The Physical Tourist

Scientific Arkhangelsk and Pomorie: A Walk Through Centuries and Thousands of Miles

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Abstract: Even by Russian standards, the country's northwestern territories contouring the White and Barents seas are vast, remote, and sparsely populated. Yet for seven centuries that faraway province has served as a nursery of religious and intellectual freedom and as a primary entry point for Western civilization and trade, containing several scientific landmarks of interest to the physical tourist. This article is intended as a concise guide to the scientifically relevant attractions in the city of Arkhangelsk and in relatively "nearby" locations which can be reached within reasonable time and with reasonable convenience; these include Mikhail Lomonosov's birthplace on Kholmogory and the Solovetsky islands. We will also briefly mention for the somewhat more remote—but still within 1000 km—territories of Kola peninsula and the Novaya Zemlya islands.

Key words: Arkhangelsk; Russian science; Mikhail Lomonosov; Solovetsky Monastery; Kholmogory; North Arctic Federal University; Archbishop Afanasy; Ivan Meschersky; Boris Rosing; Archangelsk Scientific Center

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Historical Introduction to Russia's North: Kholmogory and Arkhangelsk

What is now known as *Arkhangelskaya Oblast* (Archangelsk Region) or, in broader terms, *Pomorie* (literally "territories near the sea," fig. 1) is known to have been inhabited by Slavonic and other tribes since at least the tenth century. The first mention in the Novgorod chronicles of a regular settlement at the site "Kholmogory" dates back to 1138. At that time, the Novgorod Republic—one of the strongest Russian states—was actively developing these territories near the White Sea, with their rich supplies of fish, furs, and game, while displacing and assimilating the indigenous population named *chud'* ("white-eyed"). Later in the twelth century, Orthodox archbishop Ioann of Novgorod established the Archangel Michael monastery at the location of modern Arkhangelsk, some 90 km northwest of Kholmogory. Kholmogory was the most important trading post in the Far North of Russia for several centuries. *Pomors* (the local population of Pomorie) built special boats called *kochi.* These boats were strong and suitable for sailing in ice-bound waters, able to undertake voyages to distant places under harsh conditions for hunting and trade far beyond the White and Barents seas, such as to Northern Siberia, the trans-Urals city of Mangazeya and beyond.

Figure 1: Map of the *Pomorie* region. Source/credit: http://en.wikipedia.org/wiki/White_Sea

In 1328, Kholmogory was referred as a "city" in the Moscovite document of Prince Ivan I. In 1553 the city began to grow into a center for trade with Europe. That year, a British merchant named Richard Chancellor (d. 1556) set out with three ships to find a northeast passage to China. He became hopelessly lost in the estuary of North Dvina and landed near Kholmogory;

ultimately he wound up in Moscow, where he was presented to Tsar Ivan IV (the Terrible). This encounter led to Russia opening trade with Britain and later with other western European countries. The establishment of trade with the West led to the foundation of the Company of Merchant Adventurers (in full: *The Mystery, Company, and Fellowship of Merchant Adventurers for the Discovery of Regions, Dominions, Islands, and Places Unknown*), who began sending ships annually into the estuary of the Northern Dvina. Trading ships from Norway, Sweden, Holland, and England came in annually by the dozens during summer months because the White Sea is frozen from about November to April. In 1671 in Vavchuga, some 10 km from Kholmogory, the Bazhenin brothers established the first Russian shipyard for the construction of merchant ships. This was followed by a spinning factory, sailing factory and several shops for carpentry, casting, metalwork, rigging, and drawing**.** In the late seventeenth century, the center of business life gradually shifted from Kholmogory to Arkhangelsk, which was more convenient as a seaport.

Arkhangelsk was founded in 1584 by order of Ivan the Terrible. It was originally called *New Kholmogory* and in 1613 was renamed after its Archangel Michael monastery. In 1693, Tsar Peter the Great ordered the creation of a state shipyard in Arkhangelsk. Yet having realized that it would always be limited as a port because covered by ice almost half the year, he founded St. Petersburg in 1703, after a successful campaign against Sweden in the Baltic area. In 1722, Peter decreed that Arkhangelsk should no longer accept goods that amounted to more than what was sufficient for the town's domestic consumption, implying that essentially all international marine trade should go to St. Petersburg. This factor contributed to the deterioration of Arkhangelsk, which continued until 1762, when the decree was canceled.

