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Parrot's Laboratory in the Borderland

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Abstract: Georg Friedrich Parrot, professor of physics at the University of Tartu/Dorpat from 1802 until 1826, founded the best physics laboratory in the Russian Empire, containing *ca.* 450 experimental devices of which more than 60 had been invented by Parrot himself. Of the total number of instruments approximately 50 are still preserved in the University of Tartu Museum collections. The article is the first attempt to give a historical background of the laboratory, using Parrot's own writings, archival sources and the extant devices.

Parrot's youth was shaped by the ideas of the French Enlightenment. According to his worldview, education had to be practical, utilitarian, and based on natural sciences. A well-equipped laboratory was ineluctable for that. Lavoisier's chemistry was taught at the University of Tartu since the very beginning. Parrot emerged as one of the first French mathematical physics in a German-speaking world and introduced a new branch of physics—the physics of the Earth. His pioneering chemical theory of galvanic electricity failed to gain him recognition in his lifetime, but it shaped the worldview of later students. Parrot's organisational talent took both the laboratory and the teaching in Tartu to the highest level of the time. His textbooks helped to introduce the physics worldview to the next generation both on the secondary school and university level.

Keywords: *Enlightenment, history of physics and chemistry, Parrot, University of Tartu*

Georg Friedrich Parrot was a professor of physics at the University of Tartu/Dorpat from 1802 until 1826. During that time, he created the best physics laboratory in the Russian Empire. The laboratory contained *ca.* 450 experimental devices of which more than 60 had been invented by Parrot himself. Of the total number of devices approximately 50 are still preserved. From 1989 until now there have been three different exhibitions about Parrot's laboratory in the University of Tartu Museum but a published overview about the historical background of these historical instruments has so far been lacking.

This article explores Georg Friedrich Parrot's involvement in organisational activities and efforts in establishing contacts for creating the physics laboratory and his role in introducing new chemistry and physics. It also discusses the location of the University of Tartu on the cultural border between the East and the West and in the German and Russian cultural sphere, which was favourable to its becoming an important centre of research, and the impact of the turn to natural sciences in education on the creation of the laboratory. The focus of this paper is not the instruments but the various influences affecting the completing of the laboratory. The sources for the investigation are books and letters written by Parrot himself, archival documents, the remaining instruments located at the University of Tartu Museum, and additional background literature.

The name of Professor Parrot is mentioned in almost all writings concerning the history of the University of Tartu/Dorpat in the first quarter of the 19th century due to his activities in the organisational process of the university, whereas his activities as a physicist and especially the material part of the laboratory have gained much less attention. The most profound articles about Parrot, the physicist were published in 1967 (to celebrate his 200th anniversary) and written by Paul Prüller (1967) and Uno Palm (1967). The earlier authors have mostly used the textbooks written by Parrot in German (Parrot, 1809; 1811; 1815a; 1815b), but his 6-volume popular book in French *Entretiens sur la Physique* (Parrot, 1819–1924) could add interesting nuances, because here Parrot discusses all the news in physics, and the strong and weak aspects of new theories. Erna Kõiv compiled a catalogue about the laboratory, which included 16 of the rarest remaining items (Kõiv, 1989). She has also published an overview about the origin of the old physics instruments in Tartu (Kõiv, 1997). A book about German-speaking physicists in St. Petersburg (Hempel, 1999) gives a good overview about the physics cabinet at the St. Petersburg Academy of Sciences as well as the work conducted there by Parrot, Emil Lenz and Moritz Hermann Jacobi. Epi Tohvri (2011) and Peeter Müürsepp (2013) wrote the first in-depth papers about Parrot in English concerning Parrot's connections to various Enlightenment ideas.

Between the East and the West

Since the beginning of the 18th century, the territory of Estonia belonged to the Russian state, but the local German-speaking elite was more connected to the German cultural life. The Baltic provinces had extended autonomy in administration. The main religion in Russia was Russian Orthodoxy, whereas in the Baltic provinces it was Lutheran. If today the Russian-European controversies are approached on the East–West axis, then in the early 19th century Russia was considered to be a Nordic country. The capital of Russia was St. Petersburg and the beginning of Russian history was connected to "invitation of the Varangians, led by Rurik". Parrot also wrote in 1803 to Martinus van Marum: "I have been busy for more than a year contributing to the establishment of a new University in the North" (NHAH, 1802–1810).[1]

Both the Napoleonic wars and the activities of Russian Tsar Paul I hindered the exchange of information between Russia and the Western Europe. But the Republic of Letters, a network of personal connections between scientists still functioned, stretching from Paris to Kazan. We see a quick movement of ideas and devices—all important new inventions appear within some years in Tartu. The professors in Tartu tried to publish their work in Western journals, but due to political matters it was not always easy.

