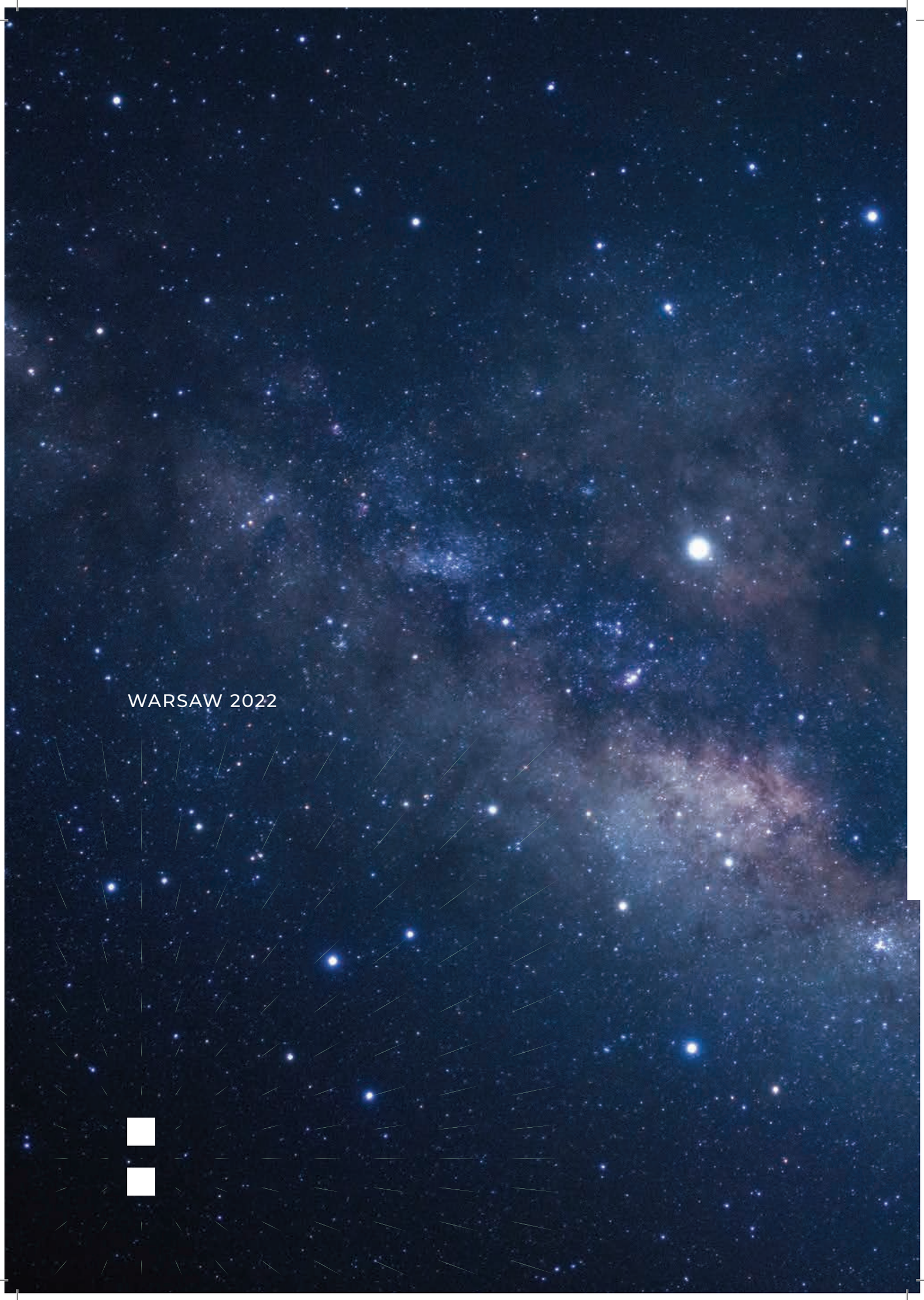

WARSAW 2022

TABLE OF CONTENTS

Ministry of Economic
Development and Technology

POLSA

10

YEARS OF POLAND
IN THE EUROPEAN SPACE
AGENCY

10

YEARS OF POLAND IN THE EUROPEAN SPACE AGENCY

Contracts worth more than EUR 140 million, 300 cooperating entities, including more than 150 directly involved in projects, access to ground and space infrastructure, cooperation with national agencies and the largest companies in the space sector, opportunities for the development of Polish technologies, significant involvement in the space projects' supply chain, staff development, and various educational programmes – these are just a selection of benefits stemming from Poland's 10 years of presence in the European Space Agency (ESA).

Over the years, the internationally recognised achievements of Polish scientists and space engineers have been the basis for seeking systemic and institutional solutions that would be an impetus for the development of the Polish space sector.

The very first contacts between Poland and ESA date back to 1994, with the signing of a cooperation agreement on the peaceful use of space. In 2002, the agreement was extended. The cooperation became closer after Poland's accession to the European Union in May 2004. Since then, the Polish government started negotiations, which resulted in the signing of the European Cooperating State Agreement with ESA in 2007. The agreement led to a significant increase in the number, quality, and advancement of Polish products and services utilising satellite technology.

POLAND IN ESA

Poland's accession to ESA in 2012 was a very important step for the development of the Polish space sector. Below are some of the key dates:

JULY
2012
The ESA's Council unanimously approved Poland's accession to ESA.

13 SEPTEMBER
2012
Accession documents were signed in Warszawa. Poland was represented by Waldemar Pawlak, Deputy Prime Minister and Minister of Economy. ESA was represented by its then Director General Jean-Jacques Dordain.

NOVEMBER
2012
The agreement was ratified by the Polish Parliament and the President of Poland

19 NOVEMBER
2012
Poland became the 20th ESA Member State.

Thanks to the cooperation with ESA, the Polish space sector has begun to develop. Currently, Polish entrepreneurs and scientists cooperate with new partners and develop various technologies. They receive financial support and have access to ESA's infrastructure. The Polish sector learns from the experience and knowledge of other countries, shares its experiences and achievements, and participates in ground-breaking projects. As a result, Poland has become a significant and recognisable partner in European space programmes.

The year 2012 marked a turning point in Poland's efforts to make active use of outer space. The first Polish student nanosatellite PW-Sat, built with the collaborative efforts of the Warsaw University of Technology and the Space Research Centre of the Polish Academy of Sciences, was placed in the geocentric orbit. A year later (2013), the first Polish scientific nanosatellite LEM was launched and, together with its twin HEWELIUSZ (2014), joined the international constellation of astronomy satellites (BRITE). To date, several other Polish designs have been put in orbit, mainly based on the CubeSat platform. Work is also underway on much larger satellites and their constellations for use in Earth observation (including by the Polish Armed Forces) and for scientific purposes, such as astrophysical research.

In 2019, the Polish Industry Incentive Scheme (PLIIS) 2012–2019, a support scheme for Polish entities, came to an end. During its period, 45% of the Polish mandatory contribution to ESA was allocated to the adaptation of Polish industry, operators, the scientific community, and other entities operating in the country to ESA requirements. Nearly five hundred applications were submitted to PLIIS, of which more than two hundred were accepted.

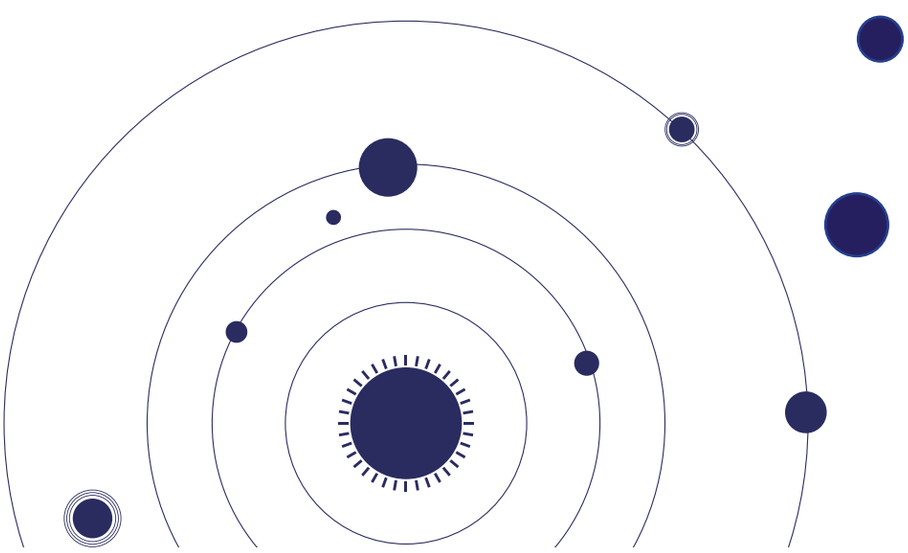
Currently, Polish contribution amounts to approximately EUR 40 million per year. These expenditures allow us to participate in various programmes, such as Earth observation, satellite navigation, telecommunications and applications, space exploration, Space Situational Awareness, and programmes for the construction of scientific instruments.

Joining ESA also enabled Polish companies and research centres to intensively develop space technologies and satellite techniques through the full participation in various ESA programmes. In recent years, Polish engineers and scientists contrinuted to many European space missions, including CASSINI-HUYGENS, ROSSETTA, BEPICOLOMBO, and SOLAR ORBITER.

Polish activities in ESA are coordinated by a delegation comprising representatives of the Ministry of Development and Technology, the Ministry of Science and Education, the Ministry of Foreign Affairs, the Chancellery of the Prime Minister, and agencies, such as the Internal Security Agency and the Polish Space Agency. The delegation is supported by experts, including representatives of the Polish Armed Forces, science, and public administration.

ESA runs two types of programmes:

1. **Mandatory programmes** – in which all Member States are required to participate (the amount of a contribution is calculated based on the country's GDP); and
2. **Optional programmes** – financed by participating states in amounts declared during the cycilcal ESA's Ministerial Councils.

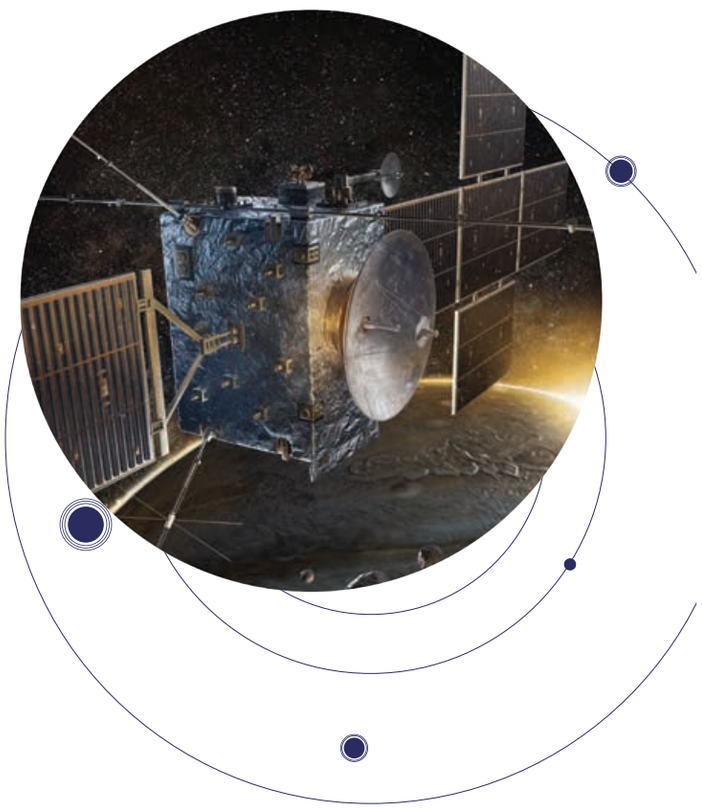


Two years after Poland's accession to ESA (2014), the Parliament of the Republic of Poland passed a law to establish the Polish Space Agency (POLSA), an executive body of the Polish government subordinate to the Ministry of Development and Technology. POLSA integrates public administration, science, and business, and acts as a partner in talks with international entities. The aim of its operation is to increase the use of satellite systems and accelerate the development of space technologies for the benefit of national administration, science, education, economy, and defence.