Still, the decline of Arkhangelsk proper and the entire Pomorie region continued through the rest of the eighteenth century and into the first half of the nineteenth. Its economy revived only at the end of the nineteenth century when a railway to Moscow (some 1000 km to the south) was completed and timber became a major export. During the Entente intervention in 1918–19, the city was occupied by British, American, and French troops[1]. During the Second World War, the city was a major port of entry for Allied aid that came under the so-called Lend-Lease agreement, in which the United States supplied its allies with materiel.

Many famous pioneers came out of *Pomorie*. These included the first governor of Alaska, Alexander Baranov (1746–1819), Erofei Khabarov (ca. 1603–ca.1671), an explorer of Siberia and the Far East; Fedot Popov-Kholmogorets (??–ca.1648 or later), codiscoverer of the Bering Strait opening with Semen Dezhnev in 1648, 80 years before Vitus Bering; and Yermak (Yermolai Timofeyevich Tokmak, 1532–1585), the legendary conqueror of Siberia. The history of Arctic exploration by Russia is closely connected with Arkhangelsk, which was the starting point for most of the exploration teams: the first expedition by Admiral Vasily Chichagov in 1765–1766, inspired by Lomonosov's prediction of the Northern Sea Route; the 1769 transit of Venus expedition of Stepan Rumovsky; the expeditions of Vladimir Rusanov in 1909–1913, Georgy Sedov's expeditions aimed at the North Pole in 1912–1914, and Ivan Papanin's drift station expedition "North Pole-1" in 1937–1938.

Today, Arkhangelsk (population about 350,000) is the administrative and cultural capital of the Arkhangelskaya Oblast (region) with geographical territory approximately the size of France and a population around 1.2 million. It remains a major seaport, now open year-round due to a powerful fleet of icebreakers. The city is primarily a center for timber and fishing industries.

Kholmogory lost its status of a city in 1925 and is now a village with a population of approximately 4,000.

Role of the Orthodox Church: Solovki and Kholmogory

Along with their main activities of prayer and the spiritual nourishment of believers, Orthodox monasteries served also as state fortresses and prisons. They were exemplary for the time for maintaining economical and farming schools, centers of cultural, educational, and (sometimes) scientific development and systematic observation. For example, one of the oldest Russian *Patriarch Nikon Chronicles,* which covers the years from 859 to 1520, has entries for 1365 and 1371 about "portents in the sun - black spaces, like nails," presumably sunspots observed by monks during periods of heavy haze after forest fires.

Fig. 2: Solovetsky Monastery. Source :http://solovki-monastyr.ru/.

Solovetsky monastery (or simply Solovki), one of the most famous Russian Orthodox monasteries, was founded in 1436 by the monks Zosima, German (Herman), and Savvatiy

(Sabbatius) on the Solovetsky Islands in the White Sea, some 260 km north-west of modern-day Arkhangelsk. Over the centuries, the monastery braved many changes of fortune and military sieges by foreigners, including Swedes, Finns, Danes, and the British (the later as late as in 1854), all ending successfully for the defenders. In the late seventeenth century, Solovki and the Pomor region began to house religious dissidents called “Old Ritualists” or “Old Believers” who were fleeing Russia’s mainland after the church institutional reform initiated by Patriarch Nikon (1605–1681) in 1653. Nikon was seeking to align the Russian Orthodox Church closer to the Greek Orthodox Church by mandating alterations in many Russian traditional practices. The Solovetsky monastery hosted many prominent Old Believers who were anathematized as heretics. The monastery was under siege for almost eight years (1668–1674) for refusing to accept the new rites. After the monastery fell to the government troops, several of the most active of the Old Believers were arrested and executed in 1682, including their spiritual leader, Archpriest Avvakum. Others fled the country or relocated in remote regions of Pomorie where government oppression was less fierce.