The beginning of the 19th century was a time of several transitions: from the cosmopolite Enlightenment to the more national Romanticism, the creation of a new European university model, and the emergence of new physics and new chemistry. Tartu was located on the western border of the Russian Empire, and on the eastern border of German culture and Western Christianity. In this fruitful borderland, after its reopening in 1802, the University of Tartu developed into a very important centre of research in natural sciences.

Compared to most German universities, the University of Tartu had managed to modernise the structure of its Faculty of Philosophy and bring it into conformity with the advances in natural sciences at the time. In 1799, the plan was to establish a chair for chemistry and pharmacy in the medical faculty, and the philosophical faculty had 7 professorships. In the statute of 1803 (Statuten der Kaiserlichen Universität zu Dorpat, 1803) the Faculty of Philosophy had increased its professorship from 7 to 13, becoming the largest in the university,

[1] *"Je suis occupe depuis plus d'un an à contribuer a l'etablissement d'une nouvelle Universite dans le Nord."* Parrot to van Marum, 2 October 1803 (NHAH, 1802–1810).

and was divided into four classes or departments, the first two of which were the Department of Philosophy and Mathematics, encompassing theoretical and practical philosophy; pure and applied mathematics; and observator (extraordinarius), and the Department of Natural Sciences, including theoretical and experimental physics; theoretical and experimental chemistry; and natural history and botany.

When Parrot was invited to the University of Tartu, he was first offered the Chair of Mathematics and Military Science, then (in 1802) the Chair of Pure and Applied Mathematics, and in 1803 he changed it for Physics.

The transition from the earlier philosophical method of research to the scientific method was profound and extensive in biology, physics and chemistry. The founders of the university planned from the very beginning a basis for research in natural sciences including clinics, physics and chemistry laboratories.

Most of the instruments in Parrot's laboratory came from Western Europe. In Russia there was only one workshop—that of the Academy of Sciences in St. Petersburg. The production of private craftsmen did not satisfy the needs of scientific research. Exchanging of letters about completing physics and chemistry laboratories and the observatory started already when the board of noble curators prepared the opening of a protestant university.[2] On February 12, 1802, Parrot presented a list of necessary instruments with the names of master craftsmen, who could prepare them (EAA, 1800–1802, p. 4). The University of Tartu sent official inquiries to the East and the West: to Schrader in St. Petersburg and Tiedemann in Stuttgart. At the beginning they hoped to receive most of the instruments from St. Petersburg, but professor Schrader asked 11,200 roubles BA in advance for 71 instruments[3] and the curators found it too expensive. Professor Johann Gottlieb Friedrich Schrader (1745–1816) was a well-known optician, but in the Academy of Sciences of St. Petersburg he had difficulties with organising the workshop. It may not have been a priority for the academy; at least the reflecting telescope ordered for the observatory of Tartu (and prepaid with 500 roubles BA) remained unfinished despite the fact that mechanic Anton Rospini tried to complete it later (Laidla *et al.*, 2017).

2 The first record of a possible order to Adams and Dollond, when they cannot find a cheaper possibility, on 29 November 1800 (EAA, 1800–1802, p. 3).

3 Letter from Schrader to the University curatorium dated to 3 February 1802 and the protocol (EAA, 1800–1802, pp. 5–7). His "no" can be found in the protocol dated to 26 March 1802 (EAA, 1800–1802, pp. 11-11p.)

