THE TARTU PERIOD OF W. STRUVE

Tõnu Viik
Tartu Observatory

1. Background

One of the greatest astronomers of the 19th century – Friedrich Georg Wilhelm Struve was born in Altona (now part of Hamburg) on 15th of April 1793 in a schoolmaster's family. His father, Jacob Struve taught classical languages, dogmatics and exegesis in Christianeum – a gymnasium founded by King Christian VI of Denmark to improve the education in frontier regions. Besides of these activities Jacob was very much interested in mathematics, he liked practical problems but he was also drawn to abstract branches of mathematics. He even found an error in *Theoria Motus Corporum Coelestium* by Gauss which Gauss acknowledged in his letter to Olbers.
Wilhelm was brought up in a family where father was respected and where intellectual and physical achievements were encouraged. Perhaps this respect gives us a clue why he first chose to study literature and later astronomy in Tartu University.
Wilhelm got his primary education from Christianeum but after entering selecta as a 14-year old youth in the spring of 1807 he was caught by a gang of French recruiters and locked up in the upper storey of a two-storey building – according to the words of his son Otto. Thanks to his good skills as a gymnast he escaped from the recruiters by a risky jump from the window. After that his family decided that it would be better for Wilhelm to go to Tartu considering that elder brother Karl was already there as a teacher in the gymnasium.

2. Wilhelm as a student

Though the Tartu University was founded already in 1632 it was first moved to Pärnu and then closed in 1710 due to the Northern War. It was reopened in 1802 and Wilhelm arrived in a practically new university. In spite of the fact that he did not have a *TESTIMONIUM MATURITATIS* but only a very favourable certificate on the success of his studies, he was immatriculated immediately under number 371. Wilhelm registered in classes of philosophy under G.B. Jäsche, in philology under his brother Karl (who had become a Privatdozent at the University) and in astronomy under J.W.A. Pfaff. Since Wilhelm had to earn his own living he first tutored von Meiner's children but later took on to teach the children of Count von Berg whose family used to live in Tartu during winter and in their manor in Sangaste (then Sagnitz) in summertime. He had to spend 34 hours a week teaching the four boys of the Count and as a result he could not attend all the lectures. Despite of that he made good progress in his studies. At the end of 1810 he passed the exams for candidacy in philology with flying colours and won a gold medal for an essay. After that he was offered the post of senior history teacher at the Tartu Gymnasium. Wilhelm declined the offer since he was so much interested in furthering his studies in mathematics and physics. He had made friends with the younger son of the rector Georg Parrot. The father of his friend saw the diligence of young Wilhelm and his devotedness to studying exact sciences and perhaps this was the reason why he secured a stipend for Wilhelm. Now he could give up his teaching in the Count's household and devote himself to studying mathematics and astronomy. The professor of astronomy J.W.A.Pfaff left Tartu in 1809 and the new professor of mathematics and astronomy J. S. Huth arrived from Kharkov in 1811. In 1813 Wilhelm passed the qualifying exam for the master's and doctor's degree and presented the thesis *De geographicae speculae Dorpatensis positione.*

3. Starting a career

Already in 1811 Wilhelm started to unpack the crates with Dollond transit which was ordered a couple of years before. Huth had secured funds for buying the granite pillars for the transit instruments but unfortunately this was all he could do for the observatory apart of encouraging Wilhelm to work in the observatory. The annual budget of the observatory was meagre and sufficed only for heating, lighting and stationery. Wilhelm had to find tools to carve out the cavities in the pillars and the holes for illuminating the field of view of the telescope. Fighting these difficulties Wilhelm could install the Dollond transit and he used the instrument to make observations for determining the geographical coordinates of the new observatory. This was done more accurately than his predecessors Pfaff and Knorre were able to do.
In the end of 1813 he was appointed extraordinary professor of mathematics and astronomy at the Tartu University. At the same time he was *de facto* the director of the observatory since professor Huth was a sick man. Wilhelm became an ordinary professor only after Huth's death in 1818.
Here we must mention Wilhelm's first step towards his other passion to come – towards geodesy. This happened as early as in 1812 when he was spending his summer in Sangaste. Having bought a sextant for his small savings, he was practising surveying when he was arrested by a Russian patrol who took him for a French spy. He was taken to Pärnu where he had to appear before a military judge. Fortunately enough for Wilhelm, this misunderstanding was soon cleared but he lost a week's work.

