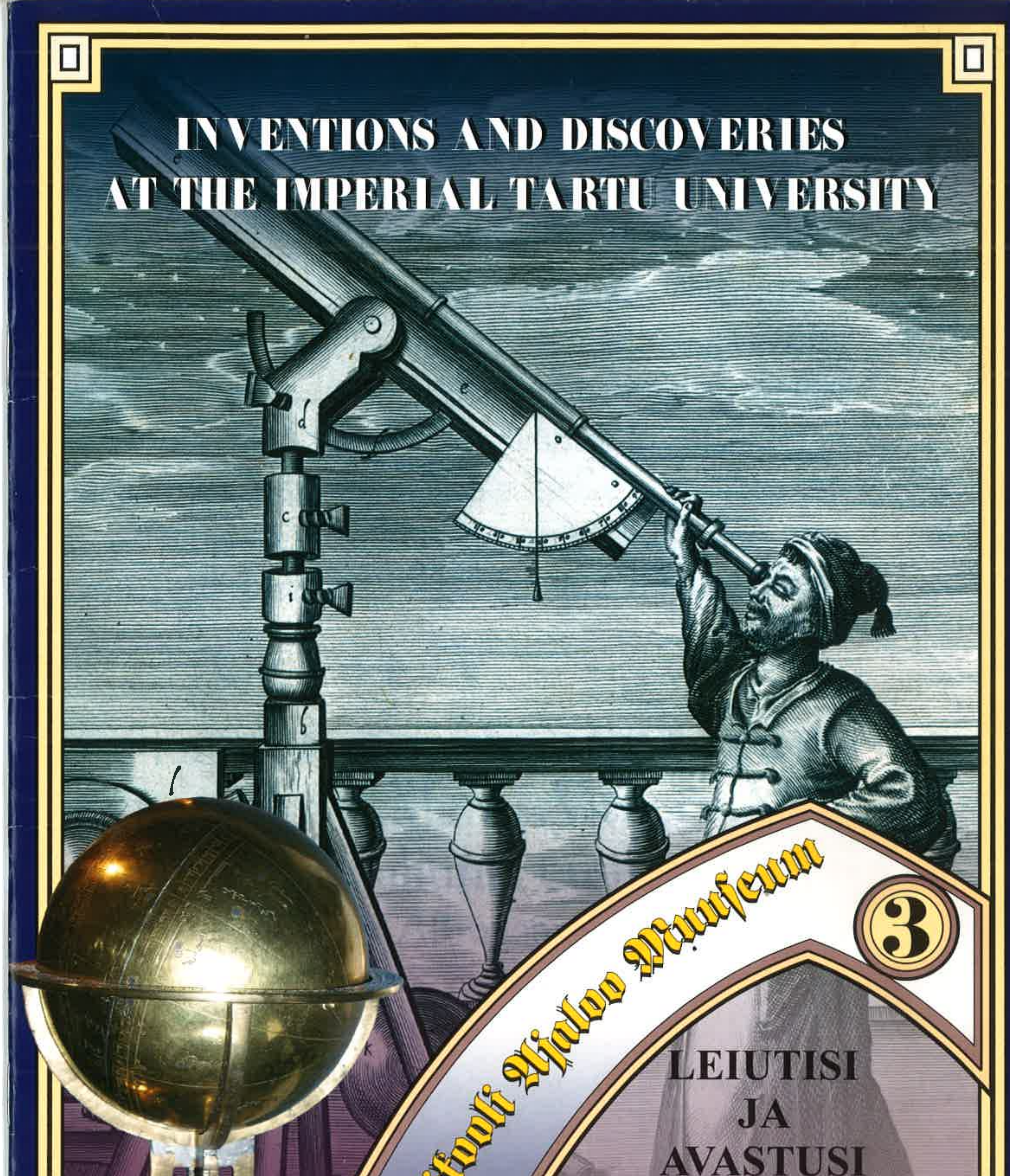
INVENTIONS AND DISCOVERIES AT THE IMPERIAL TARTU UNIVERSITY



Tartu Ülikooli Ajaloo Muuseum

3

LEIUTISI JA AVASTUSI KEISERLIKUS TARTU ÜLIKOOLIS

ASTRONOOMIA

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Käesoleva trükise väljaandmist on toetanud Tartu Kultuurkapital

Tartu Ülikooli Ajaloo Muuseum
Lossi 25
51003 Tartu
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University of Tartu
Museum of Tartu University History
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Astronoomia on teadus, mis käsitleb taevakehade ja nende süsteemide paigutust, ehitust, liikumist ja arengut. 1808-10 ehitati Tartu keskaegse piiskopilinnuse vundamendile Tartu tähetorn, mis peagi kujunes üldtunnustatud astronoomiaobservatooriumiks. Maailmakuulsaks sai Tartu tähetorn 1824. aastal, kui ta omandas Fraunhoferi 24-cm-se avaga refraktorteleskoobi, mis oli oma aja suurim ja tehniliselt täiuslikem läätspikksilm. Tartu tähetorni väljapaistvate astronoomide Fr.G.W.Struwe, J.H.Mädleri ja teiste uurimistööd mõjutasid oluliselt astronoomia arengut XIX sajandil. Kõigest sellest tahab jutustada käesolev Tartu Ülikooli Ajaloo Muuseumi väljaanne *Leiutisi ja avastusi Keiserlikus Tartu Ülikoolis. III. Astronoomia.*
Koostajaiks on muuseumi teadusloolased Toomas Pung, Mare Viiralt, Terje Lõbu, Leili Kriis, Urmet Paloveer.

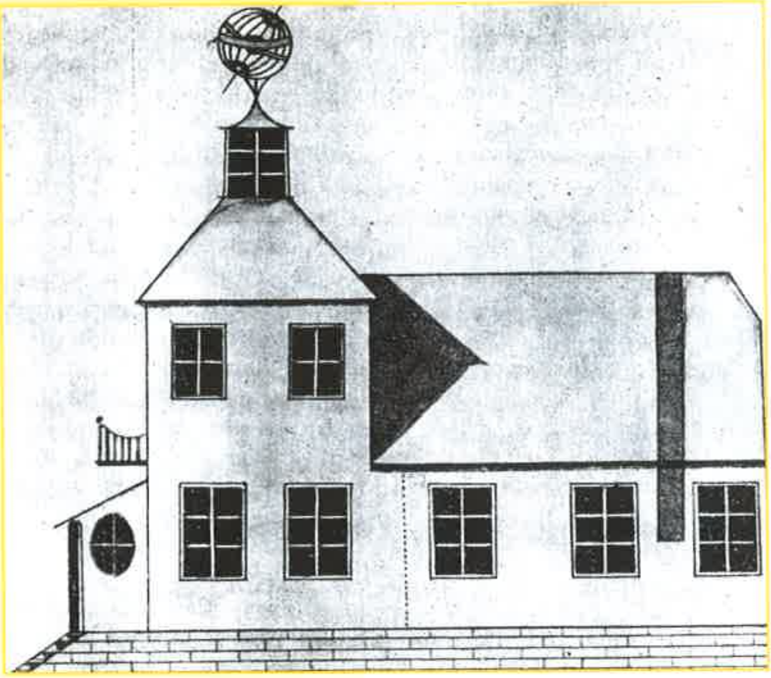
Astronomy is a science which deals with the location of celestial bodies and their systems, their build-up, movement and development.
In 1808-1810 the Observatory of Tartu was built on the foundation of the medieval Castle of the Bishop of Tartu. Soon the Observatory became a widely recognized centre of astronomical research.
The Observatory of Tartu became world famous in 1824 when the Fraunhofer telescope with the 24 cm refractor was bought. It was the largest and technically most precise lens telescope in the world at that time. The research results of Fr.G.W. Struve, J.H Mädler and other distinguished astronomers radically influenced the development of astronomy in the 19th century. The present publication of the Museum of Tartu University History gives you an overview of the contribution of the Observatory of Tartu to world science.

Inventions and Discoveries at the Imperial Tartu University Astronomy 3 was compiled by the science historians of the museum Toomas Pung, Mare Viiralt, Terje Lõbu, Leili Kriis, Urmet Paloveer.

Esimese ajutise observatooriumi rajamine, esimese teadusliku sariväljaande toimetamine

Johann Wilhelm Andreas Pfaff
05. XII 1774 Stuttgart
26. VI 1835 Erlangen

Johann Wilhelm Andreas Pfaff sündis Stuttgardis 05.12.1774, õppis Göttingeni ja Tübingeni ülikoolis (1790). Oli Tübingeni vaimulikus koolis repetiitoriks (a-st 1800).
1804.a. kutsus rektor G.F.Parrot Pfaffi Tartu ülikooli matemaatikaprofessoriks. Pfaff sattus siia oma kuulsa venna, pakutud kohast ise loobunud matemaatiku, Johann Friedrich Pfaffi soovitusel.

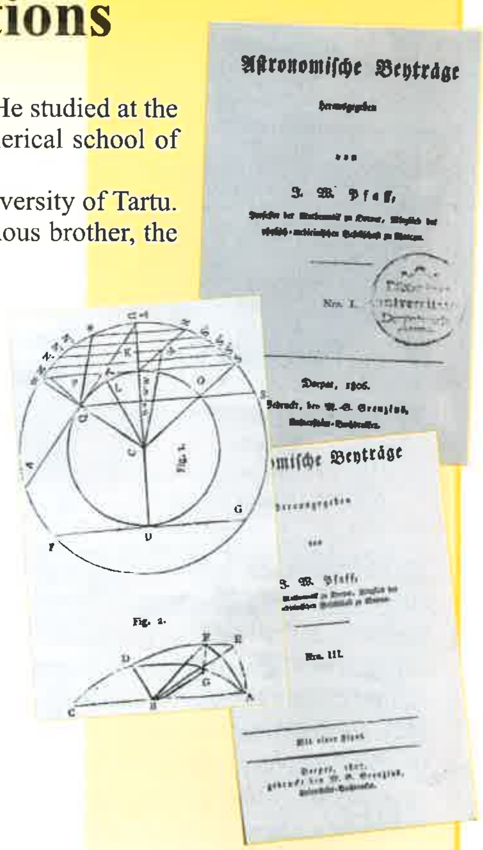


Lamberti observatooriumi üldvaade (Pfaffi järgi)
General view of Lamberts observatory (after Pfaff)