Johann Heinrich Tiedemann (1742–1811) was a mechanic and an optician in the court of Württemberg in Stuttgart. In the first years of the 19th century he was one of the most important contacts for Parrot in Western Europe concerning completing the laboratory. The choice of Tiedemann among the instrument makers in Europe was probably not coincidental. Parrot had studied in *Hohe Karlsschule* in Stuttgart (graduated in 1786). The vice curator of the University of Dorpat Johann Emanuel v. Ungern Sternberg (1763–1825) also studied in *Hohe Karlsschule* in Stuttgart in 1781–1782 (*BBL*, n.d.), a couple of years before Parrot. Tiedemann's answer was promising and the curators decided to order some microscopes, a solar microscope, a camera obscura and *Ein Dollondsches Telescop oder Achromatisches Fernrohr* (2 feet).[4]

The collection of the University of Tartu Museum contains the solar microscope (incomplete) (UAM 397:53/a AjKF 83:53/a), some simple microscope lenses (UAM 532:5-8) and an achromatic objective (UAM 532:4) from Tiedemann's workshop. By Tiedemann's mediation the university received some instruments from England as well. In Parrot's laboratory we find several instruments made in the workshop of Dudley Adams (1762–1817)—a sextant with artificial horizon (UAM 80:5) and a telescope made by Adams in London (UAM 20:2). The museum collection has a small demonstration devise, which belongs to the early achromats and was made in the late 18th century in the workshop of P. and J. Dollond (UAM 476:1). During the Napoleonic wars and the continental blockade, it was prohibited to sell British optics to the mainland. But there was already a lot of achromats in the mainland and Germany was making advances in new technologies. Parrot bought the device from Tiedemann in Stuttgart in 1804 (Kõiv, 1989, p. 28).

Another important contact for Parrot in Western Europe was Martinus van Marum in Haarlem. Their contacts started with van Marum's letter from 30 May 1802 to Parrot where he said that the Batavian society wished to award him a prize for his writings on galvanic electricity (NHAH, 1802–1810). In his letters to van Marum, Parrot sometimes discusses several scientific ideas, but his first interest was completing the laboratory. Van Marum had invented a new type of electrophore with a double disc producing both positive and negative charges (in 1784), but he no longer wanted to work as a constructor and suggested to Parrot Jacob Henrik Onderdewijngaart Canzius in Delft, who had an excellent

[4] On 12 February 1802, a letter was sent to Tiedemann (EAA, 1800–1802, p. 4), his answer came on 14 March 1802 (EAA, 1800–1802, pp. 12–12v), the order was sent on 26 March 1802 (EAA, 1800–1802, p. 8).

workshop. It appears that Parrot sent all orders to Canzius via van Marum. Parrot wanted to have a very large electrophore (with a disc of 64 [French] inches in diameter) and van Marum promised him a copy of the one in Teylers Museum. But this was never completed and Parrot only received an electrophore with a disc of 32 inches (and several other instruments primarily for the study of electricity and gases). One Gazometer constructed on van Marum's example arrived in Tartu broken, and the glass details had to be replaced. Their contact was mutually beneficial: in 1805, using Parrot's contact in Russia, Commissioner Jacob Forster (1739–1806) in St. Petersburg, van Marum ordered a big lodestone from the Urals for the Teylers Museum.[5] Parrot highly appreciated the work of van Marum and Canzius, and wrote after receiving the instruments: "All physicists should make a pilgrimage to Haarlem and Paris".[6]

When it became clear that Schrader could not deliver all the necessary instruments, Parrot decided to organise a workshop at the University of Tartu in 1807. The first mechanic was Baron Christian Friedrich Welling, who had worked for the university already since 1802, and his successor in the years 1807–1824 was a local clockmaker Benjamin Politour (Leppik, 2011a, pp. 175–178). Making ends meet in Dorpat was difficult for both men due to the small size of the city, the population at the time being 3,500, increasing to 8,000 in ten years. The university workshop was next to the workshop of the Academy of Sciences, one of the rare places in the Russian Empire where original (or copies of well-known masters' works, as there was no international patent system yet) scientific instruments could be made. So, in Russian-German scientific contacts Tartu had a significant position not only in the exchange of ideas but also in the exchange of instruments. Only in the second quarter of the 19th century did the workshop of the Academy of Sciences rise to dominance. Parrot became the leader of the physics cabinet of the Academy of Sciences in 1826 and invited his talented disciple Emil Lenz and Professor Moritz Hermann Jacobi and Theodor Girgensohn as a mechanic to join him there (Hempel, 1999, p. 110).[7]

5 Martinus van Marum to Parrot, Sept. 1805. A thank-you-letter from van Marum to Parrot, 8 September 1810 (NHAH, 1802–1810).