In line with the Polish Space Strategy (PSK), adopted by the government in 2017, POLSA supports the Ministry of Development and Technology in developing the National Space Programme (NCP). The document is to define systematic goals, plans, and challenges of the Polish space sector for the coming years based on previously allocated financial resources. POLSA closely cooperates with ESA by taking an active part in the Space Safety Programme Board. The objective of the programme is to develop technologies for the observation of artificial and natural space objects, study space weather issues, and carry out tasks related to the active removal of space debris.

The Agency is also involved in activities aimed at increasing the use of satellite data by state and local administrations and disseminating satellite data for wide use. Sat4Envi is a platform for sharing and processing satellite data provided by the Copernicus programme (Sentinel satellites) and other environmental and meteorological satellites in the Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). POLSA provides courses on the use of satellite data for public administration.

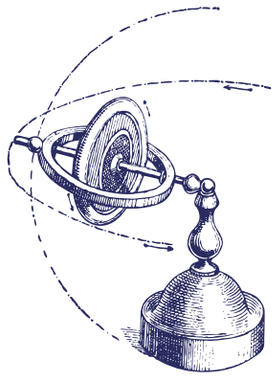
Another significant international project in which POLSA participates is ENTRUSTED whose aim is to identify the needs and expectations of end users of the secure satellite communication system. The project will lay the groundwork for GOVSATCOM, a future EU programme. The programme is intended to provide safe access to satellite communications for public administrations of the EU Member States as well as EU institutions and agencies.



POLSA

POLISH SPACE SECTOR

The size of the Polish space sector can be estimated based on the number of entities registered on the ESA's System for Tendering and Registration (ESA STAR) portal. In July 2021, there were 380 Polish entities registered. As mush as 79% of entities registered in ESA STAR were enterprises (of which 40% were small and medium-sized enterprises). The ESA data shows that 156 enterprises participated in ESA contracts (as prime contractors or subcontractors) between 2015 and the first quarter of 2020. The total employment in the Polish space sector is currently estimated at nearly 12 thousand jobs. Polish companies are particularly active in such areas as robotics and automation, mechatronics, power supply systems for on-board units, optical and communication systems for satellites, soil sensors and penetrators for space probes, and software for testing systems and subsystems of objects launched into orbit. For several years now, work has also been underway on fully retrievable Polish suborbital rockets able to reach an altitude of more than 100 km (the so-called Kármán line – border of the outer space). They are designed to be able to take a payload of several dozen kilograms, e.g. various types of scientific and engineering experiments requiring a micro-g environment.



PLANS FOR 2022 WITH ESA

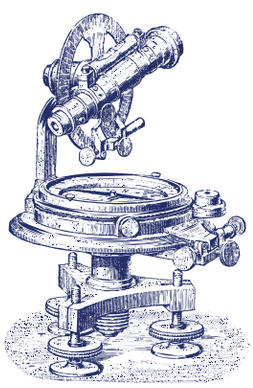
The year 2022 marks the 10th anniversary of Poland's entry into ESA. The ESA Ministerial Council, scheduled for November, will be particularly important as it will anounce key decisions regarding the financing of the European space sector, including the launch of new space programmes, the continuation of those already underway, and multi-annual financial commitments. The Polish delegation, in setting the negotiation priorities for the ESA Ministerial Council, will pay particular attention to the implementation of the National Space Programme in 2022. The programme sets out the paths for the development of the Polish space sector for the coming years. Poland's participation in the European space sector will also be affected by the space activities act. The final version of the act is to be prepared in the coming months as a result of joint works of the scientific community and public administration.

THE HISTORY OF SPACE EXPLORATION IN POLAND

Astronomical research – Polish astronomers

The history of ground-breaking Polish space research dates back to **Nicolaus Copernicus** (1473–1543), who revolutionised the perception of the Earth's place in the Solar System. The Copernican revolution opened a new chapter in astronomy, developed by successive generations of famous astronomers, such as **Galileo Galilei** (1564–1642) and **Johannes Kepler** (1571–1630). The achievements of Copernicus are known to any space enthusiast. The European Commission's Earth Observation Programme's was named in his honour (Copernicus). The native scientific community as well as central and local governments have already started preparing for next year's celebrations of the 550th anniversary of the great astronomer's birth. Another great Polish scientist who changed the state of research is **Johannes Hevelius** (1611–1687). In his observatory in Gdańsk, together with **Elisabeth Hevelius**, he made regular observations of the positions of stars, which he eagerly entered in the catalogue. He became world-famous especially for his monographs on comets (Cometographia), the Moon (Selenographia) and his posthumously published work, *Prodromus astronomiae cum catalogo fixarum et Firmamentum Sobiescianum sive Uranographia*, containing the positions of 1,888 stars, which was a record achievement at the time.

Maria Kunic (1610–1664), Hevelius' peer, was an astronomer working in Silesia, whose main achievement was the refinement of the famous Kepler's Rudolphine Tables, a system based on the Copernican model of the world, used to determine the future positions of the planets. At the time of the partitions, **Jan Śniadecki** (1756–1830) had the most notable achievements in the fields of astronomy, mathematics, and geography. He published his works in his native language, sustaining national awareness, education, and hope for a free Poland. The turn of the 19th and 20th centuries saw the rapid development of world astronomy as well as its new observation and calculation methods. Poles were also involved in those projects and their works set new directions for research. Researchers, who led the way in celestial mechanics, dealing with calculating orbits of celestial bodies, include **Felicjan Kępiński** (1885–1966), **Michał Kamieński** (1879–1973), and **Grzegorz Sitarski** (1932–2015). **Tadeusz Banachiewicz** (1882–1954) invented **Cracovian Calculus**, a new mathematical method named after the place where he worked. In the pre-computer era, it greatly facilitated and accelerated astronomical calculations made with manual arithmometers.



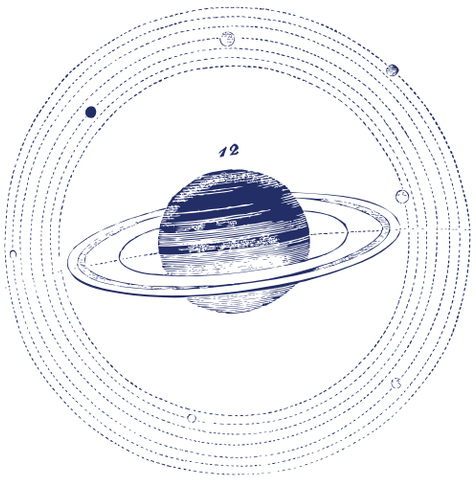
Poles also had their comet hunters, i.e. seekers and discoverers of mysterious objects with tails. Hevelius discovered at least seven of them. Others were discovered by such researchers as Lucjan Orkisz (1899–1973), Władysław Lis (1911–1980), Antoni Wilk (1876–1940), Konrad Rudnicki (1926–2013), Grzegorz Pojmański, a team composed of Marcin Gędek, Michał Kusiak, Rafał Reszelewski, and Michał Żołnowski, as well as Kacper Wierzchoś. Furthermore, Polish enthusiasts of astronomy discovered comets in photographs from the SOHO and STEREO probes. There are more than several hundred discoveries so far and their number is constantly growing.

Bohdan Paczyński (1940–2007), originator of the Optical Gravitational Lensing Experiment (OGLE) designed to search for gravitational microlensing phenomena in the Milky Way, has been repeatedly nominated for the Nobel Prize in Physics. His work has been successfully continued by **Andrzej Udalski**. The project can boast thousands of gravitational microlensing phenomena recorded, discoveries of exoplanets and new asteroids in the Kuiper Belt, and many other achievements. The All Sky Automated Survey (ASAS), also the brainchild of Bohdan Paczyński, is being implemented by Grzegorz Pojmański. The project has made it possible to discover new comets, thousands of unknown variable stars, and multiple new stars, and to continuously monitor millions of stars in the southern sky. **Aleksander Wolszczan**, who discovered the first extrasolar planetary system around a pulsar in the Virgo constellation, has achieved international fame. It was thanks to his discovery in 1992 that evidence was first obtained that our Solar System is only one of many in the Universe, sparking the massive discovery of exoplanets with space telescopes.

Poles have also made a notable contribution to the discovery of gravitational waves. This primarily includes the achievements of **Andrzej Trautman** who theoretically proved that gravitational waves can be detected by sensitive instruments. À propos the instruments, the interferometer used in the LIGO and VIRGO experiments was constructed on the basis of a principle developed by **Albert Michelson** (1852–1931), a Nobel Prize-winning American scientist who was born in Strzelno, located in today's Kujawsko-Pomorskie Province.

One of the world's best-known cosmologists is **Michał Heller**, winner of the Templeton Prize. He is a scientist-cleric who successfully combines his vocation with scientific research. He is engaged in the search for a way to create a quantum theory of gravity and explain the conditions that led to the Big Bang, i.e. the creation of everything we know today, including ourselves, animate and inanimate nature, intelligence, and consciousness.

Mention should also be made of Stanisław Lem (1921–2006), one of the greatest Polish visionaries, philosophers, and futurists, whose science-fiction novels, journalism works, and reflections on the condition of the modern world became legendary during his lifetime. He was keenly interested in the development of space and satellite technology, especially as he lived in a period of its intense development and international rivalry during the Cold War. He also devoted a lot of time to pondering the role of the human in the complex cosmic puzzle. Readers all over the world later found these themes in the pages of his now-classic books and philosophical treatises.