4. Scientific projects

4.1. Livland survey

In the winters of 1815-1816 the Livland Public Utility and Economic Society asked Wilhelm to make a survey for a new map of Livland. Since Parrot had been the secretary of the society we may deduce that he had proposed the society to approach Wilhelm with this request. Wilhelm carried out this work from 1816 to 1818 measuring astronomically the latitudes and azimuths of chosen points, and finished the work in March 1819 by the measurement of a principal baseline on the ice of Lake Võrtsjärv. This was an elegant solution although not an original one since Joseph Delisle had used this approach as early as 1737 when he started to measure the meridian arc through St Petersburg. Wilhelm measured the horizontal angles by a Troughton mirror sextant of 10-inch radius. For measuring the vertical angles Wilhelm had had made in Tartu a horizontal sector suitable for the measurement of angles up to 10 degrees. Wilhelm wrote more than 30 years later that according to the measurement of the arc of the meridian the difference in distance between the extremities was only 0.012 English miles – that means that the accuracy of these first measurements was very good. The map of Livland was published in 1839 and already long before that date Wilhelm was established as an authority where land measurements were needed like road building and draining of swamps. It must be said that Wilhelm did almost all the measurements by himself, making use of students Karl Knorre's and Wilhelm Lieven's help.

4.2. Big arc

The Livland survey was only an introduction into a much bigger project – measuring the meridian arc from Nordkap to the estuary of the Danube. In 1819 after having completed the Livland survey Wilhelm made a proposal to the University Council for the measurement of a meridian arc 3 degrees 35 minutes from the island Högland in the Gulf of Finland to the town of Jekabpils (then Jacobstadt) in Curland, Latvia. This proposal was accepted and Alexander I provided a grant for purchasing the instruments. When Wilhelm became aware that Colonel von Tenner (later General) was surveying Lithuania they linked the two surveys which made the

total arc of just over 8 degrees. Later, between 1830 and 1844, the measurements were continued towards north through Finland to Tornio at the latitude of 65 degrees and 50 minutes. At the same time preparations were made to continue the arc to south. Between 1844 and 1851 the survey was continued in both directions - to the estuary of Danube and to Nordkap. This finished the field work and surveyors started to calculate and make reductions to the observations. And finally, in 1860 *Arc du Méridien* was published.

4.3. The Fraunhofer refractor

In 1815 the new observatory on the Toome Hill was poorly equipped. The principal telescope was the transit which Wilhelm had himself installed. Later a Troughton refractor equipped with a micrometer was obtained but Wilhelm was still not content. In 1817 he ordered a Reichenbach meridian circle and in 1820 he travelled to Munich to order more instruments. He learned that Fraunhofer was making good progress in manufacturing large lenses and that Fraunhofer was building a large refractor of 9 Paris inches aperture. When he was back in Tartu he put a proposal to buy this telescope before the University officials. The new rector, Gustav Ewers supported Wilhelm and the ministry approved the proposal.
In 1824 the refractor was ready and it was shipped to Tartu packed in 22 cases. On 16th of December 1824 the instrument was ready for observation and Wilhelm had the first look through it at the Moon and some double stars. He could not praise enough this wonderful instrument! Fraunhofer had made two major innovations by having created the "German " equatorial mounting and the clock drive which helped to use the telescope very effectively and later made the astronomical photography possible.

4.4. Double stars

Alexander I recognized the value of the biggest achromatic telescope at that time by giving a diamond ring valued at 3000 roubles to Fraunhofer (and to Wilhelm!). Fraunhofer answered by completing and sending micrometers to Tartu at no extra cost. These micrometers made it possible for Wilhelm to begin his famous programme on double stars. Actually Wilhelm had observed double stars on the transit instrument since the first days in the observatory. Now, having obtained the big telescope, Wilhelm made up an ambitious plan – to make a census of all double stars down to declination 15 degrees south. This plan resulted in the publication of the book *Catalogus Novus Stellarum Duplicium et Multiplicium* in 1827, virtually 2.5 years after the Fraunhofer telescope arrived at Tartu. There were 3112 double stars in this catalogue. Though many of them were known before, the speed of Wilhelm's working was admirable. He lamented the long intervals between observations because the weather did not allow to observe just every night (the weather has not become better since!). In his book he discussed a problem whether a big telescope should be built on a site where it could be used on the largest possible number of clear nights. Nowadays the solution to this problem is: yes, this is the only way.
It is worth of mentioning that Wilhelm received the award of the Gold Medal of the Royal Astronomical Society for the work presented in this book.