From the mid-sixteenth century, the Solovestky monastery has been a center of unprecedented technical development in Pomorie and Russia as a whole. Under the governance of hegumen Philipp Kolychev (1509–1569), who later became the Metropolitan of Moscow, the monastery undertook construction of stone roads, a network of canals connecting fifty lakes around Big Solovetsky Island into a single system, with stone piers, water mills equipped with complicated mechanics and storehouses, and a sophisticated water supply system for local breweries. These structures—remarkable technical monuments of early Russian engineering — survived; some are still used today. Part of the local bay was caged off from the sea and turned into an area for keeping and breeding marine animals. Existing workshops were expanded and

many new ones were created. Heat from a wax bleaching plant was used to warm the greenhouses where the monks began to grow unusual southern plants, fruits, vegetables, and even watermelons, all this taking place at an archipelago in the vicinity of the polar circle with a mean temperature of −12° in February and +15° in July. Nowadays, one can get to Solovki from Arkhangelsk by air (about 40 minutes) or by sea from the White Sea western shore cities of Kem' and Belozersk (2 hours).

Fig. 3: (a) Athanasius, archbishop of Kholmogory (1641–1702), founder of the first Russian observatory in bell tower of the Spaso-Preobrazhensky *sobor* (Transfiguration Cathedral, built 1675–1681) in Kholmogory (b). The cathedral lost its magnificent onion-domes (the tallest was 42 m high) in 1920s and now is under long-delayed reconstruction. Source: http://commons.wikimedia.org/wiki/File:Bishop_Afanasy_Lubimov.jpg.

The first astronomical observatory in Russia was set up in 1692 by Archbishop Athanasius (1641–1702) in the bell tower of Kholmogory's majestic Transfiguration Cathedral

(figure 3). The observatory had telescopes, sextants, and astrolabes. Athanasius himself made various astronomical observations of planets and stars. He is commonly cited as the first Russian astronomer of the pre-Petrine era[2].

Archbishop Athanasius was a well-educated man. His library contained 270 titles and 490 individual volumes, including books in Latin, Greek, and German on astronomy, medicine, history, and geography. He was among the church leaders sympathizing Peter the Great, who paid three visits to his diocese. In 1701, Athanasius wrote his "Description of the Three Paths from Russia to Sweden," full of geographic and ethnographic facts that were to help Peter during the Great Northern War with Sweden. In 1720, the emperor established in Kholmogory a so-called "Mathematical and Navigational" schoolto educate cadres for the Russian Navy. This educational institution has been so important that it is reflected in the city's official emblem (figure 4), which depicts a sextant, an astronomical instrument widely used until the 18 century for navigation.

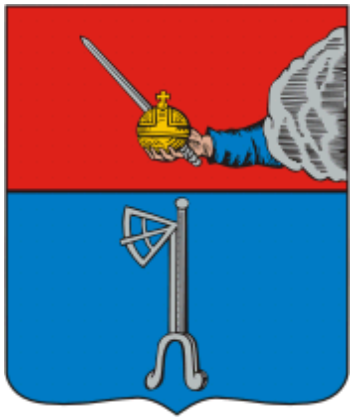

Fig. 4: Emblem of Kholmogory (approved in 1781). Source/credit: http://commons.wikimedia.org/wiki/File:Coat_of_Arms_of_Kholmogory_%28Arkhangelsk_oblast%29_%281780%29.png

Lomonosov's Birthplace

The most remarkable "must-see" place for a scientific tourist in the Arkhangelsk region is the village of Lomonosovo, just 3 km east of Kholmogory, which is the birthplace of Mikhail Vasilyevich Lomonosov (Russian: Михаи́л Васи́льевич Ломоно́сов, November 19 [O.S. November 8], 1711 – April 15 [O.S. April 4], 1765) a Russian polymath, scientist, and writer who made important contributions to science, literature and education (figure 5). He left lasting impacts on many spheres of natural sciences, chemistry, physics, mineralogy, history, art, philology, optical devices, and others. Among his many achievements were the discovery of the atmosphere of Venus and the first experimental proof and formulation of the law of conservation of mass (Lomonosov-Lavoisier law.) He is responsible for the first functional model of a helicopter and rebirth of the technology and art of mosaics, the establishment of new Russian grammar, and the founding of Russia's first University in Moscow (now named after him.) He is responsible for the development of the theory of the autochthonous origin of Slavic people and projections of what is now called the "Northern Sea Route" from the Atlantic Ocean to the Pacific Ocean. Lomonosov was also one of the greatest Russian poets, who influenced the formation of the modern Russian literary language; his talent was later overshadowed only by Pushkin. In Russia, Lomonosov is considered the "father of Russian science" and "the first Russian scientist." Culturonomical analysis also shows that since the times of the Russian eighteenth century Enlightenment, Lomonosov was and remains the most famous name in science in the country.[3]