THE HISTORY OF SPACE ENGINEERING

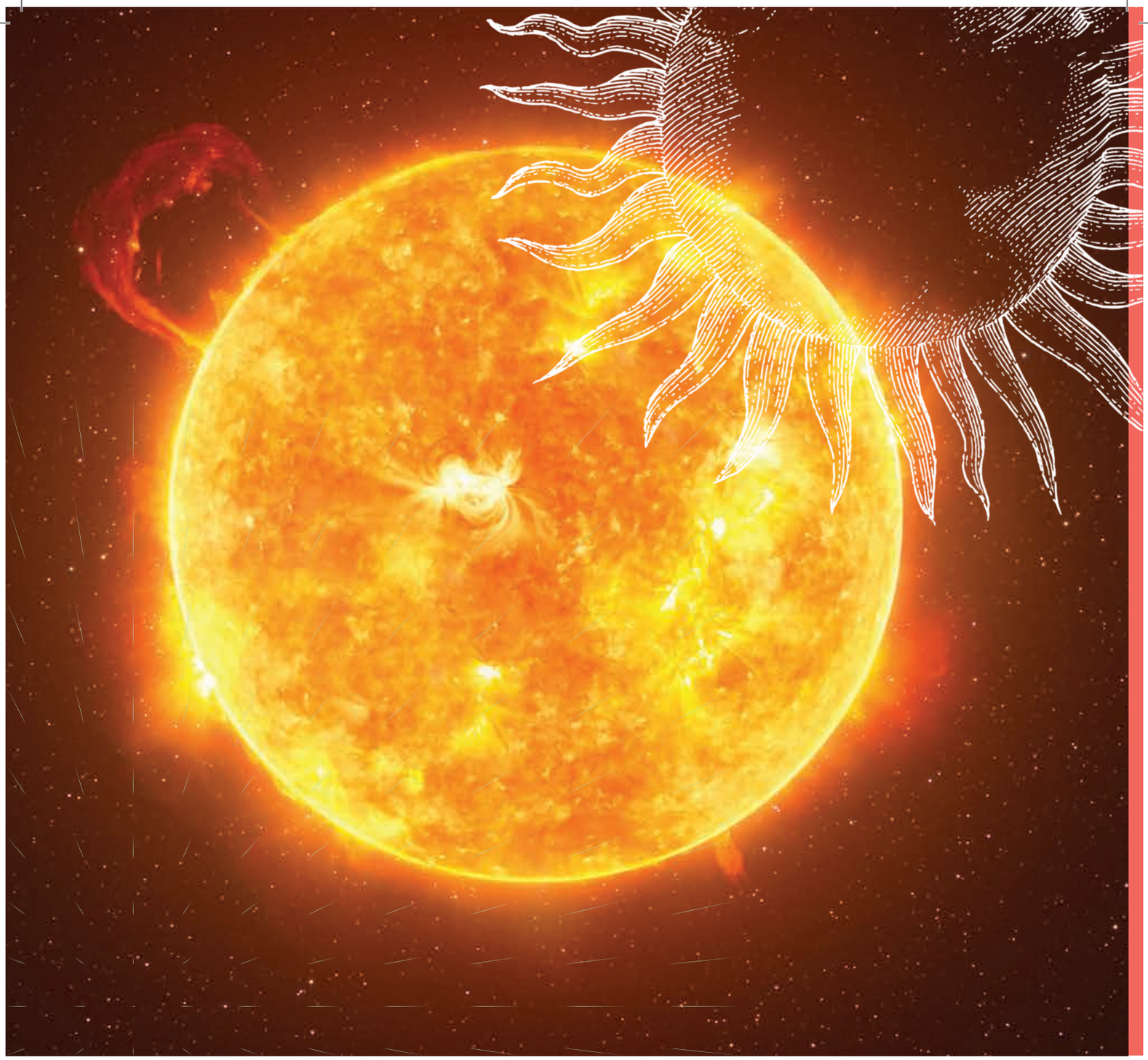
The works of the Polish military officer **Kazimierz Siemienowicz of the Ostoja Coat of Arms** (c. 1600 – after 1651) are considered to be one of the oldest indigenous achievements which benefited space engineering (although no one associated them with astronautics at the time). His fundamental monograph, *Artis Magnae Artilleriae Pars Prima*, on artillery and its use on the battlefield was the main source of knowledge in the field in Europe for more than 200 years. Issues that are relevant to us are presented in the chapter on the construction of rockets, including multi-stage rockets, which is the basis for the design of launch systems today. **Zygmunt Florenty Wróblewski** (1845–1888) and Karol Stanisław Olszewski (1986–1915), who were the first in the world to obtain a liquefied oxygen, as well as **Ignacy Łukasiewicz** (1822–1882), father of the world's petroleum industry, are the creators of the basic components of rocket fuel, which is still used today. Admittedly, these great scientists did not realise that their achievements would be used in reaching for the stars. However, it is impossible to ignore their fundamental contribution to the technology of highly refined paraffin and liquid oxygen that enables the launch of multi-tonne payloads into orbit around the Earth. The theoretical foundations of cosmonautics, in its modern sense, were laid by two scholars whose lives were linked to Poland. The first is **Konstanty Ciołkowski** (1857–1935). His works dealt with the construction of airships, the theory of movement of multistage rockets in the Earth's gravitational field, aerodynamic measurements, gyroscopic stabilisers, and liquid-fuel rocket engines. Ciołkowski's work was continued by Ary Sternfeld (1905–1980) who came from a Polish-Jewish family from Sieradz. His fundamental work, *Introduction to Cosmonautics*, contained a theory of multi-stage rocket flight and trajectories of hypothetical interplanetary flights. He was the one who calculated the orbit of Sputnik 1. After the Second World War, Polish engineers who stayed in exile contributed, among others, to the US space programme, including the famous Apollo. They include **Mieczysław Bekker** (1905–1989), creator of the Lunar Roving Vehicle and pioneer in terramechanics, **Werner Ryszard Kirchner** (1919–2008), one of the designers of the lunar module engine; **Eugeniusz Lachocki** (1921–2010), creator of power supplies for the Apollo spacecraft's onboard equipment; **Wojciech Rostafiński** (1921–2002) who worked on the pumps and compressors of the Saturn V rocket; **Kazimierz Piwoński** (1920–1996), creator of the Rendez Vous Radar for communication between the lunar module and the CSM service module; and **Stanisław Stankiewicz** (1923–2008) who worked on the composition of the air mixture used by the astronauts to breathe.

At that time, the **Space Research Centre of the Polish Academy of Sciences** (SRC PAS), established by the decision of the Presidium of the Polish Academy of Sciences on 29 September 1976, was the leading Polish centre dealing with space engineering. SRC PAS began its activity on 1 April 1977, which means that this year marks the 45th anniversary of its uninterrupted operation. The achievements of the SRC PAS are impressive: it has designed, and continues to design, instruments used in the missions of many space agencies. SRC PAS is the cradle of the history of Polish participation in the development of space technology and the leading scientific centre in this field in Poland. In the 1960s, the Institute of Aviation was involved in building rocket competence. It developed Meteor, the first Polish atmospheric sounding rocket (the work of prof. Jacek Walczewski, Ph.D., eng. and Adam Obidziński, eng.). Its flights ended in the 1970s. In recent times, the idea of a national launch system has been revisited, as evidenced by work on hybrid engine-powered rocket components that have the potential to become suborbital systems for the launch of small payloads to altitudes of 100 to 150 km.

POLES IN SPACE

The Soviet Interkosmos programme is primarily associated with **Mirosław Hermaszewski**, the first Polish pilot-cosmonaut. Together with Piotr Klimuk, he spent more than a week in orbit as part of the Soyuz 30/Salyut 6 mission, performing pre-planned biological, psychological, physiological, and geophysical experiments. Mention should also be made of **Zenon Jankowski** who was a reserve cosmonaut ready to replace Hermaszewski at any time in case of his incapacitation. The Space Transportation System (STS), a US shuttle flight programme, employed as astronauts the next generation of descendants of Polish emigrants. This includes Karol Bobko (STS-6, STS-51-D, STS-51-J), Scott Parazynski (STS-66, STS-86, STS-95, STS-100, STS-120), James Pawelczyk (STS-90), George Zamka (STS-120, STS-130), and Christopher Ferguson (STS-115, STS-126, STS-135). The latter, as a commander, was involved in the final mission of the Space Shuttle Atlantis, which closed the STS programme and the shuttle era.


CETUS
AQUARIUS
SCULPTOR
PISCIS AUSTRINUS
FORNAX
CAPRICORNUS
PHOENIX
GRUS
MICROSCOPIUM
INDUS
TUCANA
HOROLOGIUM
SAGITTARIUS
RETICULUM
HYDRUS
SCUTUM
CORONA AUSTRALIS
PAVO
TELESCOPIUM
MENSA
OCTANS
SERPENCE CAUDA
APUS
ARA
VOLANS
CHAMAELEON
SCORPIUS
TRIANGULUM AUSTRALE
- 75°
MUSCA
CARINA
CIRCINUS
NORMA
CRUX
- 60°
VELA
LUPUS
CENTAURUS
- 45°
ANTLIA
LIBRA
- 30°
HYDRA
CORVUS
- 15°
CRATER
VIRGO



EXPLORING CELESTIAL BODIES

Before and just after the political transformation, Poland took part virtually only in projects carried out by the Soviet Union and Russia. Examples include the Mars missions (Fobos 1, Fobos 2, Mars 96) and the earlier missions (Vega 1, Vega 2) designed to study Venus and the nucleus of Halley's comet. At that time, SRC PAS developed dozens of sensors and structural elements for rockets and satellites launched into near and far space. Our country's accession to European structures resulted in the first major projects under the banner of the European Space Agency and NASA, its American counterpart. Private companies started to participate in the projects in addition to scientific centres. Key missions with Polish involvement are listed below.

SUN

Solar Orbiter (2020 – to date)

European Space Agency mission carried out in collaboration with NASA. On 10 February 2020, a space probe was fired towards the Sun. The data from the mission is expected to help scientists to answer the following questions:

- ☐ **HOW CAN THE SUN'S MAGNETIC FIELD AFFECT TECHNOLOGY ON EARTH AND SPACE FLIGHTS?**
- ☐ **HOW DOES THE SOLAR DYNAMO WORK?**
- ☐ **WHAT HAPPENS TO THE POLES OF THE SUN?**
- ☐ **WHY IS THE SOLAR CORONA SO HOT?**
- ☐ **WHAT DRIVES THE SOLAR WIND?**

POLISH CONTRIBUTION:

SRC PAS WAS INVOLVED IN A PART OF THE STIX EXPERIMENT FOR X-RAY SPECTRAL IMAGING IN THE RANGE **FROM 4 TO 150 KEV.**

MERCURY

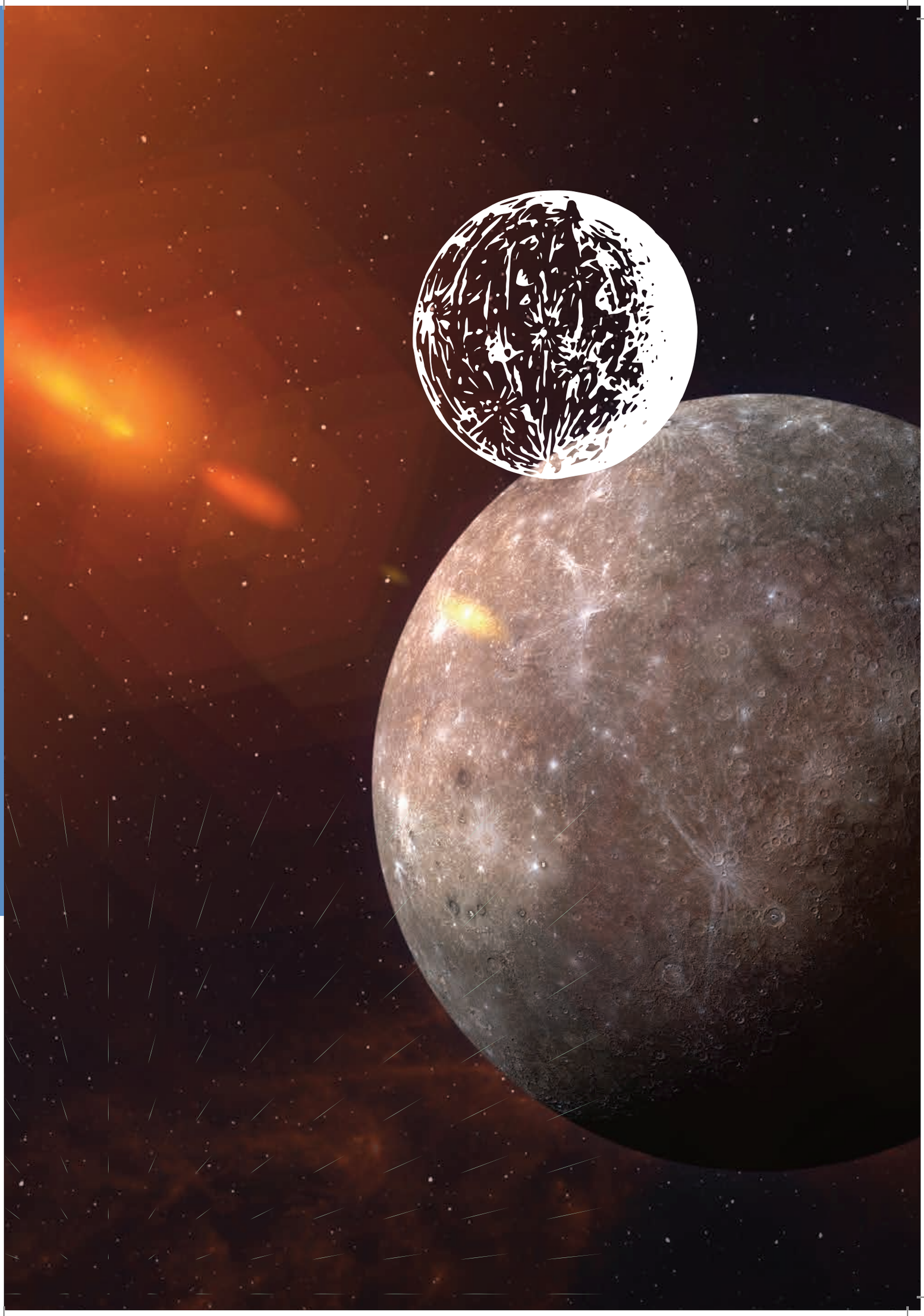
Solar Orbiter (2020 – to date)

The first joint mission between the European Space Agency and the Japan Aerospace Exploration Agency (JAXA). The BepiColombo probe was launched in October 2018. It will take more than 7 years just to reach Mercury. The planned time in Mercury orbit is approximately 1 year. The mission is expected to provide answer to the following questions:

- ☐ **HOW DID MERCURY EVOLVE?**
- ☐ **IS MERCURY'S CORE LIQUID OR SOLID?**
- ☐ **IS MERCURY TECTONICALLY ACTIVE?**
- ☐ **IS THERE WATER ICE ON MERCURY?**
- ☐ **WHAT IS THE DYNAMICS OF THE MAGNETIC FIELD? HOW IS MAGNETIC FIELD AFFECTED BY THE SOLAR WIND?**
- ☐ **WILL MERCURY'S PROXIMITY TO THE SUN HELP US TEST THE THEORY OF RELATIVITY WITH GREATER ACCURACY?**

POLISH CONTRIBUTION:

SRC PAS DEVELOPED A SYSTEM TO ORIENT THE MEASUREMENT DIRECTION OF THE MERTIS SPECTROMETER TO HELP MAP THE MINERALOGICAL SURFACE OF MERCURY WITH A SPECTRAL RESOLUTION OF LESS THAN 500 METRES.