4.5. Measuring parallax

While observing the double stars Wilhelm kept in mind another problem – to measure the parallax of a chosen star, in other words, its distance to Sun. Herschel had tried to solve the same problem by determining the change in position of a bright star relatively to a faint star close to the bright one assuming that the distance between these stars in space is very large. In his book *Catalogus Novus* ... he considered many such pairs. In 1827 he had found a perfect match – Vega and its companion, 43 seconds of arc away. Had he started to measure

the positions right away he would have been definitely the first to determine a star's distance. But he was engaged with other problems and could return to this task only in 1835-1836, making 17 micrometer measurements of timing of the transits of Vega. Wilhelm used these observations to determine the change in mean separation of Vega and its companion, the change in their mean orientation, and the parallax. That he found to be 0.125 seconds of arc with a probable error of 0.055 seconds of arc. This happens to be very close to a modern value but Wilhelm was not satisfied with it. In 1839 Wilhelm sent another paper to H. Schumacher, which contained a revised determination of the parallax of Vega – 0.2613 seconds of arc with a probable error of 0.0254 seconds of arc. This value is by far inferior to the first measurement. In the meantime two other astronomers, F.W. Bessel in Königsberg and T. Henderson at the Cape of Good Hope, had measured parallaxes of the stars 61 Cygni and Alpha Centauri, respectively. This contest ended with the victory of Bessel who received the Gold Medal of the Royal Astronomical Society.

5. Other functions

It is clear that as a professor, besides performing the astronomical observations Wilhelm had to deliver lectures to students. And that he did, delivering 20 courses during 25 years of his Tartu period. His lectures were clear and concise as confirmed by the fact that when in 1841 in St Petersburg University he lectured to public, the main hall of the University was full, even the Grand Duke was present.

He was also responsible for teaching geodesy to the officers of the General Staff of the Imperial Navy. All this burden seems to be too much but his son Otto wrote that his father usually gave informal tuition rather than regular lectures. This could be done in astronomy only because there were never too many astronomy students.

In 1820 Martin Bartels arrived at Tartu to become a professor of mathematics. So Wilhelm got free of lecturing mathematics, but he was named the Chief of the University fire brigade. On January 1829 there was a big fire threatening the main building. It was extremely cold and the water supply was hindered but thanks to Wilhelm's resolute activities the main building was saved. This brought him thanks from the Tsar himself.

Wilhelm was also a member in the University building commission. After Georg Parrot left in 1827, he was the administrator of the Cathedral park on the Toome Hill.

Besides of that he was named many times the Deputy Rector, or the Night Rector whose responsibilities were to solve the students' quarrels in night-time. We may guess that this was not so difficult a task considering the fact that Wilhelm was a strong and imposing man. And besides, he was quite often observing in the observatory, being thus quickly available.

6. Personal life

Wilhelm married Emilie Wall in 1815 in Altona. He met the girl a year before when he was visiting his parents. After a 14 day journey on a ship they arrived at Tartu. The couple had 12 children – 7 boys and 5 girls. Not all of them lived to maturity. The third son Otto replaced father as a director of Pulkovo observatory – the observatory which was founded under the supervision of Wilhelm Struve.

His wife Emilie died after having given birth to their twelfth child – daughter Emilie - in the beginning of 1834. Her health was weakened by looking for their second son Alfred who was gravely ill and died a day after the birth of Emilie.

In February 1835 Wilhelm married Johanna - the daughter of his good friend professor Martin Bartels. They had six children.

Needless to say that Wilhelm was elected an academician in 1832. As an academician he should have moved St Petersburg but in this case the Tsar made an exception and allowed him to continue to live in Tartu since the astronomical instruments in St Petersburg were inferior to

those in Tartu at that time.

7. Summary

In 19th century Wilhelm was regarded as one of the leading astronomers. His observations were precise and accurate as pointed out by his contemporaries Olbers and Airy. And what is more important – the astronomers still use his observations while their value increases with time.

Literature

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