Lomonosov was born in the village of Mishaninskaya, which later was absorbed by village of Denisovka and in 1911 renamed Lomonosovo on the occasion of the scientist's

bicentennial. It was part of the Arkhangel Governorate and is located on a Kurostrov island separated from Kholmogory by one of the distributaries of the North Dvina River. His father, Vasily Dorofeyevich Lomonosov, was a prosperous peasant fisherman turned ship owner, who amassed a small fortune transporting goods from Arkhangelsk to Pustozyorsk, Solovki, Kola, and Lapland. Lomonosov's mother was Vasily's first wife, a deacon's daughter, Elena Ivanovna Sivkova who died when Mikhail was nine. From the age of ten, Lomonosov began accompanying Vasily on trading missions to the White Sea and beyond. Learning was young Lomonosov's passion and his thirst for knowledge was insatiable. Lomonosov had been taught to read as a boy by his neighbor Ivan Shubny, and he spent every spare moment with his books. He continued his studies with a deacon of the local church (which by the way can be seen today in Lomonosovo), S. N. Sabelnikov, but for many years the only books to which he had access were religious texts. When he was fourteen, Lomonosov was given copies of Meletius Smotrytsky's *Modern Church Slavonic* (a grammar book) and Leonty Magnitsky's *Arithmetic*. In 1724, his father married for the third time, Lomonosov’s relationship with his stepmother Irina became acrimonious, and—unhappy at home and intent on obtaining a higher education, which he could not receive in Mishaninskaya —he decided to leave the village.

Fig. 5: (a) N. I. Kislyakov, "Young Lomonosov on the way to Moscow" (1947); (b) the monument to Mikhail Lomonosov (1958) by sculptor Ivan Kozlovsky in the village of Lomonosovo. Sources: http://lomonosov.aonb.ru/?id=14; V. S..

On the frosty, sub-zero day of December 7, 1730, a young, tall, physically fit nineteen-year old ran away from home (fig. 5a). He borrowed three rubles and a warm jacket from his neighbor-friend, carried the two books he had managed to acquire and treasured the most—*Grammatica* and *Arithmetica*—and persuaded the captain of a sleigh convoy carrying frozen fish to take him to Moscow, where he wanted to fulfill his dream of studying “sciences.” After years of hardship and a decade of scientific training, including five years in Moscow’s best church academy and five years in Germany, he would become the first Russian academician (fig. 5b), a

hereditary nobile with the rank of state councilor, Russia's most accomplished polymath. For the next two centuries, his name would become the cult name of Russian science. *Investigabiles viae Domini!*

Fig. 6: (a) Lomonosov's museum in Lomonosovo; (b) a scaled model reconstruction of Lomonosov's father's house in the museum. Sources: http://museum.lomic.ru/; V. S.

Fig. 7: Participants of the *XIX All-Russian Conference of Physics Students* cross the winter road from Kholmogory to Lomonosovo village over the frozen North Divina River. Kholmogory's Spaso-Preobrazhensky *sobor* (Transfiguration Cathedral) is seen in the background. Credit: V. S.

Lomonosov has cult status in *Pomorie.* In his native village of Lomonosovo (population of 123), an impressive monument to Mikhail Lomonosov by famous sculptor Ivan Kozlovsky

was erected in 1958 in front of the village administration building (figure 5b). The *Mikhail Lomonosov Memorial Museum* opened in 1940 in the building of a school constructed in 1892 at the site of Lomonosov's house, near a fish pond excavated by his father. The museum (figure 6a) has almost 5,000 items in its scientific and auxiliary collections; its library has 3,000 relevant books. Over its 70 years in existence, the museum has been visited by almost 650,000 people; the flux of visitors peaks around Lomonosov's birthday, the annual "Lomonosov's Readings" conference series and other memorial days. Eight halls host exhibitions on the native land of the scientist, his path to glory, his scientific accomplishments, and so forth. Visitors will be able to see a scaled-down model reconstruction of Mikhail's father's house (figure 6b), and of the first Russian chemical laboratory, established by Lomonosov in St. Petersburg in 1748. Also on display is a large painting "Life of a Peasant Family of the Eighteenth Century" by the artist A. I. Rumyantsev, as well as unique watches and furniture of the early- to mid-nineteenth century, portraits of Lomonosov, and much more. To get to Lomonosovo from Kholmogory, one has to either take a ferry across North Dvina River (running several times a day) or cross it over ice in the winter (figure 7).