Pfaff oli Tartus õppejõud 1804-1809, kuid jõudis mõne aasta jooksul Tartus küllalt palju astronoomia alal ära teha. Koondas enda ümber astronoomia-huvilisi ja valis andekaid abilisi üliõpilaste seast, kelledest said hiljem tuntud teadlased (Paucker, Schumacher). Pfaffi ülesandel valmistas läti rahvusest üliõpilane Williams Tartus esimese astronoomilise instrumendi: väikese passaažiriista. Pfaff rakendas tööle statsionaarsed instrumendid ja üritas lahendada geograafiliste pikkuste vahede määramist Tartu, Riia, Miitavi ja Moskva vahel. 1804-09 olid tegevuses ajutised observatooriumid (Lenzi majas ja astronoomiaharrastaja Lamberti majas), mille varustuse Pfaff tellis Saksamaalt ja Inglismaalt. Tähtsaim instrument oli 1807. a. Dollondi firmalt tellitud suur passaažiriist tähtede Tartu meridiaanist läbimineku jälgimiseks. Määras koos abilistega observatooriumi geograafilisi koordinaate ja teostas vaatlusi. Pani aluse ülikooli raamatukogu astronoomiafondile. 1806-07 andis Pfaff Tartus välja esimese astronoomiapublikatsioonide sarja *Astronomische Beyträge* (kokku 3 väljaannet), mis oli esimeseks teaduslikuks sariväljaandeks Eestis. Töötas välja kõigi kasutusel olnud riistade kohta täpse matemaatilise teooria. 1807. a. valiti Pfaff Peterburi TA kirjavahetajaliikmeks. Osales komisjonis, mis tegeles alalise tähetorni ehitamiseks projekti koostamisega ja asukoha valimisega. Pfaff lahkus Saksamaale 1809. a. kevadel. Samal aastal alustati uue tähetorni ehitust, mis lõppes 1810. a. Pfaff töötas veel matemaatikaprofessorina Saksamaal: Nürnbergi Reaalinstituudis (1809-18), Würzburgi ülikoolis (1817-18) ja hiljem Erlangeni ülikoolis. Pärast Tartust lahkumist tegeles astroloogiaga, millega kaotas oma reputatsiooni teadlaste seas. Suri Erlangenis 26.06.1835.

Taevagloobus. XIX s. II pool. ÜAM 1112:1
Celestial globe. The 2nd half of the 19th century. ÜAM 1112:1

The establishment of the first temporary observatory, editing of the first serial of scientific transactions



Johann Wilhelm Andreas Pfaff was born in Stuttgard on 5 December 1777. He studied at the Universities of Göttingen and Tübingen (1790) and worked as a tutor at a clerical school of Tübingen (since 1800).

In 1804 Parrot invited Pfaff to the post of Professor of Mathematics at the University of Tartu. Pfaff happened to come to Tartu thanks to the recommendation from his famous brother, the mathematician Johann Friedrich Pfaff, who did not accept the offered post.

Pfaff was a member of the academic staff in the years 1804-1809 but within this short period in Tartu he could do much in the field of astronomy. He attracted people interested in astronomy to his work and selected talented students to become his assistants who later became well-known scientists (Paucker, Schumacher). Assigned by Pfaff, the Latvian student Williams built the very first astronomical instrument in Tartu - a small transit instrument. Pfaff implemented stationary instruments and tried to determine geographical longitudes between Tartu, Riga, Jelgava and Moscow. In the years 1804-1809 temporary observatories functioned in the houses belonging to Lenz and the amateur astronomer Lambert. The equipment for observatories was ordered by Pfaff from Germany and England. The most important instrument was the large transit instrument ordered from the Dollond company in 1807 to observe the stars crossing the Tartu meridian. Pfaff with his assistants determined the coordinates and carried out observations. He was the founder of the astronomical collection of books at the university library. In the years 1806-1807 Pfaff published the first series on astronomy in Tartu *Astronomische Beyträge* (all in all three publications).

J.W.Pfaffi kogumik Astronomische Beyträge (1806 - 1807) väljaande ja 3. väljaande tiitelleht ja joonis

J.W.Pfaff's collection Astronomische Beyträge title page. Title page of the 3nd edition and a drawing

Pfaff worked out an exact mathematical theory for all the instruments he had used in his work. In 1807 Pfaff was elected Corresponding Member of the Academy of Sciences in St. Petersburg. He had participated in the work of a commission which was designing the permanent observatory and selecting its location. Pfaff left Tartu for Germany in the spring of 1809. In the same year the construction of the new observatory started and it was completed in 1810. In Germany Pfaff also worked as Professor of Mathematics at the Institute of Sciences in Nuremberg (1809-1818), at the University of Würzburg (1817-1818) and later at the University of Erlangen. Having left Tartu, he dealt with astrology, thus losing his reputation among scientists. Pfaff died in Erlangen on 26 June 1835.

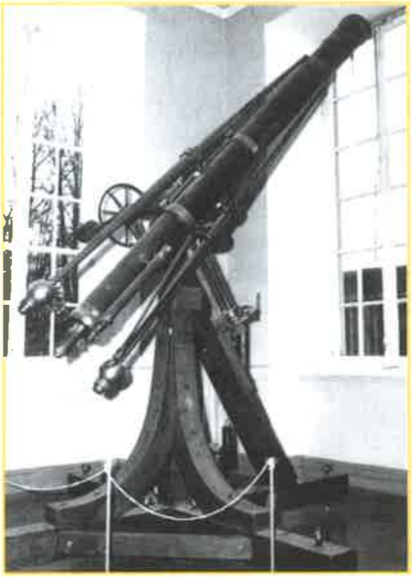
Armillaarsfäär. J. Bauer, Nürnberg. 1781. ÜAM
Armillary sphere. J. Bauer, Nuremberg. 1781. ÜAM

Tartu meridiaani kraadimõõtmine, kaksiktähtede kataloogi koostamine

Friedrich Georg Wilhelm Struve
15. IV 1793 Altonas Saksamaa
23. XI 1864 Peterburi

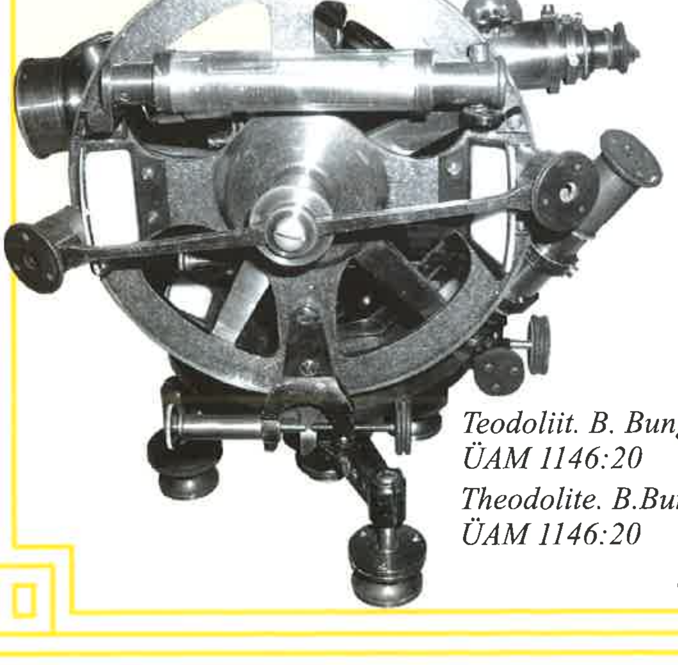
Friedrich Georg Wilhelm Struve sündis Altonas (praeguses Hamburgi eeslinnas) Saksamaal 15. aprillil 1793. Tuli Altonast Tartusse, asus krahv Bergi perekonna koduõpetajaks ja õppis ülikoolis alates 1808 isa soovi järgi filoloogiat. Lõpetas Tartu ülikooli kandidaadikraadiga 1810, kuid loobus majanduslikult soodsast õpetajakarjäärist. Rektor G.F.Parroti muretsetud eristipendiumiga õppis matemaatikat ja astronoomiat ning 1813 kaitses hiilgavalt doktoritööd Tartu tähetorni geograafiliste koordinaatide määramisest. Määrati 20-aastaselt tähetorni astronoom-vaatlejaks ja erakorraliseks matemaatika - ja astronoomiaprofessoriks. Edasine karjäär: 1820-1839 korraline astronoomiaprofessor ja Tartu tähetorni direktor, Peterburi TA korrespondentliige (1822) ja akadeemik (1832), Pulkovo tähetorni rajaja ja direktor (1839-1862). Läks erru 1862 ja suri Peterburis 23. novembril 1864.

Kokku töötas Struve Tartus 25 aastat (1813-1838), selle aja jooksul:
-luges ülikoolis 20 loengukursust, keskmiselt 6 korda igaüht (sh kõrgemat geodeesiat Professorite Instituudis);
-alustas Dollondi passaažiriistaga süstemaatilisi vaatlusi (1814);
-hankis tähetornile uusi vaatlusriistu (Reichenbachi-Erteli meridiaanring, Fraunhoferi 9-tolline refraktor, mis oli tollal maailma suurim akromaatilise objektiiviga refraktor), 1839 oli tähetornis kokku 122 instrumenti;
-määras meridiaanringiga tuhandete kaksiktähtede positsioone (kataloog "*Catalogus Novus Stellarum Duplicum et Multiplicum*");
-mõõtis esimesena maailmas täht Veega kauguse (1837);
-otsis Fraunhoferi refraktoriga kaksiktähti ja mõõtis neid mikromeetriliselt ("*Stellarum Duplicum et Multiplicium Mensurae Micrometricae*" 1837 ja "*Positiones Mediae*" 1852);
-sooritas Liivimaa trigonomeetrilise mõõdistamise (1816-19);
-juhendas meridiaankaare mõõdistamist Balti provintsides (1821-27).



Fraunhoferi 9-tolline refraktor
The 9-inch Fraunhofer refractor

Töötades väsimatult kogu elu suutis Struve paljuga teadust rikastada: tema kaksiktähtede kataloogid ja vaatlusmetoodika on arvestatavad tänapäevalgi, ta juhendas meridiaankaare mõõtmist piki Tartu meridiaani Nordkapist kuni Doonau suudmeni, tema juhatuse all sai Tartu tähetornist üks maailma paremaid, ta asutas Pulkovo observatooriumi ja kasvatas üles terve põlvkonna astronoome ja geodeete. Ka tema poeg Otto, lapselapsed Hermann ja Ludwig ning lapselapselapsed Georg ja Otto Struve olid astronoomid.