VENUS

(2005 – 2015)

Venus Express was the first probe launched by the European Space Agency towards Venus. Right at the beginning, when stating mission objectives, efforts were made to reduce construction time and costs as much as possible. Spare parts left over from the Mars Express and Rosetta projects were used to build the spacecraft. However, a number of modifications were required. The aim of the main alterations was to adapt the orbiter to the conditions prevailing in orbit around Mars. Among other things, it was necessary to strengthen the thermal and radiation insulation to reduce the risk of damage to electronic systems. The probe contributed to a better understanding of the conditions in the upper layers and vertical structure of the atmosphere of Venus as well as the extent of its greenhouse effect. The mission was launched on 9 November 2005.

POLISH CONTRIBUTION:

SRC PAS DEVELOPED, UNDER THE INTERNATIONAL COOPERATION, THE PLANETARY FOURIER SPECTROMETER (PFS) FOR THE STUDY OF THE COMPOSITION OF THE ATMOSPHERE OF VENUS.

EARTH

Ops-sat (2019 – to date)

The first mission of the European Satellite Operations Centre (ESOC) to be performed on a CubeSat satellite. Its main objective is to test new standards for data exchange between the satellite and the ground segment. The new solutions tested during the OPS-SAT mission will be used by larger missions in the future. The Polish branch of GMV Innovating Solutions sp. z o.o. is responsible for the development of all on-board mission software, i.e. the Attitude Determination and Control System, the Failure Detection Identification and Recovery as well as for the implementation of Mission Operation Services, a new data exchange standard, and POCKET+ on board the satellite. The mission was launched in December 2019.

POLISH CONTRIBUTION:

THE SPACE RESEARCH CENTRE OF THE POLISH ACADEMY OF SCIENCES IS RESPONSIBLE FOR ONE OF THE TWO KEY OPS-SAT PAYLOADS – THE CCSDS PROTOCOL CONVERTER. SRC PAS'S PARTNER IN THE DEVELOPMENT OF THIS CONVERTER IS THE POLISH COMPANY CREOTECH INSTRUMENTS S.A.

MARS

Mars Express 2003

(2003 – to date)

The first mission to Mars designed by ESA. It included the **Mars Express Orbiter** (MEO) and the **Beagle 2 lander**. After entering orbit around Mars, the orbiter photographed its **surface** with a high-resolution camera (up to 10 metres on average and up to 2 metres for selected regions), measured atmospheric composition and circulation, and scanned the subsurface ground layer. **The lander was designed to carry out geological and meteorological studies and look for signs of Martian life. The landing of the lander was unsuccessful while the orbiter is still operational. The probe was launched on 2 June 2003.**

POLISH CONTRIBUTION:

SRC PAS DESIGNED A POWER SYSTEM FOR THE FOURIER SPECTROMETER AND ITS SCANNER FOR DETERMINING THE DIRECTION OF MEASUREMENT. THE SPECTROMETER ANALYSED THE COMPOSITION OF THE RADIATION REFLECTED AND EMITTED BY THE SURFACE AND ATMOSPHERE OF MARS.

Curiosity – Mars Science Laboratory

(2011 – to date)

Another NASA's Mars mission being a part of the Mars Science Laboratory (MSL) programme. The Curiosity Rover is an autonomous science laboratory powered by a radioisotope thermoelectric generator. Its mission is to search for traces of past life on Mars, assess the current viability of organic life on Mars, and carry out meteorological, geological, and biochemical measurements. The mission was launched on 26 November 2011.

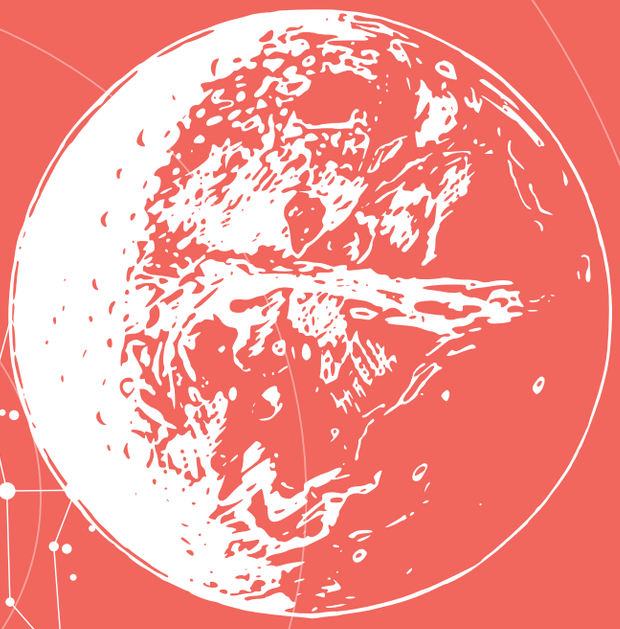
POLISH CONTRIBUTION:

VIGO SYSTEM S.A. SUPPLIED INFRARED DETECTORS USED AS A COMPONENT OF A TUNABLE LASER SPECTROMETER.

ExoMars 2016

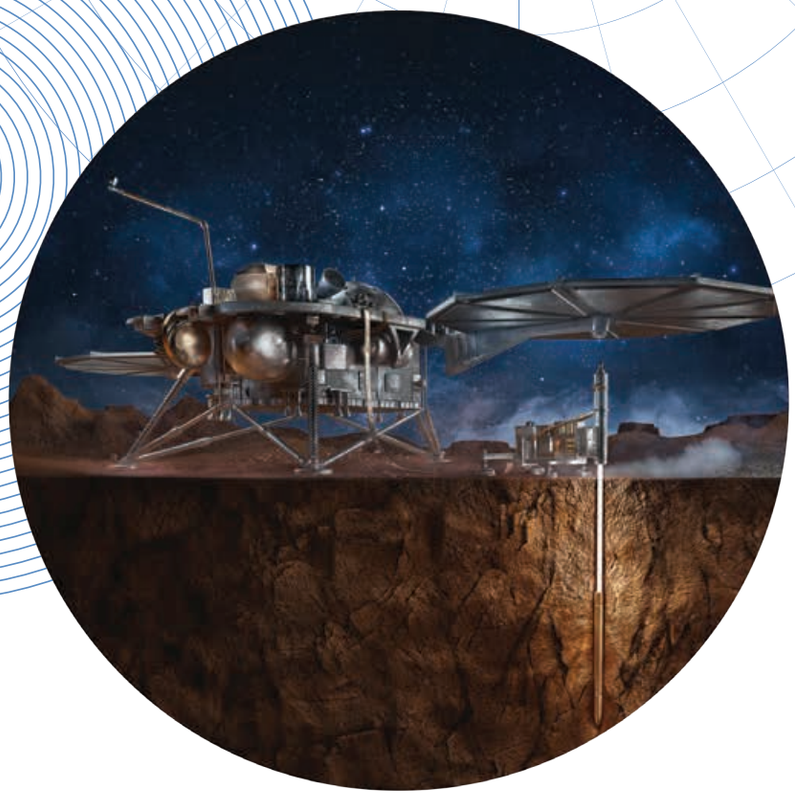
(2016 – to date)

A Martian probe carried out in cooperation between ESA and the Russian Space Agency. Its aim was to search for traces of life on Mars, study its internal structure, and detect atmospheric gases present in trace amounts. It included the Trace Gas Orbiter (TGO) and the Schiaparelli lander, which, unfortunately, crashed during landing on the surface of Mars. The mission started on 14 March 2016.



POLISH CONTRIBUTION:

THE FOLLOWING ENTITIES WERE INVOLVED IN THE DESIGN OF THE MISSION'S RESEARCH INSTRUMENTS: SRC PAS, CREOTECH INSTRUMENTS S.A. (POWER SUPPLY FOR THE CASSIS STEREOSCOPIC CAMERA), VIGO SYSTEM S.A. (DETECTORS IN SCHIAPARELLI), AND SENER SP. Z O.O. (MECHANICAL AND ELECTRICAL CONNECTION BETWEEN THE ROVER AND THE LANDER).



Insight 2018

(2018 – to date)

The InSight probe is a stationary Martian laboratory that performs planned research at the landing site. It conducts geophysical studies of Mars.

The mission started on 05 May 2018.

POLISH CONTRIBUTION:

THE HP3 MOLE, A SELF-CONTAINED MARS'S SOIL PENETRATOR PLACED ON BOARD THE LANDER, HAS BEEN DESIGNED AND MANUFACTURED BY ASTRONIKA SP. Z O.O.

JOWISZ

JUICE (scheduled to launch in 2023)

The Jupiter Icy Moon Explorer (JUICE) is a probe being developed by the European Space Agency. Its aim is to reach the Jupiter system to study three of its moons, i.e. Ganymede, Callisto, and Europa. JUICE will conduct a detailed study of Ganymede and assess the potential for life on it. Studies of the other Galilean moons (Europa and Callisto) will provide comparative analyses. The probe is scheduled to launch in 2023 and reaching the Jupiter system is scheduled for 2030.

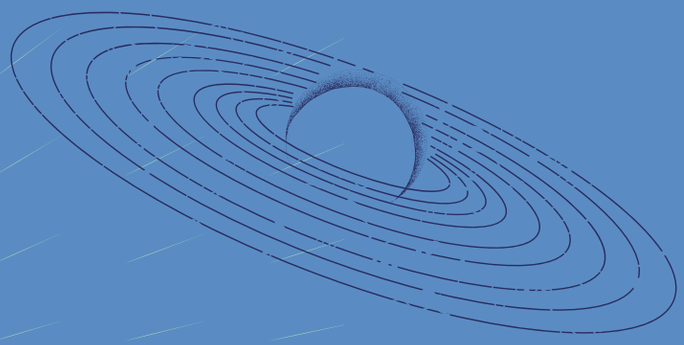
POLISH CONTRIBUTION:

TWO OF THE PROBE'S SCIENTIFIC INSTRUMENTS, I.E. THE SUBMILLIMETRE WAVE INSTRUMENT (SWI) AND THE RADIO AND PLASMA WAVE INSTRUMENT (RPWI), HAVE BEEN BEING DEVELOPED WITH THE PARTICIPATION OF SRC PAS AND ASTRONIKA SP. Z O.O. THE MISSION IS ALSO SUPPORTED BY ASTRI POLSKA SP. Z O.O. (REAL TIME SIMULATION AND SIMULATION FRONT END) AND CREOTECH INSTRUMENTS S.A. (THE ASSEMBLY OF THE PROBE SUBSYSTEMS). BESIDES, AIRBUS POLAND S.A. IS MANUFACTURING THE ELECTRICAL HARNESSES FOR THE PROBE AND SPACEFOREST SP. Z O.O. IS INVOLVED IN THE CONTROL DATA MANAGEMENT SYSTEM (CDMS).

SATURN:

Cassini/Huygens (1997 – 2017)

A space probe designed to study the Saturn system. It was a joint project of three space agencies: NASA, ESA, and ASI. In July 2004, Cassini became the first artificial satellite of Saturn. In January 2005, the detached Huygens probe landed on the surface of Titan. Thanks to the Cassini-Huygens mission, the appearance of Titan's surface was explored and its atmosphere was directly studied. The existence of active water geysers on Enceladus, hydrocarbon lakes on Titan, and previously unknown moons of Saturn were discovered. The complex structure of Saturn's rings resulting from its gravitational interactions with its moons was also explored more closely. The probe was launched in October 1997.



POLISH CONTRIBUTION:

SRC PAS DEVELOPED A SENSOR FOR MEASURING TEMPERATURE AND THERMAL CONDUCTIVITY, MOUNTED ON BOARD THE HUYGENS LANDER.