Arkhangelsk: Notable Science and Technology Sites

Historically, secular higher education in the natural sciences in the Russian North began with the establishment of Russia's first nautical school in Kholmogory in 1781 by decree of Catherine the Great.[4] This school trained navigators for the needs of the merchant fleet and was free of charge, accepting children from the age ten to twenty from all strata of the local population, with some advantages for children from low-income families and orphans. The classes taught in the school

included Russian language, arithmetic, geometry, merchant navigation, astronomy, accounting “of the Italian type” and four (!) mandatory foreign languages: Dutch, English, German, and French. The students’ talents were ranked quite categorically: "stupid," “mediocre," and "teachable." The school was relocated to Arkhangelsk in 1786, underwent a number of transformations and continues today as the State Educational Institution of the Arctic Maritime Institute named after Captain V. Voronin, located near Dobrolyubov’s Scientific Library (#13 on the map in figure 8).

There are two major universities in Arkhangelsk these days: the State Northern Medical University (see #11 in figure 8) and the Northern (Arctic) Federal University (NArFU). NArFU, the larger of the two (figure 9) was established as one of eight strategic federal universities by a 2009 decree of the Russian President. It effectively incorporates seventeen various previously existing educational units and institutions into one school (including the Arkhangelsk Institute of Forestry and the Arkhangelsk State Pedagogical Institute, which were established in 1929 and 1932, respectively). NArFU employs about 1,200 faculty members who teach 20,000 students annually in all major fields of study. A bronze monument to Lomonosov commissioned by Tsar Alexander I and cast in 1832 by famous sculptor Ivan Martos stands in front of the university’s main building (#3 in figure 8). Another modern bronze sculpture of Lomonosov is found in the entrance hall. The University also hosts the Institute for Lomonosov Studies and a virtual Lomonosov Museum.