Teodoliit. B. Bunge, Berlin. XIX s. keskpaik. Universal instrument. ÜAM 1146:20

Theodolite. B.Bunge, Berlin. The middle of the 19^th^ century. ÜAM 1146:20

Establishing the degree of longitude of the Tartu meridian, compiling the catalogue of binary stars

Friedrich Georg Wilhelm Struve was born in Altona (presently the outskirts of Hamburg) in Germany on 15 April 1793. He came to Tartu where he worked as a home tutor in the family of Count Berg. Since 1808 he studied at the university specializing in philology as recommended by his father. He graduated from the university in 1810 with the MA degree but gave up the well-paid teacher`s career. Rector Parrot offered him a special scholarship to study mathematics and astronomy. In 1813 he defended his outstanding doctoral thesis devoted to the establishment of the geographical coordinates of the Observatory of Tartu. Being twenty years old, he was appointed to the post of astronomer-observer in the Observatory and Professor Extraordinary of Mathematics and Astronomy.

His further career: 1820-1839 - Professor Ordinary of Astronomy and the director of the Observatory of Tartu, Corresponding Member (1822) and Academician (1832) of the Academy of Sciences in St. Petersburg, the founder and director of the Observatory of Pulkovo (1839-1862). Struve retired in 1862 and died in St. Petersburg on 23 November 1864.

All in all Struve worked in Tartu for 25 years (1813-1838) and within this period:

-delivered 20 different courses of lectures at the university, on average giving each one for six times (including higher geodesy at the Professors` Institute);

-started systematic observation (1814) with the Dollond transit instrument;

-purchased new observation instruments for the Observatory (the Reicenbach - Ertel meridian circle, the Fraunhofer 9-inch refractor, which was the world`s largest refractor with the acromatic lens at that time, in 1839 all in all there were 122 instruments in the Observatory ;

-established the positions of thousands of binary stars using the meridian circle (in the catalogue *"Catalogus Novus Stellarum Duplicum et Multiplicum"*);

-was the first in the world to measure the distance to the star Vega (1837);

-with the Fraunhofer refractor looked for binary stars and measured them micrometrically (*"Stellarum Duplicum et Multiplicium Mensurae Micrometricae"*- 1837 and *"Positiones Mediae"* - 1852);

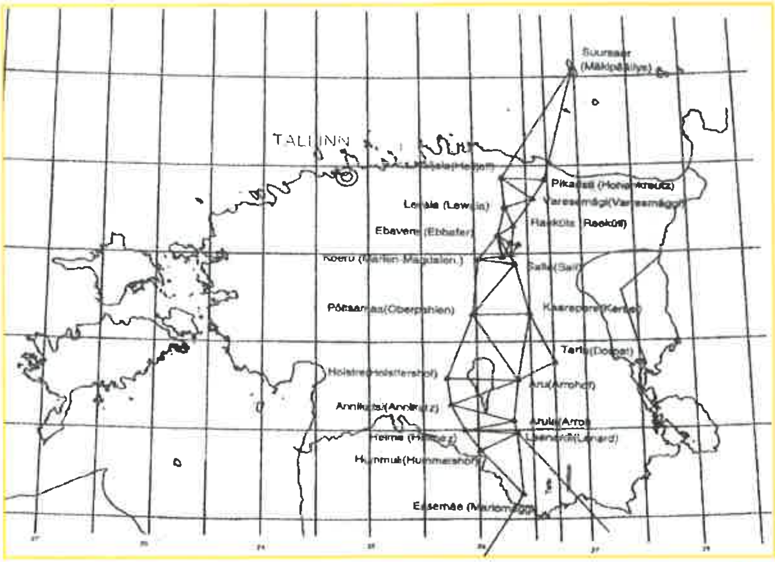
-conducted the trigonometric measurement of Livonia (1816-1819);

- supervised the measurement of the meridian arc in the Baltic provinces (1821-1827).

Tartu meridiaani kraadimõõtmise kaart

The map of Tartu Meridian Arc

Devoting all his life to meticulous work, Struve could enrich scientific knowledge - his catalogues of binary stars and the observation methodology can be used even today. He supervised the measurement of the meridian arc from Nordkap to the mouth of the Danube. Under his guidance the Observatory of Tartu became one of the best in the world. He founded the Observatory of Pulkovo and educated a whole generation of astronomers and geodesists. Also, his son Otto, the grandchildren Hermann and Ludwig, and the greatgrandchildren Georg and Otto Struve were astronomers.



Struve meridiaankaare Eestit läbiv osa
Estonian section of Struve Meridian Arc

Stellaardünaamika ja teadusliku kosmoloogia rajamine

Johann Heinrich Mädler
29. V 1794 Berliin
14. III 1874 Hannover

W. Struve järglane Tartu tähetorni juhataja kohale (aastatel 1840-1865), Saksa astronoom ja meteoroloog, professor **Johann Heinrich Mädler**, sündis 29. mail 1794 Berliinis. Töötades enne Tartusse kutsumist Berliinis, koostas ta erakordselt täpse ja põhjaliku Kuu atlase *("Mappa selenographica"*, kaasautor pankur W. Beer) ning esimese täieliku Marsi kaardi. Tartus kirjutas ta mahuka teose "Populaarne astronoomia", mis ilmus 8 trükis. Samuti koostas ta raamatu astronoomia ajaloost ja avaldas kosmograafia- ja geograafiaõpikuid ning töötas kalendrireformi põhimõtete kallal. Mädler oli huvitatud kosmoloogiast, s.t. universumi kui terviku uurimisest. Tema teos *"Centralsonne"* (1846), mis sisaldas hüpoteese galaktika struktuuri kohta, ajendas erakordselt pika järelkajaga väitluse. Oma ideid levitas Mädler arvukatel loengutel Tartus ja Riias, samuti sagedastel välismaareisidel, mis ulatusid kuni Hispaaniani.

Mädler tegi Tartus rea aastate jooksul ise arvukalt mitmesuguseid vaatlusi. Eeskätt jätkas ta Kuu uurimist ja viis edasi Struve alustatud tähtede asukoha ja kaksiktähtede mõõtmisi. Peale selle vaatles ta planeete, komeete, meteoriite, helkivaid ööpilvi, sooritas regulaarseid ilmavaatlusi ja kirjutas artikleid, mis ilmusid Tartu ja Riia ajalehtedes ning erinevates Euroopa teadusajakirjades. Kokku sisaldab Mädleri bibliogaafia 290 publikatsiooni. Mädler oli 19 akadeemia ja õpetatud seltsi liige või auliige, sealhulgas Loodusuurijate Seltsi asutajaliige. Ta oli Leipzigi ülikooli doktor ja Viini ülikooli audoktor. Kuu uurimise eest sai ta Prantsuse medali, Taani ja Preisi teenetemärgid ning Vene tsaari briljantsõrmuse. Teeninud välja pensioni, lahkus Mädler Tartust 1865.a. Ta suri 14. märtsil 1874 Hannoveris.

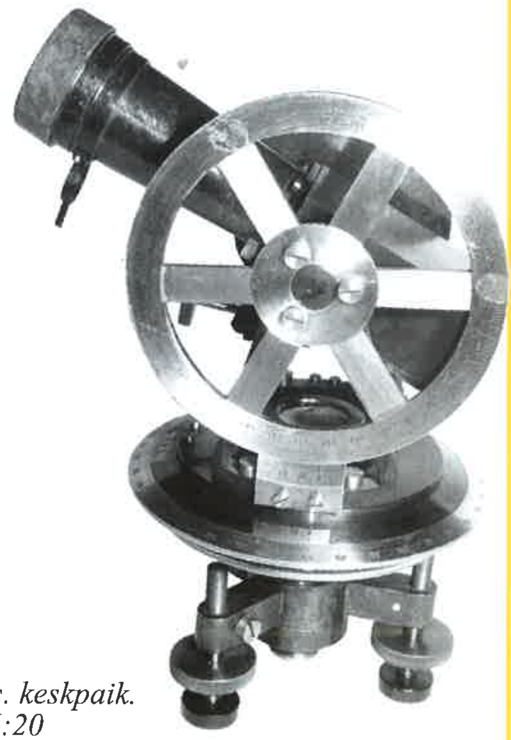

Populäre
ASTRONOMIE
Dr. J. H. Mädler.
ex 11497
Berlin, 1841.
Verlag von Carl Heymann.

Mädleri raamatu "Populaarne astronoomia" tiitelleht

Title page of Mädler's "Popular astronomy"

Astronoomia ajalukku on Mädleri nimi jäädvustatud stellaardünaamika ja teadusliku kosmoloogia rajajana ja selenograafia edasiarendajana.

Kuulsat astronoomi ei ole unustatud ka Tartus: 1996.a. paigaldati Mädlerile mälestustahvel tähetorni kompleksi kuuluva maja seinale. Huvilistel on võimalik saksa keeles lugeda tema elulugu, mille koostasid astronoomid Heino Eelsalu ja Dieter B.Hermann (Berlin, 1985).



Teodoliit. B. Bunge, Berlin. XIX s. keskpaik.
Universal instrument. ÜAM 1146:20

Theodolite. B.Bunge, Berlin. The middle of the 19th century.
ÜAM 1146:20

The creation of the stellar dynamics and scientific cosmology

Professor **Johann Heinrich Mädler**, a German astronomer and meteorologist, was the following director of the Observatory of Tartu (in the years 1840-1865) after W. Struve had left. J. H. Mädler was born on 29 May 1794 in Berlin. When working in Berlin before being invited to Tartu, he compiled a very profound and detailed atlas of the Moon (*" Mappa selenographica"* with the co- author banker W. Beer) and the first complete map of Mars. In Tartu he wrote the book "Popular astronomy" which was bulky and had eight editions. Also, he compiled a book of history of astronomy , published numerous textbooks of cosmography and geograpy and worked at the principles of the calendar reform. Mädler was interested in cosmology, i.e the investigation of the universe as an integrated whole. His book *" Centralsonne"* (1846) which contained hypotheses about the structure of Galaxy evoke an extraordinarily long discussion. Mädler spread his ideas at several lectures in Tartu and Riga, also during his frequent visits to foreign countries reaching even Spain. Mädler himself made several observations during several years in Tartu.


BEOBACHTUNGEN
Kaiserlichen Universitäts-Sternwarte
DORPAT
J. H. Mädler,
Neunter Band
Dorpat.