6 *"Tout physician droit faire un pelerinage a Haarlem et a Paris."* Parrot to Martinus van Marum, 9 July 1806 (NHAH, 1802–1810)

7 The statement of Hempel that Girgensohn was a former student of the University of Tartu seems to be erroneous, because his name cannot be found in *Album Academicum der Kaiserlichen Universität Dorpat* (Hasselblatt & Otto, 1889).

A turn to natural sciences

The scientific revolution of the 17th century thoroughly changed the way Europeans saw the world. Besides the truth of the Bible, the truth of science—based on observation and experiment—was allowed to flourish. However, as there were several ways to interpret the results, many things still remained a matter of dispute in the physics worldview of the 18th century.

Until the 18th century, books were the most important tools in university teaching and empirical sciences started to develop outside the universities. The impact that it had on the society can be compared to the digital revolution of our time. There was no longer authority of letters, but observation and experiment; the aim of higher education was no longer blessedness in that world but human bliss in this world.

Parrot was an enthusiastic supporter of natural sciences. His speech at the festive opening ceremony of the University of Tartu in 1802 was dedicated to the importance of the education in natural sciences: "Therefore, observation of nature offers us all kinds of intellectual pleasures as a dignified and most useful object of thought. […] But the importance of the Enlightenment derived from the knowledge of nature itself, without reference to our arts, [...] is what older America teaches us." (Parrot, 1803, p. 49).[8] Referring to the destiny of the indigenous people of America who lost their freedom and lives, Parrot argues: Had Native Americans known how to predict a solar eclipse (as the conquerors did), perhaps the whole destiny of America would have been different. His dissertation from the same year was about the usefulness of natural sciences to medicine (Parrot, 1802a). For Parrot, natural science was not something luxurious or unpractical, it was a matter of life and death.

At the beginning of the 19th century, physics only started to develop into a discipline in its own right. Mathematical methods and precision measurements were increasingly applied. According to Parrot, the task of physics was to guide us on the path to understanding nature, as the nature itself had provided us with two constant entities, natural phenomena as a basis for discussion about the relations between cause and effect.

[8] *"So gewährt uns die Anschauung der Natur jede Art des intellectuellen Genusses, in dem sie uns die Würdigsten und gemeinnüzigsten Gegenstände des Denkens darbietet. [...] Aber wie wichtig die aus der Naturerkenntnis fliessende Aufklärung an sich, ohne Bezug auf unsere Künste sey, [...] das lehre uns das ältere America."*

> As natural phenomena are very complex and the humans are too small and powerless for nature, a physicist needs a laboratory. In the laboratory, the physicist is capable of imitating natural phenomena more easily with a small apparatus; he can analyse, repeat and modify them, measure the results, and, this way, reach an understanding of the laws of nature. (*Entretiens*, 1, 1819, pp. 12–13)

In German universities at that time several naturphilosophical ideas were quite widely spread and it has been said that Parrot's physics has an element of *Naturphilosophie* in it (Prüller, 1967, p. 57). In his works he has clearly distanced from this way of thinking. For example, in introduction to *Theoretical Physics*, Parrot wrote:

> Indeed, it must be strictly historically documented if posterity is to believe that modern-day natural philosophy appeared nearly 100 years after, not 100 years before Newton's natural philosophy, immediately following Lavoisier's works, and that this scholastic found no Cartesius in the age of Laplace's. (Parrot, 1811, pp. iii–iv)[9]

Mathematical physics was most developed in France. Parrot's textbook in German (published in 3 volumes in 1811, 1813 and 1815) is one of few examples of that period (Hempel, 1999, pp. 111–112). Especially the chapter about mechanics is mathematically grounded and found recognition in a book review at the time (*Allgemeine Literaturzeitung*, 1811, pp. 293–296). In the second half of the 18th century, developments in mechanics (the invention of the steam engine, mechanical spinning machines, etc.) were explained theoretically more thoroughly, while this resulted in modelling and calculation of work needed in mechanisms (it required knowledge of the physical rules of levers, pendulums, transmissions, etc.). In Tartu, Parrot started with popular lectures about mechanics already in 1801. But his best achievement in this field is probably the construction of a new rotating tower to the observatory for the big Fraunhofer refractor, which arrived in Tartu in 1824. Parrot's original and thoroughly calculated construction (EAA, 1824–1826; Struve, 1825, pp. 19–22) was so successful that it was copied in several observatories built later, such as in Helsinki (1828), Pulkovo (1839), etc. (Markkanen, 1989, pp. 204–215).