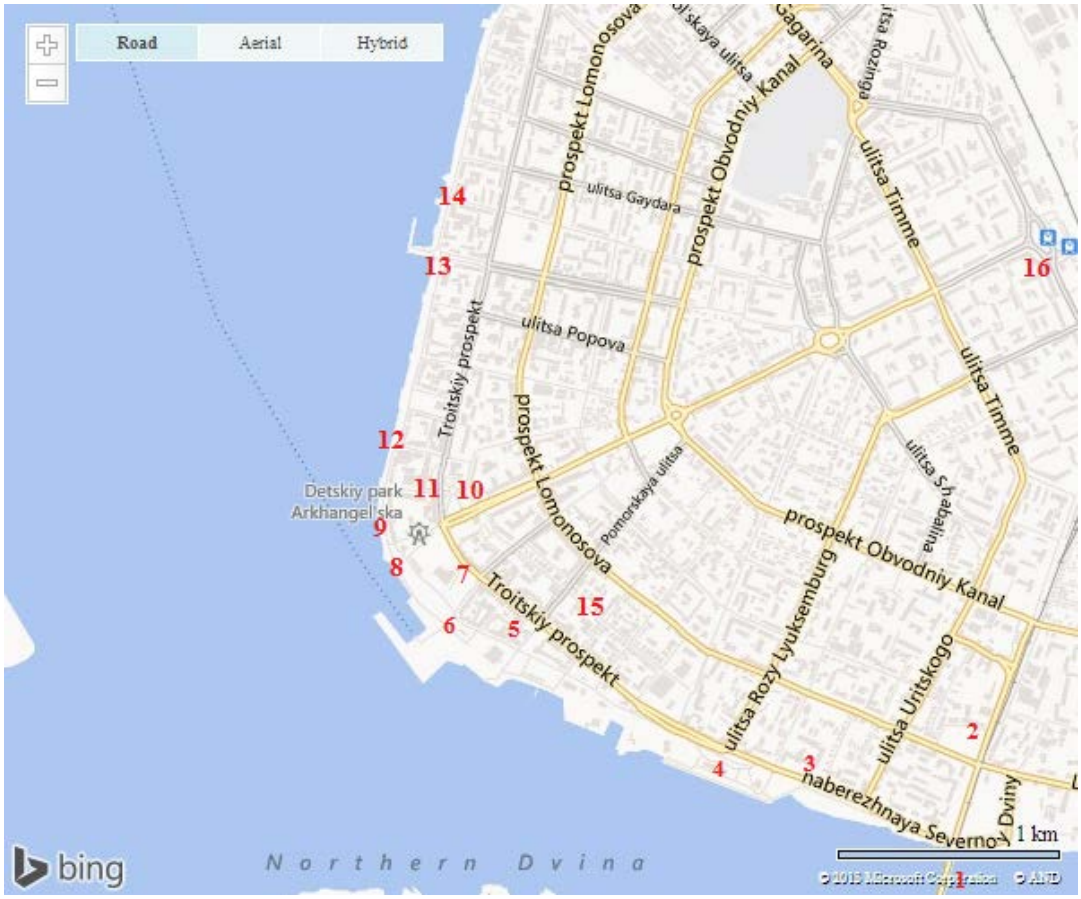

Fig. 8: Map of the center of Arkhangelsk: (1) the most northerly drawbridge in the world; (2, 3) Northern Arctic Federal University; (3) the monument to M.V. Lomonosov; (4) sea and river ship pier; (5) Museum of Arctic Exploration; (6) Northern Maritime Museum; (7) drama theatre named after Lomonosov; (8) monument to Peter the Great; (9) Arkhangelsk *Gostiny Dvor*; (10) National History Museum; (11) State Northern Medical University; (12) Peace Square; (13) Dobrolyubov's Library and the Arctic Maritime Institute; (14) monument to Admiral Kuznetsov and the Arkhangelsk Scientific Centre of Russian Academy of Sciences; (15) Chumbarova-Luchinskogo street; (16) train and bus station. Source: http://www.bing.com/maps/.

The first scientific institutions in Arkhangelsk were founded in 1933 when the USSR Academy of Sciences decided to establish the Office for the Northern Study. In 1935, it was reorganized into the Northern Base of the USSR Academy of Sciences, headed by a prominent zoologist, an honorary member of the Academy Nikolai Knipovich (1862–1939). Next organized were the Institute of Ecological Problems of the North (1978) and Institute of Environmental Physiology (1990). In 2001, these institutes became part of the Arkhangelsk Scientific Center, part of the Ural Branch of the Russian Academy of Sciences (#14 in fig. 8).

Fig. 9: The main building of the Northern (Arctic) Federal University named after Lomonosov, whose bronze monument is set near the central entrance. Source: http://www.narfu.ru/.

Besides Lomonosov, who largely overshadows the merits and achievements of the natives of these places in the natural sciences, several other famous people of physics and engineering are associated with Pomorie. Ivan Meschersky (1859–1935; see figure 10a), a

Russian mathematician widely known for his work on the dynamics of bodies of variable mass, was born in Arkhangelsk. Though the house he lived in could not be identified with certainty, it is known to be in the Solombala district of Arkhagelsk where nowadays one of the streets is named after him and a memorial plaque is installed on the house number 21 on the Meschersky's street some 2 miles north of point #14 in figure 8. After finishing Archangelsk Gymnasium in 1878 with a gold medal for all excellent marks, Ivan Meschersky continued education in St. Petersburg University and later worked at the St.Petersburg Polytechnic Institute, where he chaired the Department of Theoretical Mechanics. In 1897, he formulated Meschersky's equation for rockets.[5] His book of problems in classical mechanics remains widely used.[6]

Boris Rosing (1869–1933; figure 10b), one of the key inventors of television, worked in the physics department of Arkhangelsk Forestry Technology Institute in 1931–1933. In 1907, while in St. Petersburg, he envisioned and demonstrated a television system that had a raster scanning signal on the transmitting end and a cathode ray tube on the receiving end. The system was primitive, but definitely was one of the first experimental demonstrations of the basic principle of the design and operation of the modern television.[7] On July 25, 1907, he applied for patent on "The method for the electrical transmission of images over a distance," which was granted the same year (patent number 18076). His pupil Vladimir Zworykin (1888–1982) then developed the idea of opening the era of electronic television.[8]