Mädleri "Tartu tähetorni astronoomiliste vaatluste" tiitelleht

Title page of Mädler's diary of astronomical observations

Kuu pinnavormide kipsist mudeleid. 1850 a. ÜAM 1146:4, 16

Plaster models of lunar craters from the 1850 s. ÜAM 1146:4, 16

Primarily he continued the investigation of the Moon and the measurements of the location of the stars and binary stars which Struve had started. Beside that he also observed planets, comets, meteorites, noctilucent clouds, conducted regular weather observation, wrote articles which were published in the newspapers of Tartu and Riga and different European scientific journals. All in all Mädler`s bibliography contains 290 publications. Mädler was a member or a honorary member of 19 academies and learned societes being a founder member of the Society of Naturalists. He had a Doctoral Degree from the University of Leipzig and was elected Honorary Doctor of the University of Vienna. For the investigation of the Moon he was awarded with a medal of France, service awards of Denmark and Prussia, a diamond ring from the Czar of Russia. After retiring Mädler left Tartu in 1865. He died in Hannover on 14 March 1874.

In the history of astronomy Mädler`s name is eternalised for his creation of cosmology and further development of selenography. The famous astronomer has not been forgotten in Tartu: in 1996 a memorial plaque was fixed to the wall of a building in the Observatory`s premises. Those interested in his life can read Mädler`s biography compiled by the astronomers Heino Eelsalu and Dieter B. Hermann (Berlin, 1985).

Komeedisüsteemide kontseptsiooni loomine

Thomas Clausen

16. I.1801 Schnabeck Taani

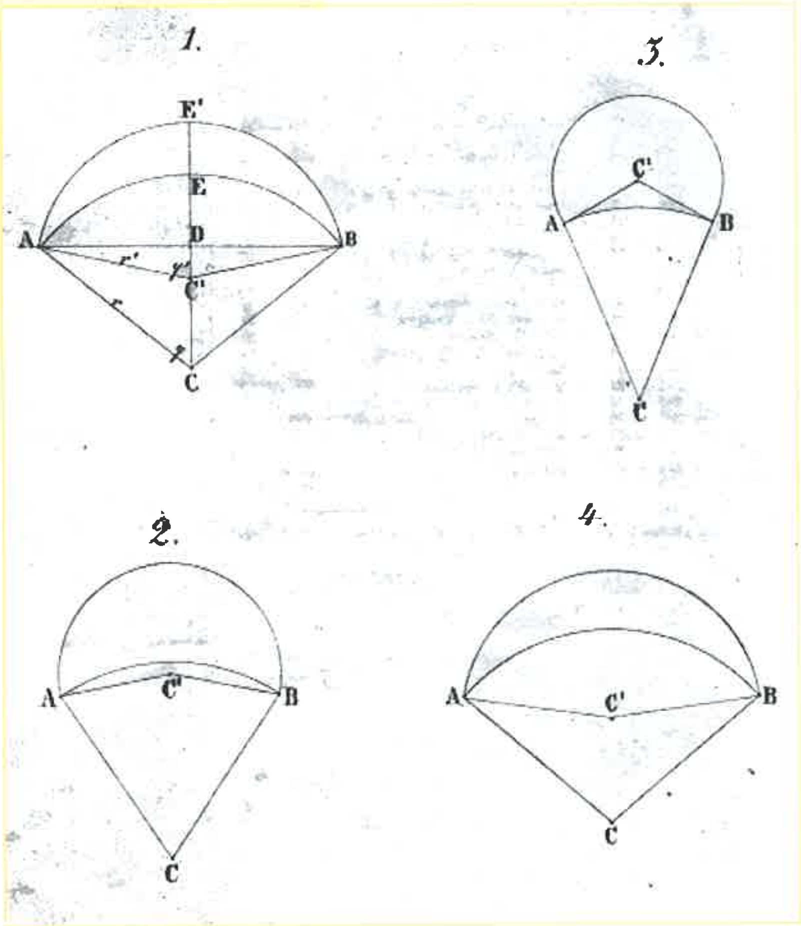
11.V.1885 Tartu

1842. aastal saabus Tartu tähetorni direktori J. H. Mädleri kutsel ning 19. sajandi ühe tuntuma matemaatiku Carl Fr. Gaussi soovitusel Tartusse astronoom-vaatlejaks mitmekülgsete huvidega laialdast tunnustust leidnud Taani päritolu teadlane-teoreetik **Thomas Clausen** (1801-1885). Tema senised uurimused käsitlesid matemaatikat, optikat, mehhaanikat ja praktilist astronoomiat. Matemaatikuna leidis Clausen kõik 5 kvadreeruvat Hippokratese kuukest, esitas teoreemi Bernoulli arvudest ning arvutas π 250 kohta. Ka astronoomias oli Clausen eeskätt teoreetik. Taani Kuninglik Õpetatud Selts andis talle preemia 1770. aasta komeedi orbiidi arvutuste eest.

Tartus avaldas ta töid meridiaaninstrumentide ja sekstantide teooriast ning tegi rohkesti komeetide orbiitide arvutusi. Arvutanud 14 komeedi orbiidi, tuli ta järeldusele, et komeedid võivad paikneda süsteemidena (nn. peredena). Seetõttu loetakse teda komeedisüsteemide - perekondade kontseptsiooni loojaks. Tugeva teoreetikuna seletas ta Tartus 5. juunil 1849. a. vaadeldud haruldast kolmekordse päikesega halot kui valguse murdumist ja peegeldumist jääkristallidel.

1865.aasta viimasel päeval kinnitati T. Clausen Tartu Ülikooli korraliseks professoriks, sellel kohal töötas ta 7 aastat kuni pensioneerumiseni. Clauseni teoreetilised uuringud olid suureks panuseks teadusse. Tema publikatsioonid ilmusid kaheksas köites (IX-XVI) saksakeelse väljaande *Beobachtungen* nime all.

Iseõppijast professor, kellel polnud isegi mitte keskharidust tõendavat dokumenti ette näidata, leidis siiski tunnustust ja lugupidamist oma aja teadusmaailmas. Ta valiti mitme ülikooli audoktoriks, akadeemiate ja teadusseltside liikmeks ja auliikmeks.



Clauseni joonised Hippokratese kuudest (1840)

The original drawings by Clausen of Hippocratean moons (1840)

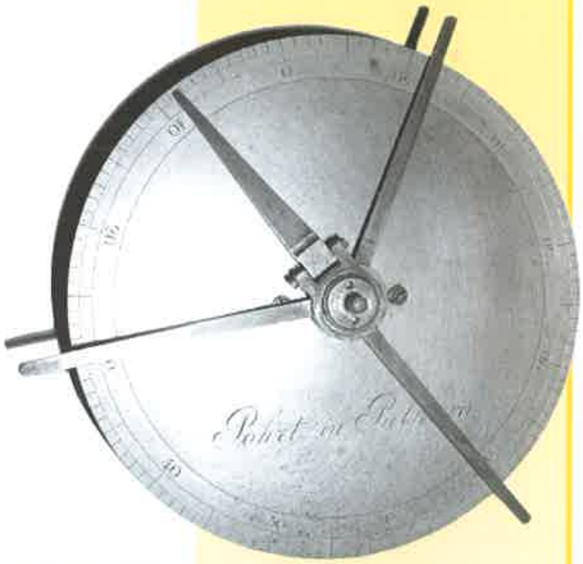
The creation of the conception of the system of comets

In 1842 the Danish scientist theoretician **Thomas Clausen** (1801-1885), who had won recognition as a many-sided researcher, arrived in Tartu at the invitation of J. H. Mädler, the director of the Observatory of Tartu, and recommended by one of the most famous mathematicians in the 19th century Carl Fr. Gauss to occupy the post of an astronomer- observer. In his research Thomas Clausen had dealt with mathematics, optics, mechanics and practical astronomy. As a mathematician Clausen found all the five quadrate of Hippocrates moons, presented his theorem of the Bernoulli numbers and calculated 250 digits of π. Also, in astronomy Clausen was primarily a theoretician. The Danish Royal Learned Society awarded him with a prize for having calculated the orbit of the comet of the year 1770.

In Tartu he published articles on the theory of the meridian instruments and sextants and calculated the orbits of many comets. Having calculated the orbits of fourteen comets, he came to the conclusion that comets might be located in systems (the so - called families). This is why Clausen is considered to be the creator of the conception of the systems - families of comets. As a strong theoretician, he explained an extraordinary phenomen - the halo with three suns - observed in Tartu on 5 June 1849 as the refraction of light and its reflection on ice crystals.

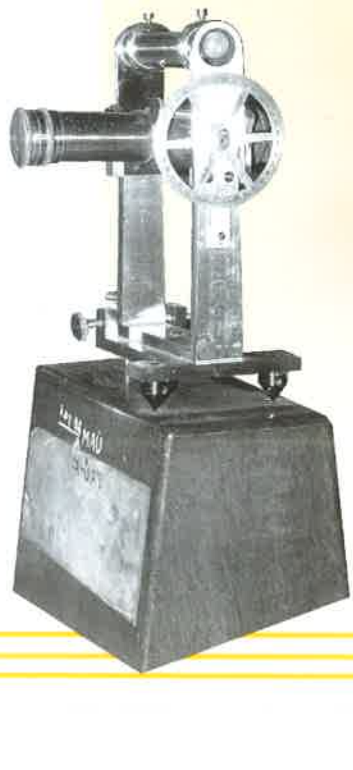
On the last day of 1865 T. Clausen was appointed Professor Ordinary at Tartu University. He occupied this position for seven years until retirement. With his theoretical research he made a great contribution to science. His publications appeared in eight volumes (IX - XVI) of *Beobachtungen* in the German language.

A self-taught professor who did not have even a certificate of secondary education became world reknown and highly respected by his colleagues - scientists. He was elected Honorary Doctor, a member of academies and scientific societies.



Vesiloodide kalibreerimise seade, U. Pohrt, Pulkovo, enne 1860.