9 *"Wahrlich, es muss historisch streng documentiert werden, wenn einst die Nachwelt es glauben soll, dass die heutige Naturphilosophie beinahe 100 Jahre nach, nicht 100 Jahre vor Newtons natürliche Philosophie erschienen, dass sie unmittelbar auf Lavoisiers Werke folgte, und das diese Scholastic im Zeitalter Laplace's keinen Cartesius fand."*

In his textbooks and in his laboratory Parrot divided physics into eight main fields: mechanics of solids, mechanics of fluids (including gases), warm, light, pure substances and their combinations, electricity, magnetism and physics of the Earth. In addition to the mechanics, the latter deserves special attention. Parrot is one of the founders of a new branch in physics—the physics of the Earth (Buntebart, 1981, p. 97). In Parrot's own words this was

> the mountains and seas, volcanoes and auroras—nature's own laboratory, where the researcher's only legacy is the act of observation. Physics of the Earth is the part of physics that connects the physicist with nature, with any point on Earth or under the sky, where his imagination is able to take him. Places where there are puzzles or even fears are where the physicist is in his element. On top of a mountain or on the ocean, ice field or near an erupting volcano—he observes, considers, calculates, doing all of this with sublime serenity, exposing the king of Nature within him. His soul is touched merely by the admiration of everything that exists. (*Entretiens*, 5, pp. 293–294)

In the list of Parrot's laboratory, the part connected to the physics of the Earth contains only a few instruments—some eudiometers, hygrometers, barometers (including the barometer constructed by his son, Parrot junior[10]), and electrometers (Parrot tried to measure atmospheric electricity). But his organisational activity shows his big interest in this field. Parrot organised expeditions to study the magnetism of the Earth, conduct barometric height measurements and it is highly likely that he also looked for facts to either prove or refute the catastrophism theory of his youth friend George Cuvier (1769–1832). In 1811, Parrot's son Friedrich Georg travelled together with the mineralogist Moritz von Engelhardt (1779–1842) in the Crimea and Caucasus, where, among other things, he used a barometer to measure height differences. In 1817 he went on an expedition to the Pyrenees and Alps, in 1829 he climbed Mount Ararat, and in the 1830s he conducted magnetic measurements at North Cape. The geophysics program of the Russian Kolomskaya expedition, which started in 1820 and was led by Ferdinand von Wrangel (1797–1870) was planned in Tartu, including making some instruments (EAA, 1802–1896, pp. 100–101).[11] The scientific program of the circumnavigation of Otto von Kotzebue in 1823–1826 was elaborated in the University of Tartu too. For that purpose, 19 scientific apparatuses were

[10] The instrument was used on the expedition to Ararat and is held at the UT Museum (UAM 864 Aj).

[11] A curator of the University of Tartu asked why some equipment has been ordered from the UT for the expedition, and on 17 October 1820 Parrot answered that the geophysical experiments were planned by him.

designed and built in the workshop of the university and five young men from the University of Tartu participated as researchers (biologist Johann Friedrich Eschscholtz (1793–1831), geologist Ernst Reinhold Hoffmann (1801–1871), astronomer Ernst Wilhelm Preuss (1793–1839), physicist Heinrich Friedrich Emil Lenz (1804–1865) and physician Heinrich von Siewald (1797–1829)) (Prüller, 1967, pp. 77–78). At the same time when young Parrot was on his Ararat expedition, Emil Lenz together with Adolf Theodor von Kupffer (1799–1865) tried to conquer Mount Elbrus, but had to give up before reaching the peak. Georg Friedrich Parrot was more or less behind all of this. Also connected with the physics of the Earth was the Russian Meridian Measurement in the years 1816–1856, carried out by Parrot's protégé Friedrich Wilhelm Struve (1783–1864). At the University of Tartu the turn to natural sciences was profound and supported by well-equipped physics and chemistry laboratories and an excellent observatory. Physics and chemistry were obligatory subjects for all students of medicine. Astronomy, botany, chemistry or physics were not yet professions, but turned into professions for the next generation.