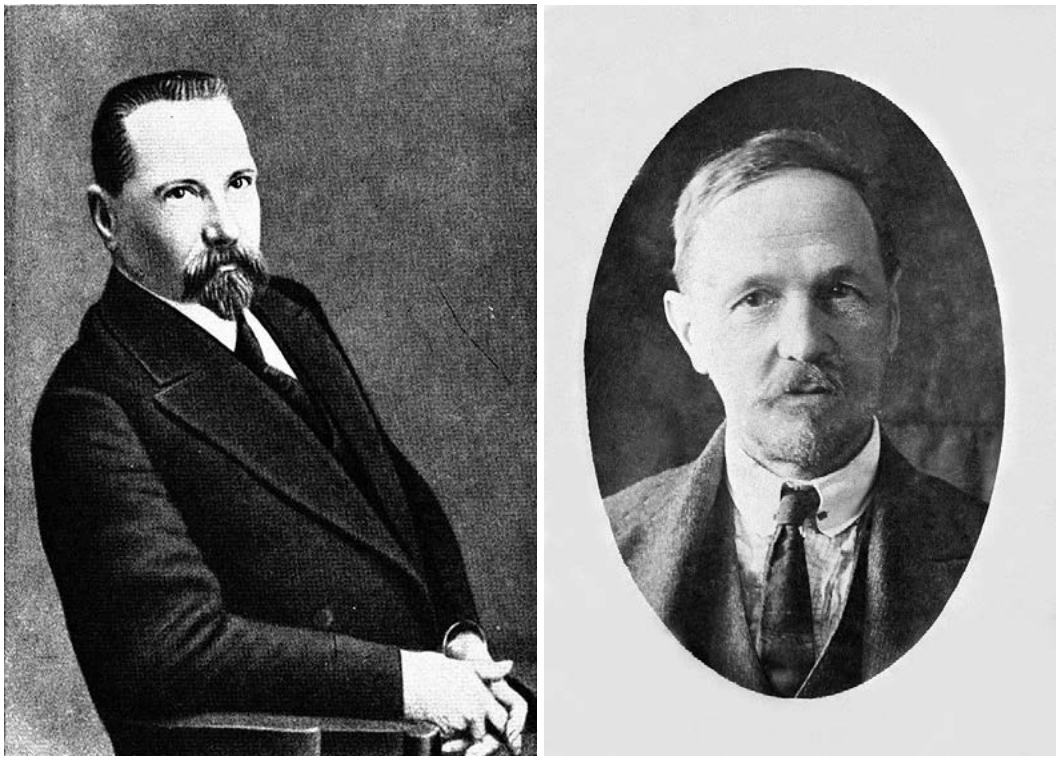

Figure 10: (a) mathematician Ivan Meschersky (1859–1935); (b) engineer Boris Rosing (1869–1933), inventor in the field of television. Source: http://journal.spbu.ru/?p=10086; ref. 9.

Rosing was arrested in 1930 under suspicion of helping “counter-revolutionaries”—the charge was dropped in 1956—and exiled to Arkhangelsk. There, Rosing continued his scientific activities. In the laboratory of the Forestry Technology Institute (#2 in figure 8, now part of NArFU), he continued to improve a device for orientation of the blind (figure 11) and developed a reading machine for the blind, a pioneering attempt at pattern recognition using a photocell detector. Rosing also worked on an electrocardiograph for the Arkhangelsk hospital. In 1933, Rosing died of a brain hemorrhage and was buried at the Arkhangelsk cemetery.

Figure 11: (a) Boris Rosing in the laboratory working on the prototype reading machine for the blind; (b) Rosing's device for orientation of the blind. *Sources:* http://technolog.edu.ru/ru/university/ob-universitete/izvestnye-vypuskniki-tekhnologicheskogo-instituta/item/1114.html; ref. 9.