A device for calibrating levels, U. Pohrt in Pulkowo, before 1860



Passaaži instrument. Brauer, Pulkovo. 1847. ÜAM

Transit instrument. Brauer in Pulkowo. 1847. ÜAM

Esimese Galaktika-välise supernoova avastamine

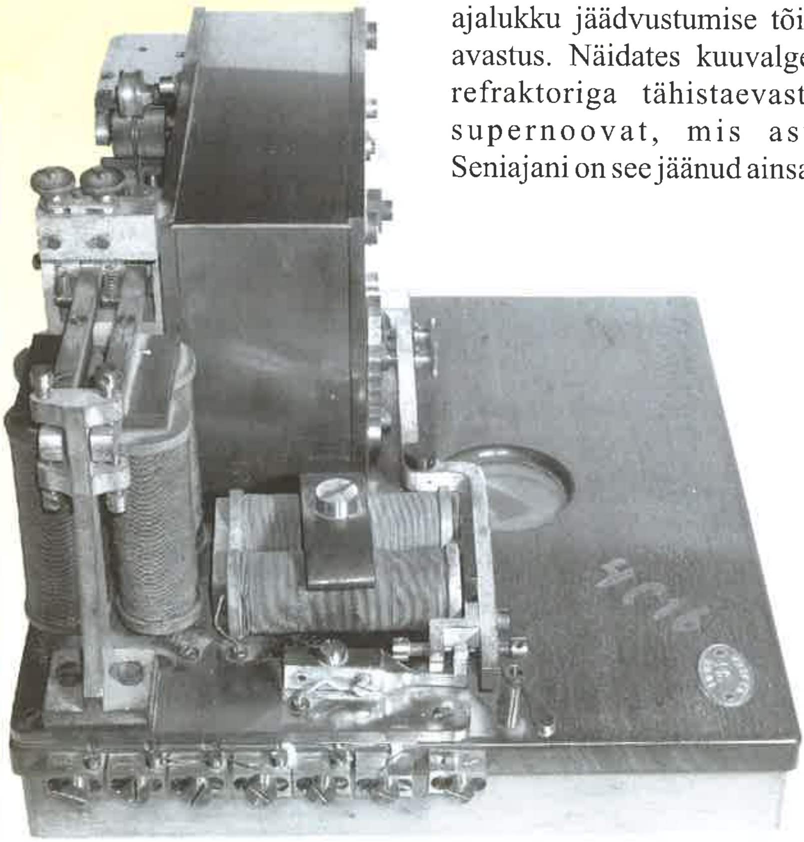
Carl Ernst Albrecht Hartwig

14. I 1851 Frankfurt Maini ääres
03. V 1923 Bamberg

Tartu tähetornis esimese Galaktika-välise supernoova avastanud **Carl Ernst Albrecht Hartwig** sündis Maini-äärses Frankfurdis. Erlangeni, Leipzigi, Göttingeni ja Müncheni ülikoolides õppinud Hartwig suundus kõrghariduse omandamise järel Strassburgi (Strasbourg), kus ta töötas õpetajana ja kohaliku observatooriumi assistendina. 1884. aastal kutsuti Hartwig Tartusse, kus temast sai Tartu tähetorni astronoom-vaatleja ning Tartu ülikooli õppejõud. 1886. aastal lahkus Hartwig kesise palga tõttu Bambergi, et juhtida sealse observatooriumi ehitust. Ehitustööde lõppedes sai temast uue observatooriumi direktor ning sellel kohal töötas ta kuni surmani.

Erinevalt oma eelkäijatest astronoom-vaatleja ametipostil, ei osalenud Hartwig Tartu tähetorni põhilises töös tsooni tähtede koordinaatide määramises meridiaanringiga, mis tavaliselt oli astronoom-observaatorite ülesandeks. Vabamat tegutsemist nautinud Hartwigil õnnestus teha kaks avastust, mida ei juhtunud Tartu tähetornis just väga sageli. 1885. aasta suvel uuris Hartwig helkivaid ööpilvi, olles nende üks esmaavastajaid ja esmavaatlejaid. See saavutus ei pälvinud aga teiste astronoomide seas erilist tähelepanu. Rahvusvahelise tuntuse ja astronoomia ajalukku jäädvustumise tõi Hartwigile 1885. aasta augustis tehtud avastus. Näidates kuuvalgel õhtul sõpradele Fraunhoferi 9-tollise refraktoriga tähistaevast, märkas Hartwig Galaktika-välist supernoovat, mis asus Andromeeda tähesüsteemis. Seniajani on see jäänud ainsaks Andromeeda udukogust leitud supernoovaks. Kuigi nimetatud supernoovat märkasid sõltumatult ka mitmed teised astronoomid, oskas ainult Hartwig taibata selle tähendust. Ülejäänud pidasid seda algul kuuvalguseks või optiliseks efektiks teleskoobis. Tehtud avastusele järgnes pikem diskussioon ning nimetus "supernoova" võeti kasutusele alles 1930. aastatel.

Hartwigi nimi on antud ühele 79 kilomeetrise läbimõõduga kraatrile Kuu nähtaval küljel. Ka on tema auks nimetatud üks Marsi kraatritest.



Kronograaf. R. Fuess, Berlin. XIX s.lõpp . ÜAM 1146:33

Chronograph. R. Fuess, Berlin. The end of the 19th century. ÜAM 1146:33

The discovery of the first supernova outside Galaxy

Carl Ernst Albrecht Hartwig, who discovered the first supernova outside Galaxy in the Observatory of Tartu, was born in Frankfurt am Main. Having studied at the Universities of Erlangen, Leipzig, Göttingen and Munich, he went to Strasbourg where he began to work as a teacher and assistant at the local observatory. In 1884 he was invited to Tartu where he occupied a post of the lecturer at Tartu University and the astronomer-observer at the Observatory. In 1886 he left Tartu because of his meagre salary and moved over to Bamberg to supervise the construction of the observatory there. When the building of the observatory was completed, he became the first director of the observatory. He occupied the post until his death.

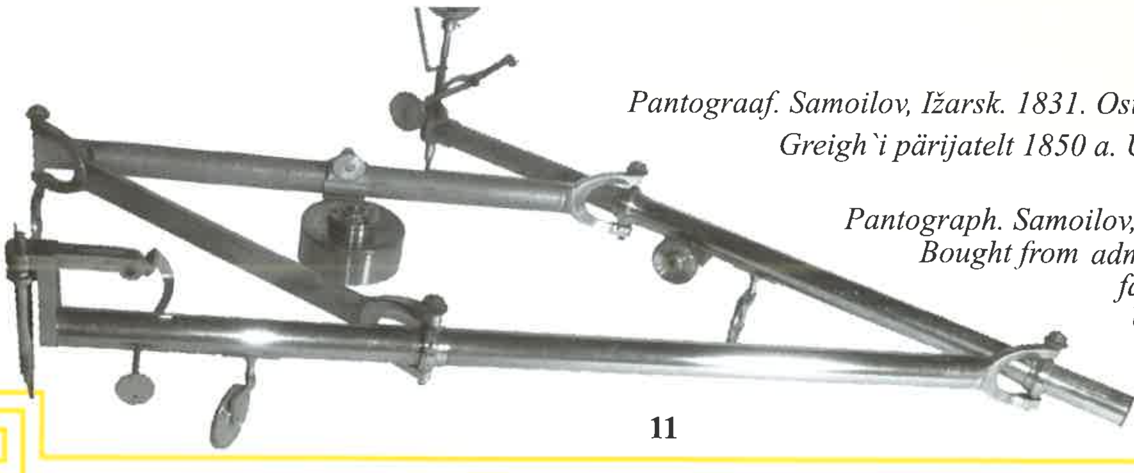
Differently from his predecessors in Tartu, working as an astronomer-observer, Hartwig did not participate in the principal work of the Observatory of Tartu - the determination of the coordinates of the zone with the help of the meridian circle which commonly was the task of the astronomer-observer. Having enjoyed relative liberty in his work, Hartwig succeeded in making two discoveries which did not happen at the Observatory of Tartu very often. In the summer of 1885 Hartwig investigated the noctilucent clouds being one of the first to discover and observe them. His achievements, however, did not capture any attention of other astronomers.

International recognition and a permanent place in the history of astronomy was gained by Hartwig after he had made a discovery in August 1885. Showing his friends the starry sky at a moonlit night, using the 9- inch Fraunhofer refractor, Hartwig noticed a supernova outside Galaxy which was in the Andromeda system of stars. Until today this is the only supernova found in the Audromeda nebula. Although several other astronomers independently noticed the same supernova, only Hartwig was able to understand its importance. The others thought it was moonlight or an optical effect in the telescope. A longer discussion followed the discovery and the term "supernova" began to be used only in the 1930s.

Kell. XX s. algus. Nn. poolesekundi kella kasutati vaatlusaja kellana üleval tornis. ÜAM 1146:23

Clock. The beginning of the 20th century. The so-called half a second clock was used as an observation clock in the tower. ÜAM 1146:23

Hartwig`s name has been given to a crater with the diameter of 79 km on the visible side of the Moon. Also, one of the craters of the Mars has been named in honour of Hartwig.



Pantograaf. Samoilov, Ižarsk. 1831. Ostetud admiral Greigh`i pärijatelt 1850 a. ÜAM 1146:65

Pantograph. Samoilov, Ižarsk. 1831. Bought from admiral Greigh`s family in 1850. ÜAM 1146:65

Peter Carl Ludwig Schwarz - Liivimaa ja Siberi mõõdistaja

Peter Carl Ludwig Schwarz
23. V 1822 Gdansk
17. IX 1894 Tartu

Peter Carl Ludwig Schwarz sündis 1822.a. Poolamaal Gdanskis, kuid kasvas üles Peterburis, kus tema isa oli näitlejaks õueteatris. Aastail 1841 - 1846 õppis Tartu ülikoolis. Juba üliõpilasena alustas Schwarz tööd tähetornis, tehes Clauseni juhendamisel astronoomilisi vaatlusi. Pärast stuudiumi lõpetamist jäeti ta siia assistendina tööle. 1849.a. võeti Schwarz Struve soovitusel kaasa astronoomilisele ekspeditsioonile, mis suundus teisele poole Baikalit Amuuri jõe piirkonna geograafilistele uurimistele. Neli aastat möödusid rasketes tingimustes asustamata ja teedeta aladel. Ekspeditsioonilt tõi Schwarz kaasa vaatlusmaterjale ja kogemusi astronoomilisteks välimõõtmisteks.

Vähem kui aasta kodus olnud, määrati Schwarz uue samalaadse ekspeditsiooni juhiks. Selle organiseeris Vene Geograafia Selts Ida-Siberi, Sahhalini saare ja osa Hiina põhjaprovintside füüsilis-geograafiliseks uurimiseks. Nelja aasta jooksul koos kolme abilisega (kelledest üks sai surma) määras ta paljude punktide geograafilised koordinaadid ning mõõdistas 15 000 versta pikkuselt marsruute. Ekspeditsiooni aruanne avaldati trükis 1864.a.