Two sisters—physics and chemistry

In Parrot's worldview, physics and chemistry were closely connected, "like two sisters, born on the very same day to bring happiness into people's lives; the two branches of a tree, caressed by the same Sun and nourished by the same roots." (*Entretiens*, 1, 21).

When Parrot started his scientific activity in Livonia, in Riga, at the beginning of the 19th century, he organised together with David Hieronymus Grindel (1776–1836) a circle for "New chemistry". What was the new chemistry? The Enlightenment science greatly valued empiricism and rational thought, the ideal of advancement and progress. In chemistry, the most important steps in that direction were made by Antoine Lavoisier (1743–1794), who changed the science of chemistry from a qualitative to a quantitative one. He is most noted for his discovery of the role oxygen plays in combustion. He recognized and named oxygen (1778) and hydrogen (1783) and opposed to the phlogiston theory.

We know that Parrot, together with Grindel, analysed the air in Riga hospitals (Stradyns, 1967). For that purpose, Parrot constructed, in 1799, a new type of eudiometer—a tool for quantitative analysis of the quota of oxygen in the air—using the oxidation of phosphorus.[12] Parrot said that neither Humboldt nor Berthollet had the exact instrument at the time (Parrot, 1802b).

Their other interest was the electrolysis of water. In 1799, the voltaic pile, the first permanent source of electricity, was invented. This made it possible for electricity (until this moment mostly triboelectricity), which had been nothing but a means of entertainment in eighteenth-century salons, to become an important source of energy over the course of the next century. Parrot contributed to this, first, by being one of the first inventors of the chemical theory of voltaic pile, and second, his being the teacher of Emil Lenz, whose rules we learn in school today.

In 1800, shortly after the invention of the voltaic pile, William Nicholson and Anthony Carlisle in England discovered that electricity can decompose water into hydrogen and oxygen. Shortly afterwards, Johann Wilhelm Ritter (1776–1810) also discovered the same effect, independently. Besides that, he collected and measured the amounts of hydrogen and oxygen produced in the reaction.

This led to many questions. Is electricity in voltaic pile the same as triboelectricity? Where does it come from? What is actually the electrolytic effect? From the 1790s to the 1840s the question divided scientists into two camps—those who defended Volta's notion of a contact force and those who argued that the galvanic cell could be better explained in chemical terms. Although the chemical view had many adherents in the early years of the century, in most countries the contact theory soon became generally accepted (Kragh, 2003, pp. 133–134, 137).

Parrot was among the first who saw the cause of galvanic electricity in chemical reaction. His experiments in Riga were made in a span of 20 days in September 1801. The core of the theory was that chemical reaction is the cause not the result of electricity in a voltaic pile (Parrot, 1803a; Parrot, 1829, p. 51).

This allowed Parrot to invent a horizontal voltaic pile in 1801. In his laboratory he had different models of voltaic piles, both invented by himself and by others, smaller and bigger. While the equipment for triboelectricity remained almost the same after 1809, Parrot introduced everything that was new in this field in the section of chemical electricity (UAM 483:1).

The main reason why Parrot is often neglected in later overviews might be the very negative opinion of Wilhelm Ostwald:

12 The UT Museum collection contains one item (UAM 473:23 Aj).

> As the oldest representative of the chemical theory of voltaism, Parrot, professor from Dorpat and later academic in St. Petersburg, came forward in 1829, when the dispute had most violently escalated by the appearance of de la Rive. In a letter he wrote to the editors of the *Annales de Chimie et de Physique* (42, 45. 1829) to protect his rights, he describes how he had upheld the chemical theory since 1801.
>
> Looking more closely at the theory proposed by Parrot, however, one finds little that has any duration. Parrot was an imaginative and rather self-confident man, who allowed himself to be more inclined to explain a distinct idea than to test it, and even in the 1829 excerpts of his Chemical Theory, one finds hardly anything of enduring value, and instead much absurdity, even for that time (Ostwald, 1896, pp. 429–430).[13]