BIOMASS

(scheduled to launch in 2023)

The aim of the Biomass mission is to provide vital information about the state of our forests and the changes taking place in them. The data will be used to improve our knowledge of the role forests play in the carbon cycle. The main instrument of the BIOMASS satellite is a P-band radar requiring an impressively large antenna with a diameter of as much as 14 metres. Experts from the Polish branch of GMV Innovating Solutions Sp. z o.o. are responsible for preparing the analysis for the entire mission, including two main phases, i.e. the tomographic phase and the interferometric phase. To obtain the target data, the former requires seven images of the same area of the Earth, and the latter three images.

POLISH CONTRIBUTION:

THE MISSION, ORGANISED BY ESA, WILL ALSO INVOLVE SENER POLSKA SP. Z O.O., A WINNER OF THE CONTRACT TO DESIGN THE EQUIPMENT FOR ASSEMBLING AND TESTING THE SATELLITE'S STRUCTURE AND ITS MAIN RESEARCH INSTRUMENT. THE MISSION IS ALSO SUPPORTED BY PIAP SPACE SP. Z O.O. (THE MULTI PURPOSE TROLLEY AND ADAPTORS) AND AIRBUS POLAND S.A. (ELECTRICAL HARNESSES FOR THE SATELLITE).

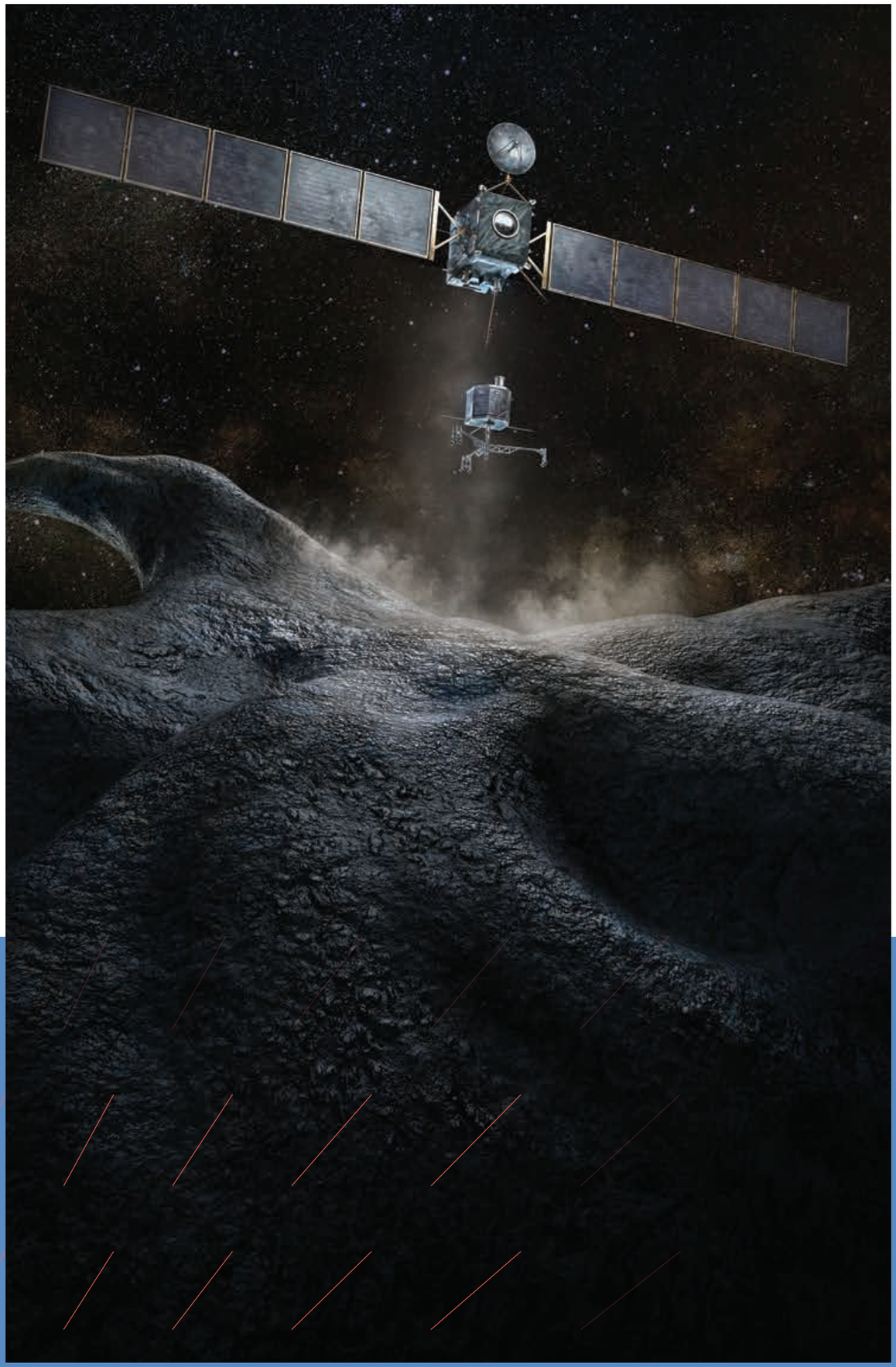
EARTHCARE

(scheduled to launch in 2023)

EarthCARE is an Earth observation mission organised by ESA in cooperation with the Japan Aerospace Exploration Agency (JAXA) and the Japanese National Institute of Information and Communication Technology (NICT). It is part of Earth Explorers, ESA's project whose aim is to answer a range of Earth science questions and focus research on various aspects of the Earth system. The EarthCARE satellite, scheduled to launch in 2023, will study clouds and microparticles present in the atmosphere, generally known as aerosols, and their interactions with solar radiation.

POLISH CONTRIBUTION

THE MISSION IS SUPPORTED BY GMV INNOVATING SOLUTIONS SP. Z O.O. INVOLVED IN THE SPECIFICATION, DESIGN, FABRICATION, INTEGRATION, TESTING, AND MAINTENANCE OF THE PROCESSOR THAT ALLOWS FOR L0 PROCESSING OF DATA PROVIDED BY THE SATELLITE.

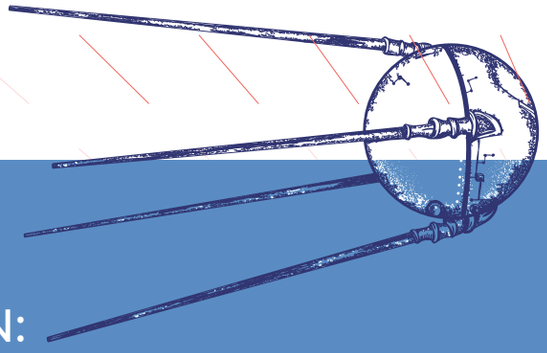


OTHER RESEARCH MISSIONS

ROSETTA/PHILAE

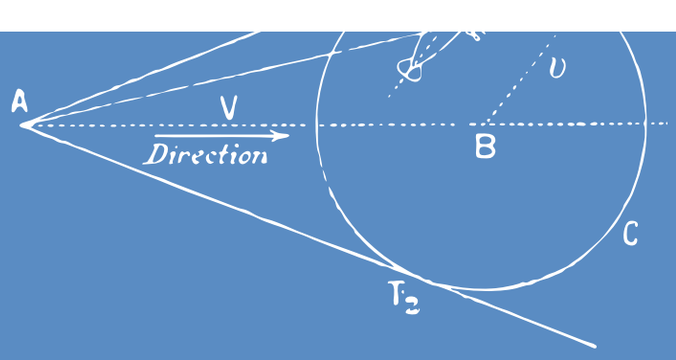
(2004 – 2016)

The aim of the ESA's Rosetta space probe was to enter orbit around comet 67P/Churyumov–Gerasimenko and place the Philae lander on its surface. The probe performed in-situ studies of cometary matter and observations of changes in the comet's activity as it approached and moved away from perihelion. Rosetta launched on 2 March 2004 and the lander landed on the comet's surface on 12 November 2014. The main objective of the mission was to carry out research to help understand the origin of comets, the links between cometary and interstellar matter, and the role of comets in the formation of the Solar System.



POLISH CONTRUBUTION:

SRC PAS DEVELOPED THE MULTI PURPOSE SENSORS FOR SURFACE AND SUBSURFACE SCIENCE (MUPUS) SOIL PENETRATOR USED ON BOARD THE PHILAE LANDER.



BRITE PL

(Lem, 2013 – to date; Heweliusz, 2014 – to date)

BRITE-PL is part of a larger project under the Canadian-Austrian-Polish collaboration. The mission developed two Polish satellites: Lem and Heweliusz. The former is the second artificial satellite fully integrated in Poland and the first Polish scientific satellite. Its task was to observe stars that are brighter and hotter than the Sun and to gain a better understanding of the convective processes inside massive stars. It was launched on 21 November 2013. Heweliusz, another satellite integrated in Poland, was launched on 19 August 2014. It was the last of the international astronomical satellites from BRITE Constellation. It was equipped with a telescope with a red filter facilitating observations of cold red stars. BRITE satellites belong to the so-called nanosatellites with a mass of less than 10 kg.

Lem, the first Polish BRITE satellite was built mainly from subassemblies and subsystems provided by a Canadian partner, while Heweliusz consisted largely of components designed at the Space Research Centre of the Polish Academy of Sciences and manufactured in Poland. The names of the first Polish scientific satellites are not coincidental – they were chosen in a naming contest. Stanislaw Lem turned out to be unrivalled and the figure with the second highest number of votes was Johannes Hevelius.

EUCLID

(launch in 2023)

The mission, scheduled to launch in 2022, involves a space telescope to study dark matter and energy, i.e. issues crucial to the development of cosmological models of the Universe.

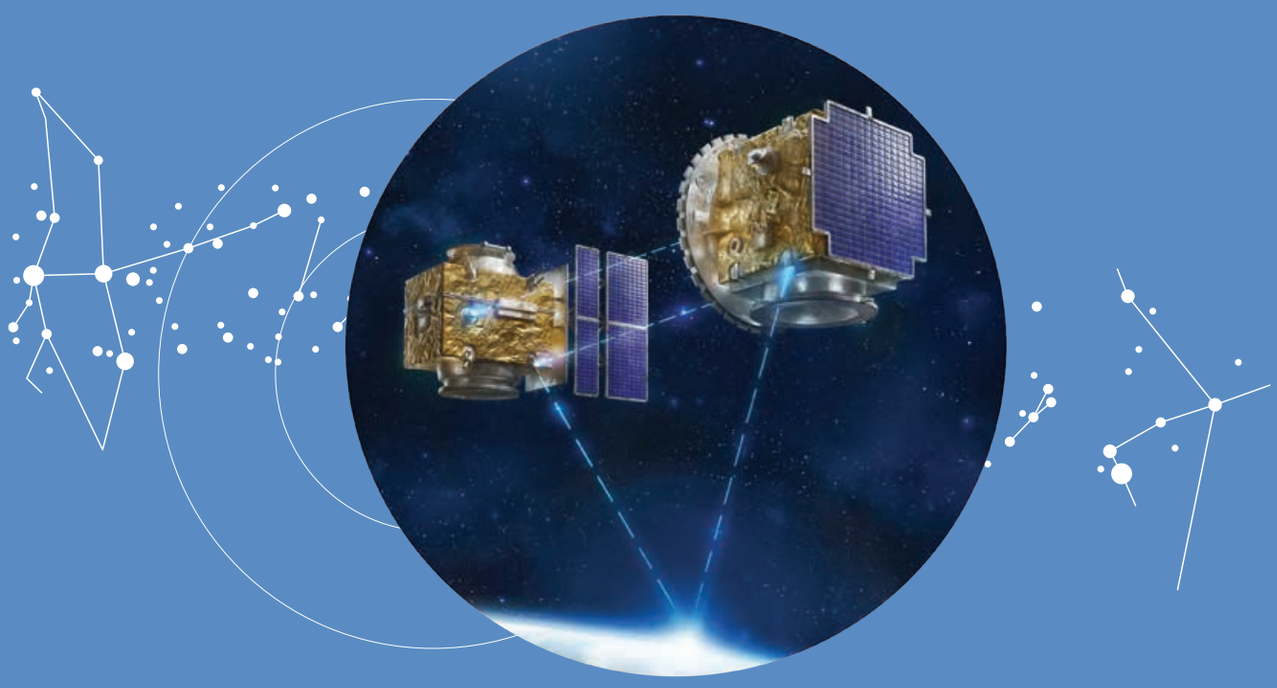
POLISH CONTRIBUTION:

THE MISSION IS SUPPORTED BY SENER POLSKA SP. Z O.O. (DESIGN AND MANUFACTURE OF MECHANICAL GROUND SUPPORT EQUIPMENT (MGSE) FOR THE EUCLID SATELLITE INTEGRATION) AND GMV INNOVATING SOLUTIONS SP. Z O.O.