Kuigi uurimustööde eest Siberis oli Schwarzile määratud eluaegne pension, geograafiaseltsi kõrgeim autasu - Konstantini medal ja Peterburi akadeemia Demidovi preemia, ei pööranud ta teadusele selga. Lausa vastupidi - nüüd pühendus seni looduse meelevallas rassinud mees tasakaalukale kabinetitööle (niivõrd-kuivõrd see astronoomi puhul on üldse võimalik). 1865.a. asus Schwarz Tartu tähetorni astronoom-observaatori kohale, kus alustas Tartu tsooni vaatlust, mis jäigi tema edaspidiseks põhitööks.

1872 sai Schwarz Tartu tähetorni direktoriks ja Tartu ülikooli astronoomiaprofessoriks. Sel ametikohal (kuni surmani 1894.a.) tuleb tema teeneks pidada ettenägelikku silma alluvate leidmisel, kuna paljud siinsed observaatorid said tunnustatud teadlasteks. Kahjuks mitte küll Tartus, vaid hiljem mujal töötades.

Tähetorni majanduslikud olud Schwarzi direktoriks olemise ajal polnud kiita, kuna astronoomia areng polnud ülikoolis prioriteetide hulgas. Seetõttu oli uute instrumentide muretsemine üpris keerukas. 1873.a. saadi Repsoldi heliomeeter, mis telliti Veenuse päikesekettast ülemineku jälgimiseks 1874.aastal. Seda haruldast nähtust jälgis Schwarz heliomeetriga Hiina piiri ääres Nertšinskis. Enne Tartusse tagasijõudmist tuli sellel unikaalsel aparaadil end eksponeerida näitusel Londonis ning 1882.a. rändas ta prantsuse ekspeditsiooniga Kariibi meres asuvale Martinique`i saarele, kus temaga jälgiti taas Veenuse üleminekut päikesekettast (millegipärast prantslased ei maini laenamist!). Praegu on instrument vanaduspuhkusel Tartu tähetornis.

Schwarzi ajal muretseti Tartusse Pulkovo observatooriumi töökojast Herbsti passaažiriist, mille valmistaja mehhaanik W. Herbst pärines Helmest. Selle aparaadiga täpsustati 1884.a. Tartu tähetorni geograafilist laiust, mille oli määranud juba Struve oma diplomitöös.

Lisaks heliomeetrile ja passaažiriistale täienes kuni 1890. aastate alguseni tähetorni kogu veel pendelkellaga *(Hohwü)*, kahe prismaringiga *(Pistori ja Steinheli)*, kahe nivelliiri ja ühe nivelliir-teodoliidiga.

Nivelliir. Pistor & Martins, Berlin. XIX s. I pool ÜAM 1146:21
Level. Pistor & Martins, Berlin. The 1st half of the 19th century. ÜAM 1146:21

Peter Carl Ludwig Schwarz - a land-surveyor of Livonia and Siberia

Peter Carl Ludwig Schwarz was born in Gdansk, Poland, in 1822 but grew up in St. Petersburg where his father was an actor at the theatre of the Imperial Court. In the years 1841-1846 he studied at Tartu University. Being a student, Schwarz began to work at the Observatory under the guidance of Clausen. Having completed his studies, Schwarz was appointed to a post of the assistant. In 1849 Struve recommended Schwarz for the participation in the astronomical expedition which was sent to the Trans-Baikal region to study the geography of the River Amur basin. Four years were spent in hard physical conditions in the unpopulated and roadless area. From the expedition Schwarz brought along observation materials and he had gained experience for astronomical observation in field conditions.

Spending less than a year at home, Schwarz was appointed leader of a similar expedition organised by the Society of Geography to Eastern Siberia including the island of Sakhalin and a part of northern provinces of China with the purpose of physical-geographical investigation. During four years Schwarz with his three assistants (one perished) determined the geographical coordinates of several points and surveyed routes with the overall length of 15,000 versts. The expedition report was published in 1864. Although for his research in Siberia, Schwarz was given a life-long pension, the highest award of the Society of Geography - the Konstantin Medal - and the Demidov Award of the Academy of Sciences. He, on the contrary, did not want to retire. Being a man who had spent so much time in the natural environment, he began to devote his time to balanced theoretical research in his office (if it is possible for an astronomer). In 1865 Schwarz occupied the post of an astronomer-observer and started observing the Tartu zone which later became his major task. In 1872 Schwarz became the director of the Observatory of Tartu and Professor of Astronomy at Tartu University. At this post (until his death in 1894) Schwarz displayed predictiveness in recruiting colleagues because several Tartu observers became well-known scientists, unfortunately not as yet in Tartu but later working elsewhere. When Schwarz was the director of the Observatory, the financial resources of the Observatory were limited because the development of astronomy was not a priority at the university and this is why it was quite complicated to purchase new instruments. In 1873 the Repsold heliometer was bought with the purpose of observing Venus cross the disc of the Sun in 1874. Schwarz observed this rare phenomenon with the heliometer in Nerchinsk at the Chinese border. Before the instrument reached Tartu again, it was exhibited in London and in 1882 it was taken to the island of Martinique in the Caribbean Sea by a French expedition where the members again observed Venus crossing the disc of the Sun (the French even did not mention the fact of borrowing the instrument). At present the instrument is exhibited in the Observatory of Tartu.

When Schwarz worked in Tartu, a Herbst passage instrument was bought from the Observatory of Pulkovo. It was made by the mechanic W. Herbst who came from Helme. In the year 1884 with this apparatus the geographical latitude of the Observatory of Tartu was more exactly determined. It had initially been measured already by Struve and fixed in his graduation thesis.

Nivelliir loodiga. Ertel & Sohn, München. XIX s. II pool. ÜAM 1146:64

Level-theodolite. Ertel & Sohn, Munich. The 2nd half of the 19th century. ÜAM 1146:64

Horisontaalring-nivelliir. Ertel & Sohn, München. XIX s. II pool. ÜAM 1146:68

Horizontal ring level. Ertel & Sohn, Munich. The 2nd half of the 19th century. ÜAM 1146:68

Before the 1890s in addition to the heliometer and the quadrate of Hippocrates moons the collection of instruments at the Observatory received a pendulum clock *(Hohwü)*, two levelling instruments and one levelling theodolite.

Vene seismoloogia rajamine, horisontaalpendlite kasutamine seismoloogilisteks eesmärkideks

Grigori Vassiljevitsh Levitski
27. X/8. XI 1852 Harkov
26. X 1917 Peterburi

Grigori Vassiljevitsh Levitski sündis 27. oktoobril /8. novembril 1852 Harkovis. Lõpetas kodulinnas gümnaasiumi ja õppis 1870-74 Harkovi ülikooli keemiaosakonnas ja Peterburi ülikooli matemaatikaosakonnas ning Peterburi mäeinstituudis. Lõpetas 1874 Peterburi ülikooli matemaatikakandidaadi kraadiga. Pärast magistritöö kaitsmist Peterburis 1879 töötas Harkovi ülikoolis: 1879 astronoomia eradotsendina, 1880 dotsendina ja 1884 erakorralise professorina, juhatades ühtlasi astronoomiakabinetti ja observatooriumi. Levitski rajas Harkovis uue observatooriumi, mis oli varustatud moodsa tehnikaga. 1893 rajati selle juurde ka seismoloogia osakond.

1894 viidi Levitski üle Tartu ülikooli korralise astronoomia professori kohusetäitjaks ja määrati tähetorni direktoriks. Levitski töötas Tartus 14 aastat, 1894-1908. 1898 sai Levitski Harkovi ülikooli audoktori kraadi ja kinnitati samal aastal korraliseks professoriks. 1900. aastast oli ta Peterburi TA alalise Seismoloogia Keskkomisjoni liige. Oli Loodusuurijate Seltsi esimees aastatel 1901-1905. 1903 sügisel määrati Levitski 4 aastaks Tartu ülikooli rektoriks, kuid vabastati 1905 sügisel sellelt kohalt. 1904 läks ta pensionile koos õigusega tööd jätkata, 1905 omistati talle teenelise professori nimetus (*prof emeritus*).

Ülikoolis luges Levitski üldist astronoomiat, kõrgemat geodeesiat, praktilise ja teoreetilise astronoomia kursusi. Levitski alustas Tartus tähetorni reorganiseerimist, püüdes eelkõige parandada observatooriumi halba majanduslikku seisukorda. Mehhaanik Herbsti abiga parandas Levitski observatooriumi vanu instrumente. Tellis mitmeid uusi instrumente: Repsoldi seniitteleskoop ja erinevate konstruktsioonidega horisontaalpendlid seismilisteks mõõtmisteks. Levitski ajal laiendati tähetorni hoonete kompleksi: 1897 ehitati teleskoobi jaoks kivist paviljon pöörleva kupliga; pendlite paigutamiseks kohandati vana püssirohukelder. 1895. aastast alustati Tartus süstemaatilisi visuaalseid ja 1897. aastast fotograafilisi päikeseplekkide vaatlusi. Tartus vaadeldi komeete, meteoriite ja helkivaid ööpilvi, milleks kaasati ka üliõpilasi. Enamik artikleid ja teadustöid oli pühendatud komeetide orbiitide määramisele.

1896 rajati Tartu observatooriumi juurde seismoloogiaosakond ja alustati süstemaatilisi seismoloogilisi vaatlusi. Tartu seismoloogiajaama tööks oli maavärinate registreerimine, kasutatava ja saabuva aparatuuri uurimine ja täiustamine, seismoloogia bülletääni väljaandmine, kaadri ettevalmistamine.

Levitski võttis osa konverentsidest ja käis teaduslikel reisidel seoses seismilise teenistuse organiseerimisega: 1901 rahvusvaheline seismoloogia-konverents Strassburgis, 1902 teaduslik lähetus Kaukaasias, 1906 konverents Roomas, 1907 konverents Haagis. Levitski kõige kaalukamaks teaduslikuks panuseks on jäänud tema teadusajaloolised tööd: Harkovi ja Tartu observatooriumide ajalood (1899) ning Tartu ülikooli professorite leksikon (1902-03).

1908 määrati ta Vilniuse õpperingkonna kuraatoriks ja lahkus Tartust, 1911 aga kolis Peterburi ja asus seal pedagoogilisele tööle Naiste Pedagoogilises Instituudis. 1915. aastast oli ta Vene Astronoomia Seltsi esimees. Levitski suri 26. oktoobril 1917 Peterburis.