This negative opinion from someone who later became a Nobel Prize winner (1909) suggested that there is nothing to research in Parrot's theory. Ostwald's reproaches are probably directed against Parrot's way of connecting to each other the phenomena of heat, light, magnetism and electricity, using the theory of imponderable fluids. In *Theoretische Physik*, the theory is more profound and detail: E+ is connected to heat and E- is connected to light, and similarly Parrot tries to draw parallels with magnetism (M+ as heat and M- as light). This theory seemed ungrounded enough even to a contemporary reviewer (*Allgemeine Literaturzeitung*, 1814, pp. 417–424), but again, the connection is an important part of the theory. Without knowing the structure of atom, all explanations remained hypothetical.

Zamboni pile (made from gold and silver paper), invented by Giuseppe Zamboni in 1812, seemed to be proof for contact theory—it was said to be completely dry and did not need any moisture (thus excluding the chemical reaction). Parrot bought it quickly for his laboratory (in 1815, after the end of the war in Europe) and made a series of very precise experiments and measurements. In 1816, the laboratory had Zamboni piles with 800, 3,000 and 5,000 discs of gold and silver

[13] *"Als ältester Vertreter der chemischen theorie des Voltaismus meldete sich im Jahre 1829, als eben durch das Auftreten von de la Rive der Streit am heftigsten entbrannt war, der Dorpater professor und spätere Peterburger akademiker Parrot. In einem Briefe, den er zur Wahrung seiner Rechte an die Redaktion der Annales de chimie et de physique (42, 45. 1829) schrieb, schildert er, wie er seit 1801 die chemische Theorie aufrecht erhalten habe.*

Sieht man sich die von Parrot gegebene Theorie näher an, so findet man allerdings wenig, was irgend eine Dauer besitzt. Parrot war ein phantasiereicher und ziemlich selbstbewusster Mann, der sich mehr anlagen sein liess, eine ausgesprochene Idee auseinander zu setzen, als sie zu prüfen, und auch in dem 1829 gegebenen Auszuge seiner Chemischen Theorie findet man kaum etwas von bleibenden Werth, dagegen vieles auch für jene Zeit absurdes."

foil and paper in different glass tubes together with devices for experimenting with vapour (UAM 483:1). Parrot's conclusion was that the Zamboni pile is actually not dry, and the amount of moisture influences the effectiveness of the pile (Parrot, 1817).

Parrot introduced his chemical, or more precisely oxidation, theory of galvanic electricity in all of his textbooks. We can imagine that he used the same theory in his teaching. Parrot was an influential teacher, beloved by students (Baer, 1986, p. 73). In his textbook for district schools the chapter about electricity is more practical—it contains instructions on how to construct a lightning rod, what are the conductors and isolators and how that electricity can be used in medicine for the treatment of paralysis and epilepsy. According to Parrot, the chemical and triboelectricity are the same and in a Volta pile electricity appears as a result of a chemical reaction (Parrot, 1815b, pp. 221–226, 376–378).

Parrot was also ready to believe that chemical affinity is electrical. Some authors see in these unifying theories the quality characteristic of Romantic science. For example, David Knight has said about Davy and Faraday:

> Davy's research program was developed by Faraday, and his insight that chemical affinity was electrical is still a fundamental tenet of Chemistry. This was a special case of the Romantic belief that all force was one, which led some men of science in the next generation towards the conception of the conservation of energy, and the creation of classical physics. (Knight, 1990, p. 21)

In regard to that, uniting the theories of electricity and magnetism played an important role in the mid-19th century. As to magnetic phenomena, the fact that the compass needle always aligns in the North–South direction because of the magnetic field of the Earth was well known. The lifting force, which was considered in relation to the mass of a magnet, was perceived to indicate the magnet's quality. During the time when Parrot was setting up his laboratory, the relationship between electricity and magnetism was unknown. In his books Parrot developed ideas about connections of these phenomena already in 1814. What raised suspicion was the fact that magnetism does not cause such chemical phenomena as electricity. However, in the 1820s, many experiments by Ampère, Oersted, and others gave the impression that electrical and magnetic matters meant the same thing. In the 5th volume of his *Entretiens* (printed in 1822) Parrot immediately discussed these experiments in great depth (*Entretiens*, 5, 1822, pp. 270–286). In the same book Parrot claimed that the whole world can be divided into two categories—weighted matter and weightless matter. According to him, the latter included heat, electrical and magnetic fluids (*Entretiens*, 5, p. 287).