PROBA-3

(scheduled to launch in 2023)

PROBA is an ESA's programme designed to perform orbital demonstrations of satellite platform and payload technologies. PROBA-3 is a scientific mission whose aim is to explore the solar corona and demonstrate the precision formation flight technology. The mission involves two small satellite platforms of 350 kg and 200 kg intended to orbit in formation with the relative position control accuracy of less than 1 mm. The two satellite platforms will be controlled in space to behave as if they were a part of an ultra-stable rigid structure, building a kind of a large telescope (with separate lens and detector). This rigid structure will be controlled to rotate and point to any direction in space.



POLISH CONTRIBUTION:

THE MISSION IS SUPPORTED BY A NUMBER OF POLISH ENTITIES: ASTRI POLSKA SP. Z O.O., SPACE RESEARCH CENTRE OF THE POLISH ACADEMY OF SCIENCES, CREOTECH INSTRUMENTS S.A., GMV INNOVATING SOLUTIONS SP. Z O.O., N7SPACE SP. Z O.O., PCO S.A., AND SENER POLSKA SP. Z O.O.

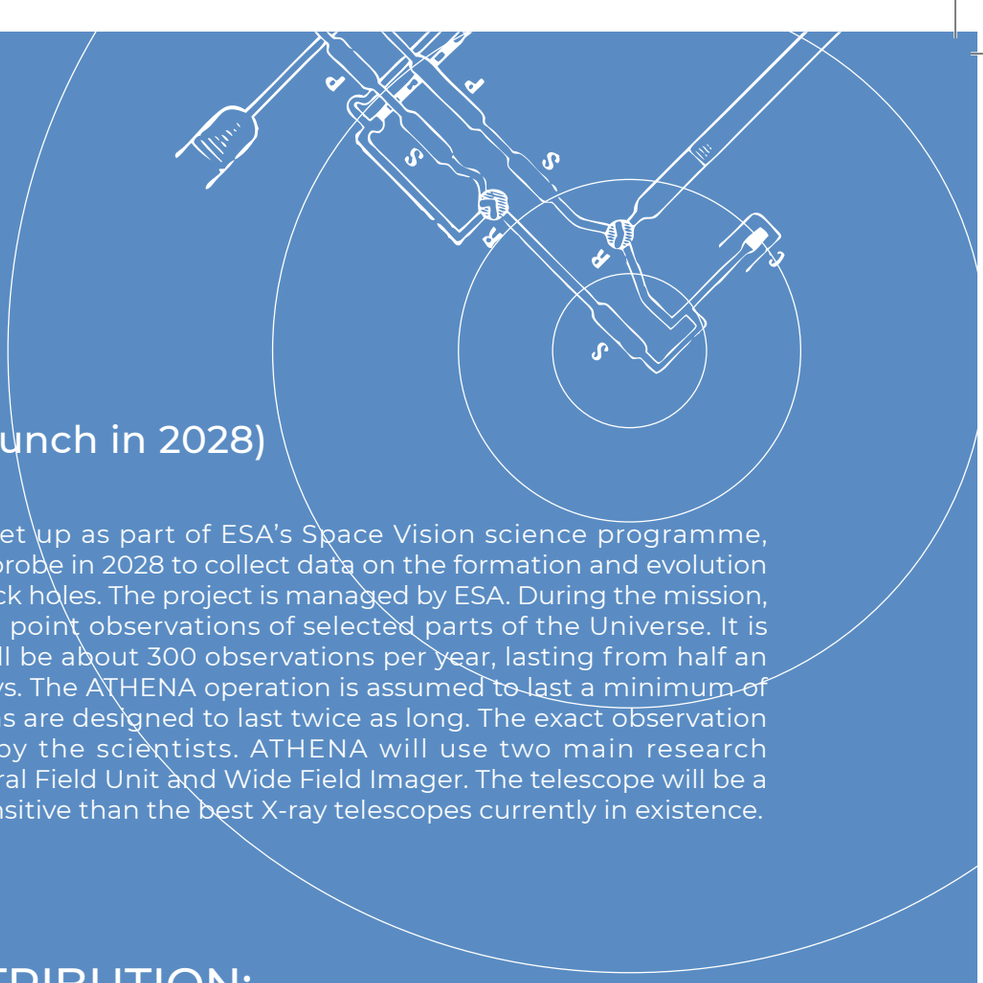
EXTREMELY LARGE TELESCOPE

(scheduled to start operating in 2025)

Poland is also involved in a project to build the largest optical telescope on Earth with a diameter of 39 m. Its construction started in 2014 and is scheduled to be completed in 2025. The telescope is located in the Cerro Armazones Mountain with an altitude of 3,060 metres above sea level in the central part of the Atacama Desert. Thanks to Poland's membership of the European Southern Observatory, Polish companies are involved in the construction of the telescope and our astronomers will be able to contribute to discoveries made with it in the future.

POLISH CONTRIBUTION:

ENGINEERS FROM SENER POLSKA SP. Z O.O. ARE RESPONSIBLE FOR THE DESIGN, MANUFACTURE, ASSEMBLY, AND TESTING OF INSTRUMENTATION FOR THE TWO MIRROR MODULES OF THE ELT TELESCOPE. ASTRONOMERS AND PHYSICISTS FROM NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ WILL TAKE PART IN THE DESIGN OF ONE OF THE ADVANCED SPECTROGRAPHS TO BE MOUNTED ON THE ELT TELESCOPE.



ATHENA

(scheduled to launch in 2028)

The ATHENA mission, set up as part of ESA's Space Vision science programme, is designed to launch a probe in 2028 to collect data on the formation and evolution of galaxy groups and black holes. The project is managed by ESA. During the mission, the telescope will make point observations of selected parts of the Universe. It is estimated that there will be about 300 observations per year, lasting from half an hour to more than 11 days. The ATHENA operation is assumed to last a minimum of five years, but all systems are designed to last twice as long. The exact observation sites will be selected by the scientists. ATHENA will use two main research instruments: X-ray Integral Field Unit and Wide Field Imager. The telescope will be a hundred times more sensitive than the best X-ray telescopes currently in existence.

POLISH CONTRIBUTION:

THE CONSTRUCTION OF THE TELESCOPE IS SUPPORTED BY ENGINEERS FROM SENER POLSKA SP. Z O.O. WHO ARE TO DESIGN THE INSTRUMENT SELECTION MECHANISM. OTHER DOMESTIC ENTITIES CONTRIBUTING TO THE MISSION INCLUDE THALES ALENIA SPACE POLSKA SP. Z O.O., ASTRONIKA SP. Z O.O., AND THE NICOLAUS COPERNICUS ASTRONOMICAL CENTRE OF THE POLISH ACADEMY OF SCIENCES.

GAIA

(2013 – to date)

ESA's unmanned space probe designed to carry out high-precision astrometric measurements. The mission is the successor to the Hipparcos satellite.

POLISH CONTRIBUTION:

POLISH ASTRONOMERS ARE INVOLVED IN DEVELOPING AND INTERPRETING THE DATA OBTAINED BY THE MISSION.

COMET INTERCEPTOR

(launch in 2029)

Comet Interceptor will consist of three probes whose working names are A, B1, and B2. Combined together, they will go into an interim orbit in 2028 or 2029, 1.5 million km from Earth, to await the appearance of a long-period comet. Scientists estimate that the target object of study will be identified after two to three years. The discovery of the target object will be supported by modern telescopes on Earth. It will take the probe several years to fly to the selected comet. Shortly before reaching their destination, the probes will split up and start observing the comet from three different locations. This is to provide a unique three-dimensional image of the comet's nucleus and tail.

POLISH CONTRIBUTION:

THE MISSION IS SUPPORTED BY THE SPACE RESEARCH CENTRE OF THE POLISH ACADEMY OF SCIENCES, WHICH WILL DESIGN AND PERFORM THE DFP (DUST, FIELD, PLASMA) INSTRUMENT CONSISTING OF NINE SEPARATE COMPONENTS PLACED ON TWO SATELLITES.

ELECTRA

(launch in 2023)

Electra will be Europe's first commercial full electric-propulsion satellite.

POLISH CONTRIBUTION:

SENER POLSKA WILL DESIGN AND MANUFACTURE THE MECHANICAL GROUND SUPPORT EQUIPMENT (MGSE) FOR SATELLITE ASSEMBLY.

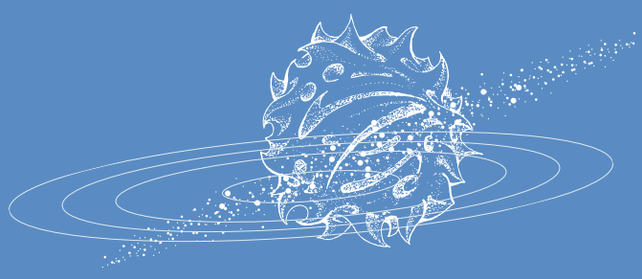
PLATO

(launch in 2026)

PLATO is an ESA mission designed to search for Earth-like exoplanets.

POLISH CONTRIBUTION:

AS PART OF THE CONTRACT, SENER POLSKA WILL DESIGN, MANUFACTURE, AND TEST EQUIPMENT TO SUPPORT THE INTEGRATION OF THE PROBE COMPONENTS.



ARIEL

(2013 – to date)

Ariel is a space telescope whose aim is to observe at least 1,000 known exoplanets using the transit method and to study and determine their chemical composition and thermal structure.

POLISH CONTRIBUTION:

THE DEVELOPMENT AND CONSTRUCTION OF THE PRECISION TARGETING SYSTEM FOR THE ARIEL TELESCOPE HAS BEEN ENTRUSTED TO THE SPACE RESEARCH CENTRE OF THE POLISH ACADEMY OF SCIENCES. ENGINEERS FROM THE CENTRE ARE RESPONSIBLE FOR THE EXECUTION OF THE OPTO-MECHANICAL PART AND THE FGS CONTROL ELECTRONICS AS WELL AS FOR THE COORDINATION AND SUPERVISION OF THE WORK OF THE CO-IMPLEMENTING INSTITUTIONS.

USE OF SATELLITE DATA

Sat4Envi

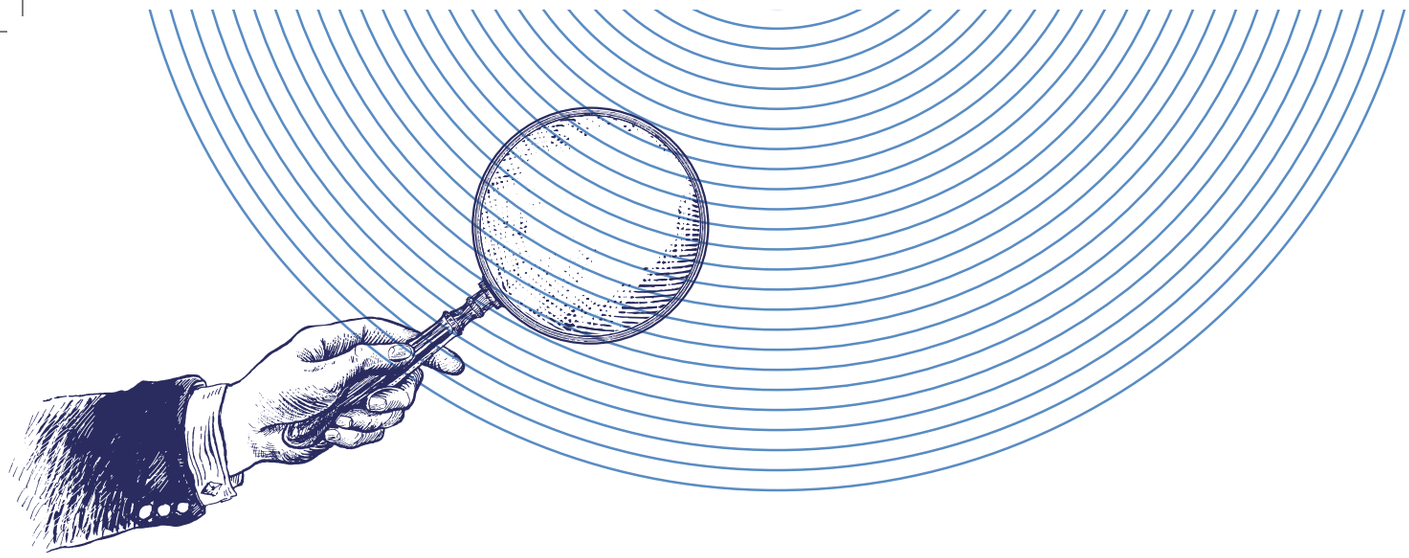
Sat4Envi (system for operational collection, sharing, and promotion of digital satellite information on the environment) is a project implemented by the Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB) and its partners, i.e. the Space Research Centre of the Polish Academy of Sciences, the Academic Computer Centre CYFRONET AGH, and the Polish Space Agency (POLSA), and co-financed by the Operational Programme Digital Poland.