Koordinaatide mõõtmise riist. Repsold & Söhne, Hamburg. 1896. ÜAM 1146:83
Coordinate measuring machine. Repsold & Söhne, Hamburg. 1896. ÜAM 1146:83

Creation of Russian seismology, the use of horizontal pendulums in seismology

Grigory Vassiljevitsh Levitski was born on 27 October / 8 November 1852 in Kharkov. He finished secondary school in his home town and in the years 1870-1874 he studied in the Department of Chemistry at Kharkov University, the Department of Mathematics at St. Petersburg University and at the Mining Institute in St. Petersburg. He graduated from St. Petersburg University with the Degree of Candidate of Mathematics. After defending his Master`s thesis in 1879 he worked at Kharkov University: in 1879 as Private Docent of astronomy, in 1880 as Docent and in 1884 as Professor Extraordinary leading the work of the Centre of Astronomy and the Observatory. In Kharkov he established a new Observatory which was equipped with modern technology. In 1893 the Department of Seismology was opened at the Observatory.

In 1894 Levitski was sent to Tartu University to occupy the post of Acting Professor of Astronomy and he was also appointed director of the Observatory. Levitski worked in Tartu for 14 years, in 1894-1908. In 1898 Levitski was conferred the doctoral degree at Kharkov University and in the same year he was nominated Professor Ordinary. Since the year 1900 he worked as a member of the permanent Central Commission of Seismology at the Academy of Sciences in St. Petersburg. In the years 1901-1905 he was the Chairman of the Society of Naturalists. In the autumn of 1903 Levitski was appointed Rector of Tartu University for four years but he freed the post in the autumn of 1905. In 1904 he retired with the right to continue his work, in 1905 he became Professor Emeritus.

At the university Levitski delivered lectures on general astronomy, higher geodesy, conducting courses of practical and theoretical astronomy. Levitski started to reorganise the work of the Observatory of Tartu, primarily trying to improve the unfavourable economic conditions. With the help of the mechanic Herbst he repaired the old instruments in the Observatory and purchased several new instruments - the Repsold zenith telescope and horizontal pendulums of different technical designs for seismic measurements. When Levitski worked at the Observatory, a whole complex of buildings was added to the main building of the Observatory - in 1897 a stone pavilion with a revolving cupola was built for the telescope, the ancient gun powder cellar was reconstructed for installing pendulums. In 1895 systematic visual observation and in 1897 photographic obervation of solar spots started. In Tartu, with the help of students, comets, meteorites and noctilucent clouds were observed. Most of the articles and scientific papers were devoted to the establishment of the orbits of comets.

In 1896 a seismology department was opened at the Observatory and systematic seismological observation started. At the seismologcal station in Tartu earthquakes were registered, the new equipment was studied and perfected, a seismology bulletin was published and new members of the staff were trained. Levitski participated in scientific conferences and made several business trips connected with the organisation of seismic service: in 1901- a seismology conference in Strassburg, in 1902- a research trip to the Caucasus, in 1906- a conference in Rome, in 1907- a conference in the Hague.

Levitski`s most important scientific contribution includes his science history papers " The History of the Observatory of Tartu" (1899) and " The Lexicon of Professors of Tartu University" (1902-1903).

In 1908 Levitski was appointed Curator of the Vilnius Educational Area and he left Tartu. In 1911 he moved over to St. Petersburg where he began to teach at the Pedagogical Institute for Women. Since 1915 he was the Chairman of the Society of Russian Astronomy. Levitski died on 26 October 1917 in St. Petersburg.

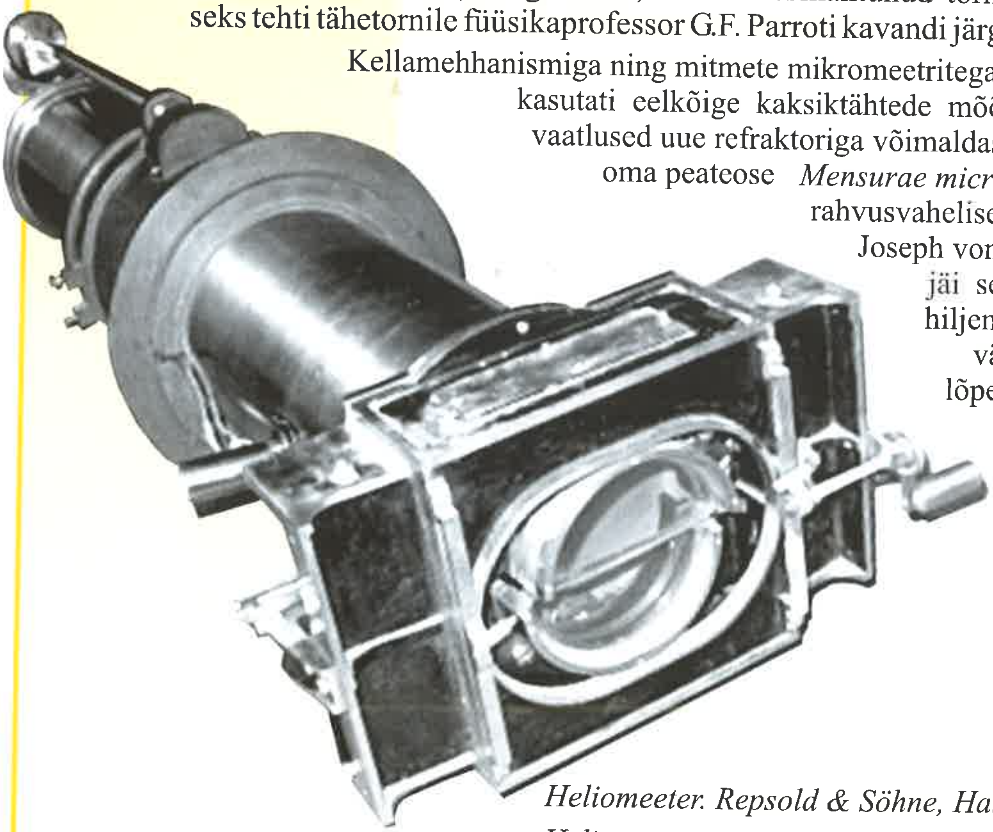
Levitski raamatute tiitellehti
Title pages of Levitski's books

Tartu tähetorni ajaloolised vaatlusriistad

Esimesi astronoomilisi vaatlusi omaaegsete vaatlusriistadega tehti Tartus asjaarmastajate poolt 1790. aastatel. Ülikooli taasavamise järel 1802 hakati soetama ka astronoomilisi vaatlusriistu. 1805. a. organiseeris matemaatikaprofessor Johan Pfaff vaatlusi ajutises observatooriumis ühe eramaja ärklikorrusel. Vaatlustulemused avaldati publikatsioonis *Astronomische Beyträge* Tartus 1806 - 1807. a.

Esimesed riistad saabusid ülikoolile 1805 - 1806. a. Inglismaalt: peegelpikksilm (*Herschel*, 1806), peegelteleskoop (*Troughton*, 1806) ja passaažiriist (*Dollond*, London, 1807). Tähetorn valmis aastail 1808 - 1810. Riistade monteerimise ja proovivaatlustega alustati 1813. a. kui tähetorni astronoom-observaatoriks määrati äsja edukalt TÜ lõpetanud 20-aastane professor Wilhelm Struve. Regulaarseid vaatlusi alustati 20. jaanuaril 1814. a. Vaatlusandmed avaldati 1817. aastast *Observationes Astronomicas...* Edaspidi Tartu tähetornile tellitud vaatlusriistad olid enamasti pärit Saksamaa mehhaanika ja optika töökodadest. Tellimused täideti 3 - 4 aasta jooksul, millele järgnes riista monteerimine kohapeal. 1822. a. saabus kohale Reichenbachi meridiaanring (*Reichenbach & Ertel*, München), mida Struve kasutas meridiaankaare mõõtmiste juures Baltikumi ulatuses (1821-27). 1824. a. saadi tähetornile nüüdseks harulduseks muutunud riist teadusloos suur Fraunhoferi refraktor-teleskoop (*Utzschneider und Fraunhofer*, München). Omal ajal maailma suurim läätsteleskoop objektiivi läbimõõt 9 Pariisi tolli (24 cm), toru pikkus (objektiivi fookuskaugus) 13 jalga ja 4 tolli (4,5 meetrit), kogukaal 1,6 tonni - ei mahtunud torni ära ning selle paigaldamiseks tehti tähetornile füüsikaprofessor G.F. Parroti kavandi järgi pööratav kuppel (1825).

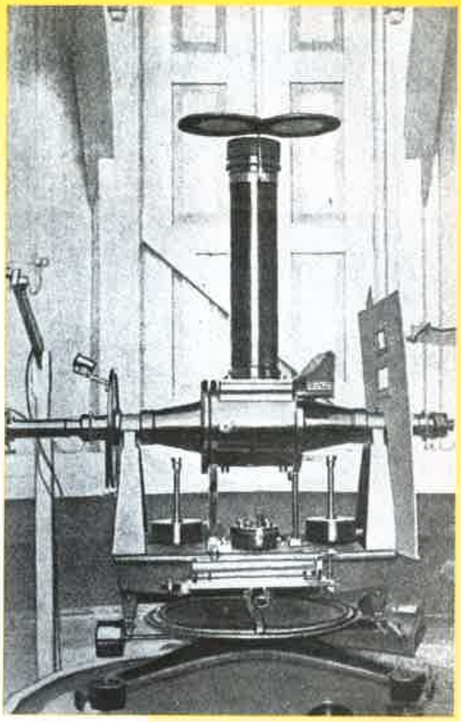
Kellamehhanismiga ning mitmete mikromeetritega komplekteeritud refraktorit kasutati eelkõige kaksiktähtede mõõdistamiseks. Kaksiktähtede vaatlused uue refraktoriga võimaldasid Struvel avaldada 1837.a. oma peateose *Mensurae micrometricae...* , mis tõi talle rahvusvahelise tuntuse. Teleskoobi loojale Joseph von Fraunhoferile (1787-1826) jäi see aga suurimaks tööks, sest hiljem ehitatud samalaadse, pisut väiksema eksemplari Bonnis lõpetasid juba tema järeltulijad.



Heliomeeter. Repsold & Söhne, Hamburg. 1873. ÜAM 1170:8

Heliometer. Repsold & Söhne, Hamburg. 1873. ÜAM 1170:8

Struve ajast on pärit teisigi riistu: teodoliit (*Pistor & Martins*, Berlin), kaks vertikaalringi firmalt *Ertel & Sohn* (München), üks neist (optika *Utzschneider & Fraunhofer)* oli kaasas ülikooli ekspeditsioonil Araratile 1829 - 1830.



Seniitteleskoop. Repsold & Söhne, Hamburg. 1897.