In Russia, the birth of the new branch of physics was primarily connected to Parrot's student Emil Lenz, whose destiny Parrot shaped more than once (Hempel, 1997, pp. 79–83). In 1828, it was Parrot who succeeded in moving of the physics laboratory of the Academy of Sciences into a new building and acquiring new equipment, including everything for the research of the relation of electricity and magnetism. The equipment allowed Lenz to reach fundamental conclusions in this field. Lenz discovered the laws governing thermoelectric current and the direction of induced current and he is considered the founding father of electrical engineering in Russia.

Theory and practice

Utilitarianism was an organic part of Parrot's worldview. Not just knowledge, but practical knowledge is the most valuable. Theory had to be implemented into practice. As a reflection of this there are a many examples of practical machines in his laboratory—steam engines, pumps, rope works, etc.

Parrot came to Livonia at a time when the local community had been energised in the circumstances of economic boost during the period of *Statthalterschaft* (1783–1796). It was a time of disputes about ways to improve the situation of the peasantry; plans were made to establish a Livonian university and a charitable society. Parrot was immediately engaged in all of these processes. In August 1795, Parrot wrote his "On the Possible Economic Society in Livonia" (Parrot, 1795) on the commission of Friedrich Wilhelm von Sivers (1748–1823). Sivers was *Landrat* and Marshal of Nobility of Livonia (1792–1797) and owner of the Rencēni manor. He was looking for a suitable secretary for a possible charitable society and found this in his home tutor Parrot.

On January 10, 1796, the Livonian Charitable and Economic Society was established in Riga and Parrot was appointed its first permanent secretary. The aim of the society was to spread economically useful science-based knowledge and to contribute to the development of factories and manufacturing companies that processed local raw materials. In 1811, the society was moved from Riga to Tartu to be closer to the university. It remained the most important organisation in the Baltic provinces for implementing scientific innovation into practice until 1917, and carried on its activities until 1939.

In 1814, the work 'Smoke cottage and lighting' was published, concerning the topic how to improve the ventilation of peasants' cottages (Parrot, 1814). In the following years, Philippo Paulucci, Governor-General of Estonia, Livonia and Courland, initiated a program for the improvement of peasants' cottages, which was principally based on Parrot's proposals (Leppik, 2011b, p. 106).

We usually speak about Johann Wilhelm von Krause as the architect of the University of Tartu, but it was Parrot who invented its special constructions. The distinguished physicist constructed ventilation systems for clinics and lightning conductors for different buildings, not to speak about the rotating tower of the Tartu Old Observatory (1825), which was discussed above (Leppik, 2011c).

Perhaps it is worth mentioning that it was Parrot's horizontal voltaic pile that was used by Moritz Hermann von Jacobi in the first electric engine that powered a boat on the Neva River in 1839.

Conclusions

The early 19th century was the time of transition from the cosmopolite Enlightenment to the more national Romanticism. The traditional European university model was in transition. New physics and new chemistry were emerging. Tartu was located on western border of the Russian Empire, and on eastern border of German culture and Western Christianity. This borderland was extremely fruitful, especially for the following generation. After its reopening in 1802, the University of Tartu developed into a very important centre of research in natural sciences. The transition from the earlier philosophical method of research to the scientific method was profound and extensive, first of all in biology but also in physics and chemistry. The founders of the university planned from the very beginning a basis for research in natural sciences including a physics laboratory. Parrot's organisational talent and tireless work took both the laboratory and the teaching in Tartu to the highest level of the time.

Parrot's youth was shaped by the ideas of the French Enlightenment, but the political situation in France, violence and the civil war, made him adherent of the more modest German Enlightenment. Still, according to his worldview education had to be practical, utilitarian, and based on natural sciences. A well-equipped laboratory was indispensable for that. Since the very beginning the chemistry of Lavoiser was taught at the University of Tartu. Parrot was among the first to introduce French mathematical physics in the German-speaking world and created a new branch of physics—the physics of the Earth. His textbooks helped to introduce the physics worldview to the next generation both on the secondary school and university level.

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