The main objective of Sat4Envi is to build a system for sharing satellite data from the Copernicus programme and data from other environmental and meteorological satellites collected in the resources of the IMGW-PIB Satellite Remote Sensing Department.

The CGS platform will be used to access data from the surface of Poland (and at a distance of 500 km from the borders): archival and current data from the Copernicus Programme (Sentinel) satellites, meteorological satellites (METEOSAT, NOAA, Metop), and environmental satellites (MODIS data from Terra and Aqua).

SatBałtyk

The aim of the SatBałtyk project was to prepare and launch a technical base and practical operational procedures for the efficient routine determination of the states of the Baltic environment, i.e. the mapping of its structural and functional characteristics. This includes energy influx and characteristics, temperature distributions, the dynamic state of the sea surface, the concentration of chlorophyll and other phytoplankton pigments, toxic algal blooms, the occurrence of upwelling events, the appearance of pollution spots including oil spills, and the characteristics of primary organic matter production. The project was carried out by a consortium comprising the Institute of Oceanology of the Polish Academy of Sciences, the University of Gdańsk, the Pomeranian Academy in Słupsk, and the University of Szczecin.



Safedam

The aim of the SAFEDAM project was to develop a dike monitoring system using a non-invasive, flying, unmanned, low-altitude scanning measurement platform and utilise aerial and satellite imagery. The system uses multi-source photogrammetric data. It allows the use of both visible light and near-infrared optical range data and radar data from air.

It enables the expert assessment of flood embankments used by flood infrastructure management specialists and emergency safety authorities. The project was carried out by the Warsaw University of Technology, Faculty of Geodesy and Cartography, the Institute of Meteorology and Water Management, MSP Marcin Szender, Astri Polska Sp. z o.o., and the Central School of the State Fire Service in Częstochowa.

GeoMetre

GeoMetre is a project launched in June 2019 and led by the Central Office of Measures (GUM) acting as a member of a European consortium under the European Metrology Programme for Innovation and Research (EMPIR). Its main objective is to contribute significantly to improving the International Terrestrial Reference Frame (ITRF).

GUM has developed a new dedicated reference line of 200 m in cooperation with the Warsaw University of Technology. The reference level calibrated and verified (using GNSS techniques) as part of the project's upcoming activities will be the optimum reference for calibration and verification of the new instrumentation in the project and other commercial mid-range distance meters.

Help me in distress (HID)

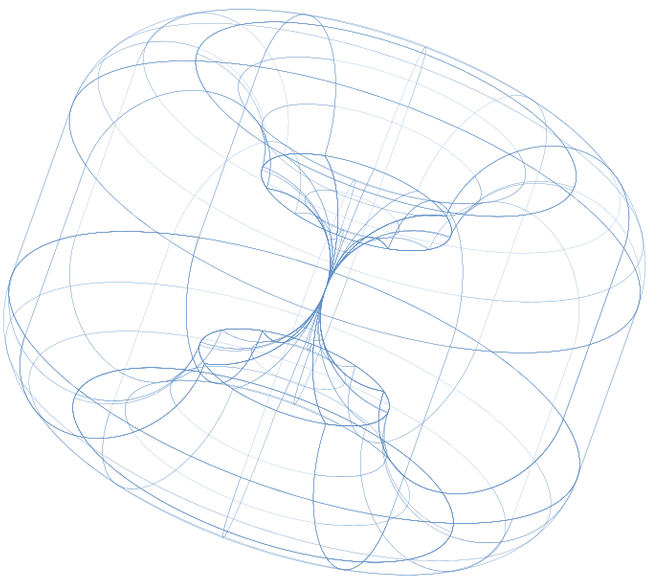
The aim of the project is to create an advanced information system to report, monitor, and respond to emergencies (in order to save the lives and health of the injured and ensure public safety) as well as to coordinate the response. The system will be based, among others, on Galileo data. The project is funded by the ESA's NAVISP programme and implemented by ITTI Sp. z o.o.

GeoRoute

The product is to serve as a mobile application and web service for planning excursions/hikes in a highly customised way. It will allow the user to discover areas in the designated environment and to navigate to and in them based on a specific combination of natural, cultural, and other phenomena, applied and calculated according to the user's personal preferences. The entire system will be supported by manufacturer-owned precision datasets and extensive open datasets, such as Copernicus services, satellite data streams, and Open Street Map. Thanks to functionalities, such as the community and the projected crowdsourcing, the product will be continuously reviewed in situ and updated using corrected data. The project is funded by the ESA's NAVISP programme and implemented by Geosystems Polska Sp. z o.o.

GEOCARDIO

The system is designed to improve emergency medical services by providing location information and basic medical data of a casualty with an implanted CIED. The project is funded by the ESA's NAVISP programme and implemented by Hertz Systems.



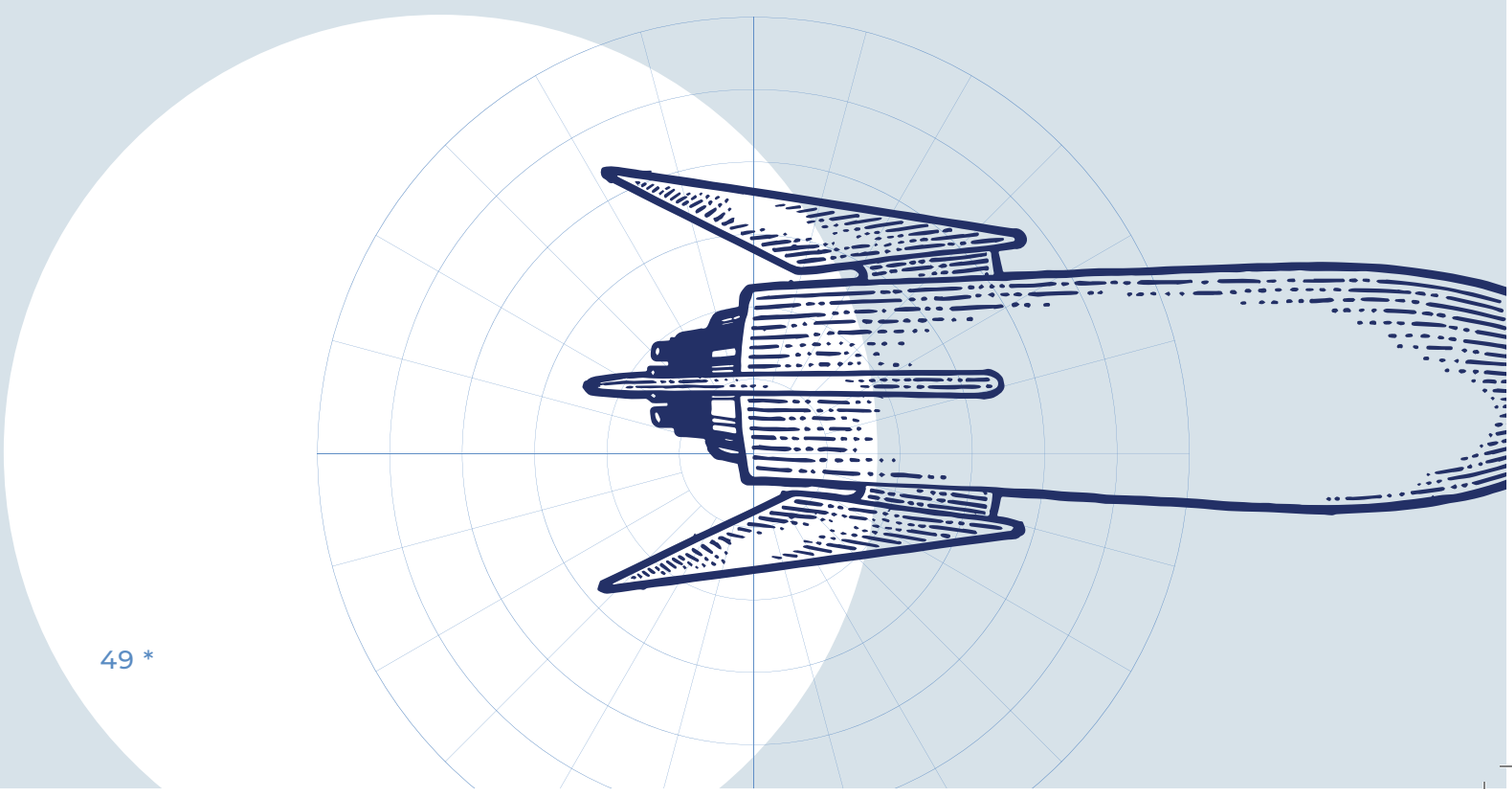
OTHER AREAS OF ACTIVITY

Carrier rockets

In October 2017, a test flight (with a ceiling of 15 km) of the ILR-33 AMBER suborbital rocket constructed by the Institute of Aviation took place at the Drawsko Training Ground. Its success was officially announced on 27 November 2017 during an open meeting of the Space and Satellite Research Committee of the Polish Academy of Sciences (Prof. P. Wolański).

Basic information on Amber:

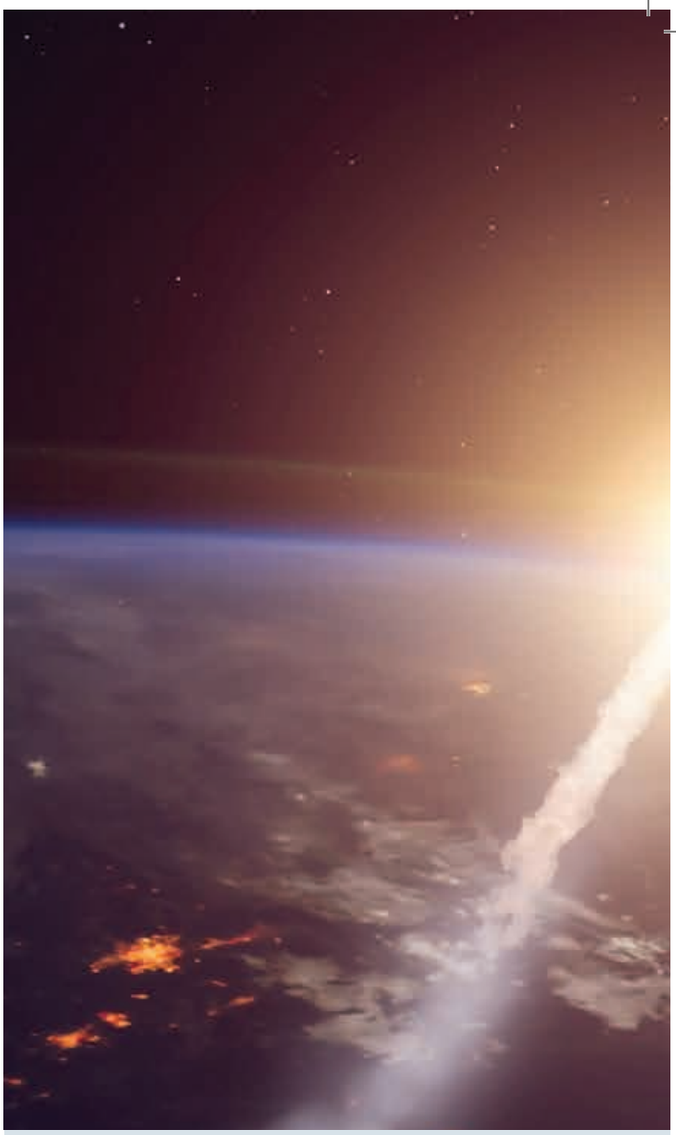
1. Length: 5 m
2. Diameter: 23 cm
3. Main engine: 4 kN hybrid; Fuel: polyethylene; Oxidiser: 98% H2O2
4. Auxiliary engines: 2×6 kN solid-fuel engines
5. Payload: 5 kg
6. Absolute ceiling: up to 100 km
7. Funding: own resources of the Institute of Aviation