At present, physics education and scientific research show encouraging sustainable development at the NArFU's Institute of Natural Sciences and Biomedicine, which specializes in fundamental physics, nanotechnology, and medical physics. The Institute has three departments: the Department of Theoretical Physics, where research in the field of atomic physics and physics of particle accelerators is conducted; the Department of General Physics, where studies of the physics of fine media (ice) take place; and the Department of Physics, which mainly deals with the problems and methods of teaching physics. The Institute has modern laboratory equipment for teaching, research, and educational experiments and actively cooperates with international research centers, such as Joint Institute of Nuclear Research (Dubna, Russia). Other parts of NArFU related to the natural sciences are the Institute of Mathematics, Informatics, and Space Technology, and the Institute of Pure and Applied Chemistry. Training in engineering and technical specialties is offered by NArFU's Forestry Institute, the Institute for Energy and

Transport, the Institute of Oil and Gas, and the Institute of Shipbuilding and Marine Arctic Technology. Many alumni are employed by local enterprises Sevmash and Zvezdochka in the nearby city of Severodvinsk, which produce and repair nuclear submarines and ships for military and civilian purposes, and at the Plesetsk spaceport some 180 km south of Arkhangelsk (see map in figure 1 and figure 12a), which holds the world record for the total number of space launches (about 1,600). The traditions of the Arctic research continue today. For example, every year students and teachers undertake the NArFU Arctic expeditions at the "Floating University" on the ice-strengthened oceanographic research ship "Professor Molchanov" (figure 12b). The participants engage in teaching and research in the natural sciences and medicine, related to specific Arctic conditions.

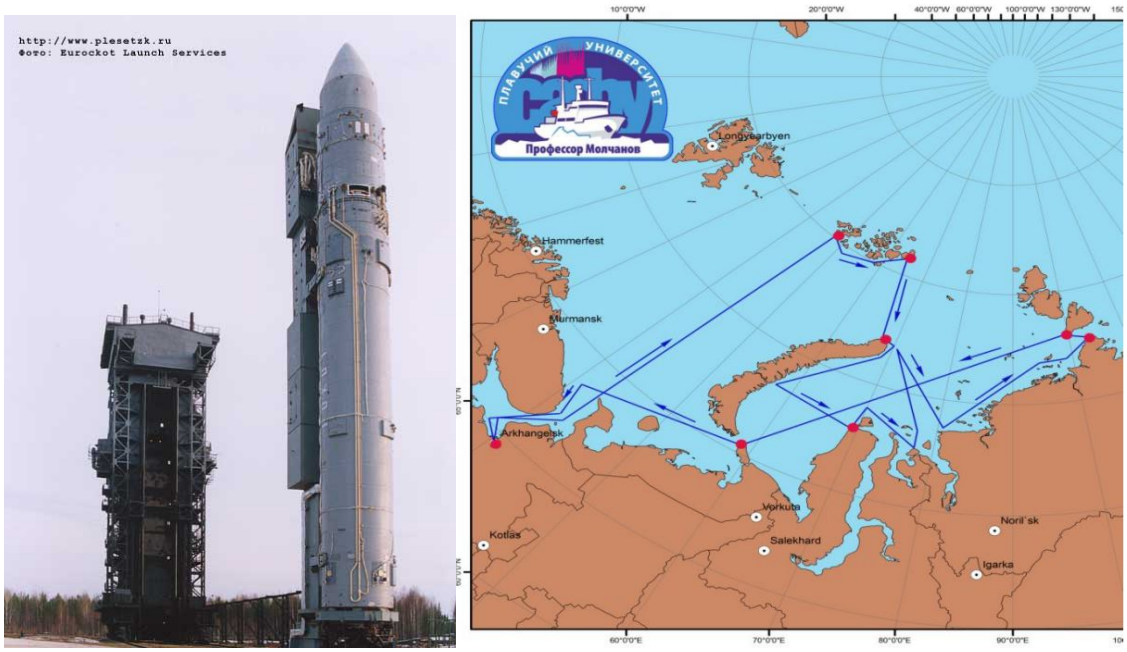

Fig. 12: (a) rocket at the launch pad at the Plesetsk cosmodrome, now widely used for scientific space missions; (b) the route of the 2014 NArFU ”Floating University.” Sources: http://www.plesetsk.ru; http://narfu.ru/science/expeditions/floating_university/.

There are many other interesting tourist spots at and near Arkhangelsk, including Arkhangelsk historical museums of “Gostiny Dvor” (Merchants’ Court, #9 in figure 8), the Northern Maritime Museum (#6), the Museum of Arctic Exploration (#5) , and a historic street Chumbarovka (#15). Some 25 kilometers south of the city is the Malye Korely museum of wooden architecture under the open air, where innumerable original seventeenth–nineteenth centuries *Pomorian* wooden cottages, mills, churches, and even entire villages are collected.

Acknowledgments

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