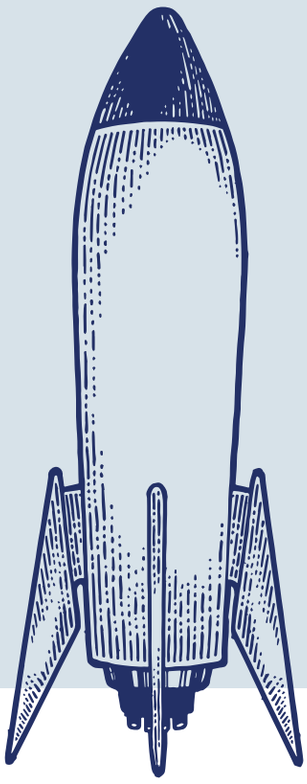


In September 2018, the first flight of ILR-33 AMBER was to take place in the Central Air Force Training Ground (CPSP) in Ustka (at the maximum possible altitude, over 50 km according to the projections). Preparations for the launch were entirely on the part of the Institute of Aviation and CPSP in Ustka accompanied by the Polish Space Agency. The flight was to take place between air defense exercises (closed naval training ground and airspace). The launch did not take place due to bad weather (the jet stream occurring on those days). For the launch purposes, the danger altitude was raised to unlimited.

The flight took place on 10 September 2019 at an altitude of 23 km, which is significantly lower than expected. In addition, in May 2019, AMBER made a successful flight from the Drawsko Training Ground to test the new control system. Candle-2 – a rocket of SpaceForest sp. z o.o. from Gdynia developed under the Dependable Embedded Wireless (DEWI), a large European project of the ARTEMIS Joint Undertaking), used as a flight demonstrator of a wireless sensor network. Main engine: SF1 hybrid 2 kN; Oxidiser: nitrous oxide (N2O); Fuel: paraffin; Ceiling: approx. 10 km.

In November 2018, SpaceForest's Bigos 4 rocket (another one, after Candle-2) tested under the Suborbital Inexpensive Rocket (SIR) project of the National Centre for Research and Development, reached a ceiling of 15 km at the Drawsko Training Ground. SIR aims to develop a PERUN rocket with a 50 kg payload to a ceiling of up to 150 km by 2023. Another flight took place in January 2020 at the Drawsko Training Ground. A 1:1 scale prototype of the Perun rocket fitted with the engine from the Bigos-4 rocket.





Basic information on PERUN:

1. Length: 11 m
2. Diameter: 45 cm
3. Maximum ceiling: 150 km
4. Fully retrievable supersonic research rocket
5. Lightweight composite construction – carbon fibre and aluminium alloys
6. Hybrid propulsion – rocket engine with nitrous oxide and paraffin (green fuel)
7. No legal restrictions on the handling, storage, and transport of the rocket
8. Two-stage, parachute recovery system

EU SST

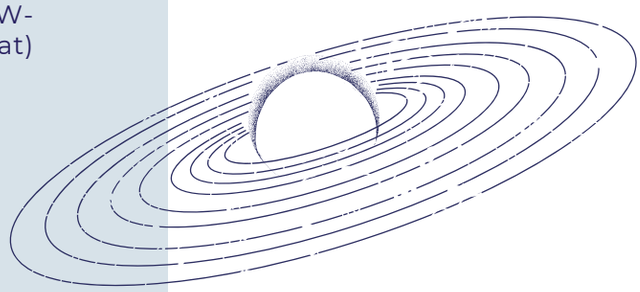
SPACE SECURITY

The Polish Space Agency is a member of the EU SST consortium carrying out the tasks related to observation and tracking of artificial space objects for the European Union under the Space Surveillance and Tracking (SST) programme. The main objective of the programme is to protect Europe's space infrastructure, ground facilities, and EU citizens from the threats posed by the orbiting of thousands of operational artificial satellites and more than one million pieces of space debris. EU SST warns satellite operators of possible in-orbit collisions, space debris from satellites that broke up into pieces as well as the possibility of space debris falling to Earth and the dangers arising from it. A good example of this is the recent uncontrolled deorbit of the CZ-5B Chinese rocket body.

Polish scientific and economic entities carry out a number of ESA's Space Situational Awareness (SSA) activities, including, in addition to SST, observations of Near Earth Objects (NEOs) and Space Weather (SWE). Poland has many entities involved in SSA. Strong scientific centres include the Adam Mickiewicz University in Poznań, the Space Research Centre of the Polish Academy of Sciences, the Borowiec Astrogeodynamic Observatory, and the Nicolaus Copernicus Astronomical Centre of the Polish Academy of Sciences. There are also a number of operators with networks of optical telescopes and SSA data processing capabilities, such as the Polish Fireball Network which monitors the activity of showers of meteors that reach the Earth's surface on a nationwide scale.

STUDENTS RESEARCH CIRCLES

Mention should also be made of the young scientists who are pursuing their passions in space engineering. This includes not only flights in stratospheric balloons and successes in Mars rover competitions but also advanced experiments assigned and carried out under ESA Education programmes. On top of this, more student cubesat satellites (PW-Sat and PW-Sat2, payload for KrakSat) are underway.

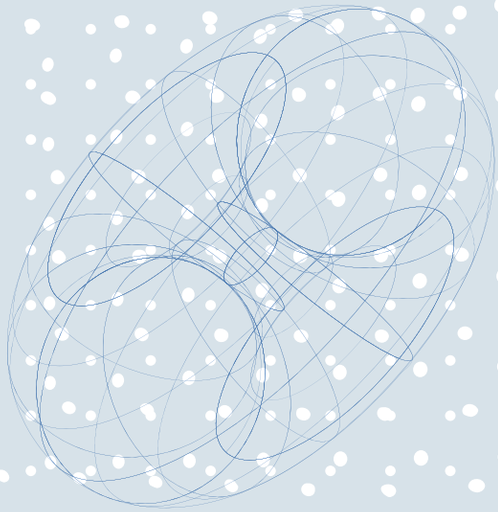


ROBOTIC ARMS

In 2020, PIAP Space sp. z o.o. and ESA signed a contract for the TITAN project (Development of a Robotic Arm for In-Orbit Servicing Operations). The aim of the project is to develop a prototype of a multi-articulated robotic arm for the future deorbiting and servicing of in-orbit satellites. A laboratory model of a robotic joint will be developed, followed by a prototype consisting of various types of joints, which will be subjected to full environmental testing on a shaker as well as to thermal and thermal-vacuum tests. Ultimately, the project will achieve a technological readiness level of TRL6.

SOIL PENETRATORS FOR SPACE PROBES

The core business of Astronika sp. z o.o. is the design, construction, integration, and testing of mechanical systems. It specialises in space mechanisms and instruments (in particular geological penetrators, hold-down release mechanisms, and antenna systems – ultralight structures), strength analysis, and tribological testing. The mechanism for the Mars ground penetrator on board the InSight mission was entirely made in Poland. Astronika designed and integrated the mechanism, the parts of which were manufactured by the Space Research Centre of the Polish Academy of Sciences. In addition, Astronika, as a coordinator of the device's production process, subcontracted works to several Polish entities, i.e. the Institute of Aviation, the Institute of Welding, the Łódź University of Technology, the Warsaw University of Technology, and Towes.



ARTIFICIAL INTELLIGENCE

KP Labs sp. z o.o. is a space sector company based in Gliwice. The company's mission is to accelerate space exploration through the development of autonomous spacecraft and robotic technologies. KP Labs' expertise includes flight software, hyperspectral imaging instruments, AI algorithms, and the Leopard high-performance computing unit for on-orbit data processing.

PROCESSING LARGE AMOUNTS OF DATA

CloudFerro sp. z o.o. provides cloud computing services and specialises in the development of big data. It collaborates with ESA, EUMETSAT, ECMWF, DLR, and many others. Its chief product is the CREODIAS platform, a public cloud with an integrated repository of Copernicus satellite imagery, equipped with a range of applications that allow users to easily search, view, and process satellite data. The architecture of the environment gives users access to diverse remote sensing data and computational resources for its processing, guaranteeing simplicity, scalability, and repeatable processes and production chains.

INTERNATIONAL CHARTER "SPACE AND MAJOR DISASTERS"

This project is based on international cooperation. It provides access to satellite data for the monitoring and subsequent management of natural and industrial disasters. It combines data acquired from satellite-based Earth observation from different space agencies, enabling the coordination of resources and expertise to respond rapidly to extreme phenomena as well as help public administrations in their civil protection efforts.

$$\hat{H} = \sum_{n=1}^{N} \frac{\hat{p}_n^2}{2m_n} + V(x_1,$$

LIST OF PAGES

PAGES | 9 | 11 | 29 | 36 | 39 | 40 |
* GRAPHICS | BARTOSZ MORAWSKI |
POLSKA AGENCJA KOSMICZNA

PAGE | 28
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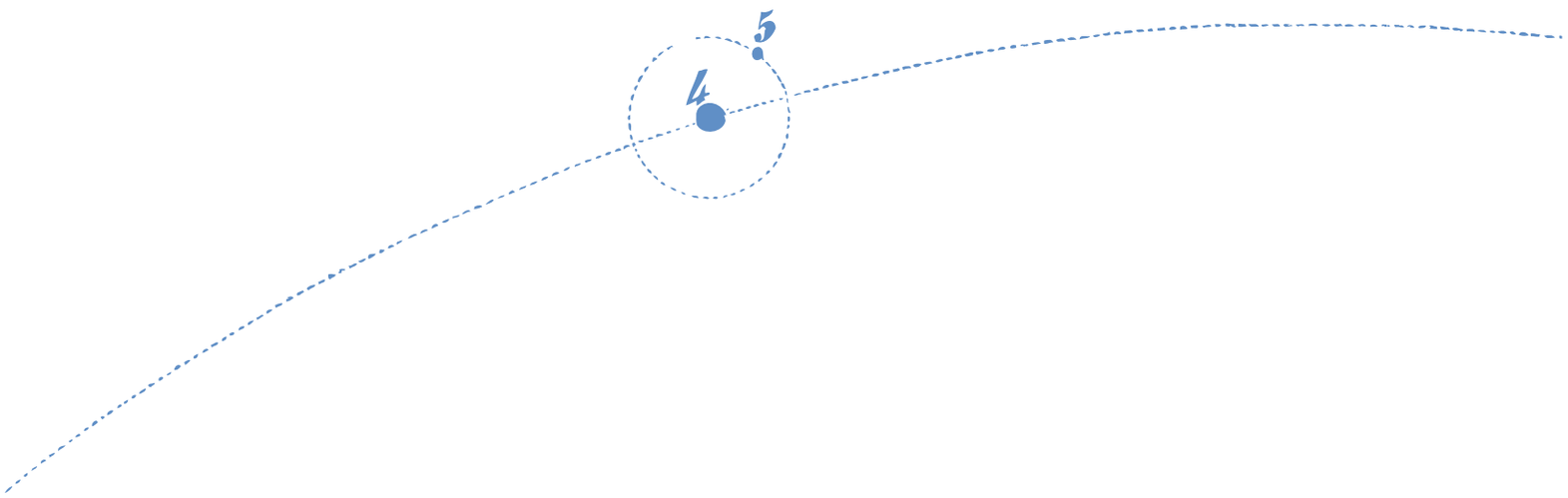

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