Zenith tube. Repsold & Söhne, Hamburg. 1897. ÜAM 1170:4

Prof. Mädler uuris Kuu pinna kujundeid, valmistas neist mudeleid ja avaldas Kuu pinda kujutava suure kaardi ("Mappa Selenographica" 1837 ja 1869). Tema ajal 1850. aastatel soetati tähetornile kipsmudelid Kuu pinnavormide kujutistega: tasandikud ("mered"), mäeahelikud, kraatrid. Säilinud on 16 kipsmudelit. Teodoliit (*B. Bunge*, Berlin-Lichtenfelde) oli kasutusel kõrgete objektide vaatlemiseks.
Prof. Ludwig Schwartzi ajal soetati mitmeid geodeetilisi uurimisriistu: teodoliit (*Pistor & Martins*), sekstant (*Steinheil, Ertel & Sohn*) horisontaalring-nivelliir firmalt *Ertel & Sohn*, Münchenist (toru pikkus 50 cm., suurendus 20 x, ratsurvesilood). Prof. Mädler korraldas 1860. a. päikesevarjutuse vaatluseks ekspeditsiooni Hispaaniasse. Sajandi viimasel veerandil korraldati teisigi samalaadseid ekspeditsioone. Päikese mõõtmiseks osteti firmast *Repsold und Söhne* heliomeeter ("päikesemõõtja"). Heliomeetriga on vaadeldud kahel korral Veenuse üleminekut Päikesest (9. detsembril 1874. a. Taga-Baikalimaal ja 1882. a. Martinique saarel (Kariibi meres).

1897. a. ehitati Toomemäe nõlvale vaatluspaviljon, kuhu paigaldati samal aastal saadud seniitteleskoop (*Repsold und Söhne,* Hamburg). Vaatlusriista on kasutatud pooluse kõrguste muutuste mõõtmisel Tartus 1907 - 1909 ning Permis ja Tomskis 1916 - 1934. Sama firma meistritelt pärit koordinaatide mõõtmise riista (1896) kasutati kuni 1989. aastani taevakehade positsioonide mõõtmisel fotoplaatidelt.
1908. a. telliti Tartu tähetornile uus teleskoop firmalt *Carl Zeiss* Jenas. Teleskoop (objektiivi läbimõõt 20 cm, fookuskaugus 3 meetrit) jõudis Tartusse 1911. a. ning vahetas välja 87 aastat tornis seisnud Fraunhoferi refraktori, mis leidis koha tähetorni esimesel korrusel. Zeissi teleskoobi juurde osteti samast ka Petzvali tüüpi objektiiviga fotokaamera (objektiivi läbimõõt 160 mm, fookuskaugus 78 cm), mis oli mõeldud komeetide ja asteroidide fotografeerimiseks ning taevaalade pildistamiseks. 1927. a. paigaldati Petzvali astrograaf eraldi riistana vaatluspaviljoni Toomemäel.

1964. aastal kolisid astronoomid vastvalminud Tõravere observatooriumi. Tartu tähetorni Zeissi refraktor jäi huviliste teenistusse ning vanad vaatlusriistad eksponaatidena tähetorni muuseumi. 1993. a. restaureeris ja konserveeris suure Fraunhoferi refraktori vaskosad astronoom Enno Ruusalepp koostöös Saksa Muuseumi restauraatoritega Münchenis.

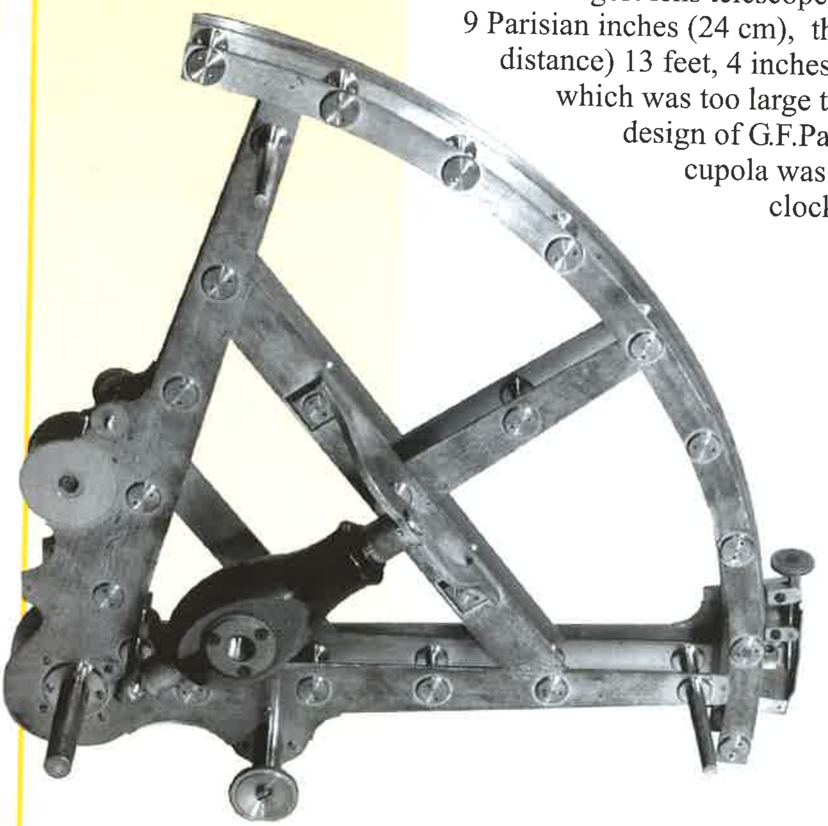
Sekstant. Steinheil, Ertel & Sohn, München. XIX s. II pool. ÜAM 1146:82

Prism sextant. Steinheil, Ertel & Sohn, Munich. The 2nd half of the 19th century. ÜAM 1146:82

Historical observation instruments in the Observatory of Tartu

In Tartu the first astronomical with observation instruments were made by amateurs in the 1790s. After the reopening of the university in 1802 new astronomical observation instruments were purchased. In 1805 the Professor of Mathematics Johan Pfaff organised observation in a temporary observatory in the attic of a private house. The observation results - *Astronomische Beyträge* - were published in Tartu in 1806-1807.

The first instruments for the university came from England in 1805-1806: the reflecting telescope (*Herschel*, 1806), the refracting telescope (*Troughton,* 1806) and the transit instrument (*Dollond,* London, 1807). The building of the Observatory was completed in the years 1808-1810). The installation of the instruments and test observations started in 1813 when the successful graduate of Tartu University, 20-year-old professor Wilhelm Struve was appointed astronomer-observer of the Observatory. Regular observations began on 20 January 1814. Observation data had been published since 1817 in *Observationes Astronomicas...* The later procured observation instruments were mostly made in mechanics and optics workshops of Germany. Orders were satisfied within three or four years. The local installation soon followed. In 1822 the Observatory received the Reichenbach meridian circle (*Reichenbach & Ertel,* Munich) which Struve used for measuring the meridian arc in the Baltic countries (1821-1827). In 1824 the Observatory obtained the instrument which has become very rare in science history museums today- the large Fraunhofer refracting telescope (*Utzschneider und Fraunhofer,* Munich). At that time it was the largest lens telescope in the world- the diameter of the objectiv 9 Parisian inches (24 cm), the length of tube (the objective`s focusing distance) 13 feet, 4 inches (4.5 meters), the total weight 1.6 tonnes- which was too large to be installed in the tower. Thus, after the design of G.F.Parrot, a professor of physics, the revolving cupola was built (1825). The refractor, supplied with clockwork and several micrometers, was used Primarily to measure binary stars which allowed Struve to publish his major book *Mensurae micrometricae...* , making him internationally recognised. For Joseph von Fraunhofer (1787-1826), the creator of the telescope, it remained his most important instrument because a similar, somewhat smaller copy in Bonn was completed by his followers. There are other instruments from the Struve`s times there: the level (*Pistor & Martins,* Berlin), two vertical circles *Ertel & Son,* (Munich), one of them (optics from *Utzschneider & Fraunhofer*) was taken along to the university expedition to Ararat in the years 1829-1830.



Peegelsekstant. Troughton, London. 1920.a.

Reflection sextant. Troughton, London. 1920s.
ÜAM 1146:60

Professor Mädler investigated the surface figures of the Moon, made scale models and published a large map of the surface of the Moon (*Mappa Selenographica* 1836 and 1869). In the 1850s, when he worked at the Observatory, gypsum models of surface forms of the Moon were bought: plains ("seas"), mountain ranges, craters. Sixteen models have survived. The theodolite (*B. Bunge,* Berlin - Lichtenfelde) was used for observing high objects.

When professor Ludwig Schwartz worked at the Observatory, several geodetic instruments were bought: the theodolite (*Pistor and Martins*), the prism sextant (*Steinheil, Ertel & Son*), the horizontal level - theodolite (*Ertel & Son,* Munich) with the tube length of 50 cm, magnification 20x, a spirit level. In 1860 professor Mädler organised an expedition to observe the solar eclipse in Spain. At the end of the century several other expeditions of the kind were organised. For measuring the sun, a heliometer was bought (*Repsold und Söhne).* Two times the transfer of Venus across the Sun has been observed (on 9 December 1876 in the Trans-Baikal region and in 1882 on the island of Martinique in the Caribbean Sea).

In 1897 an observation pavilion was built on the slope the Toome Hill where the zenith telescope was installed in the same year (*Repsold und Söhne,* Hamburg). The observation instrument had been used to measure the changes of the heights of the Pole in Tartu in the years 1907-1909 and in Perm and Tomsk in the years 1916-1934. The same company had supplied the Observatory with the instrument for measuring coordinates (1896) which was in use until 1989 for measuring the positions of celestial bodies on photographic plates.

In 1908 a new telescope was ordered from the *Carl Zeiss* company in Jena (diameter of the objective - 20 cm, focussing distance - 3 meters) and it arrived in Tartu in 1911 to replace the Fraunhofer refractor which had been functioning for 87 years in the tower. The new telescope was placed on the ground floor. Later a photo camera with the Petzval-type objective (diameter of the objective 160 mm, focussing distance 78 cm) was bought and added to the Zeiss telescope. It was used for photographing comets, asteroids and areas in the sky. In 1927 the Petzval astrograph was installed as a separate instrument in the observation pavilion on the Toome Hill.

In 1964 astronomers moved over to to the newly built Observatory at Tõravere. The Zeiss refractor remained in the Observatory of Tartu to be used by amateurs and old observation instruments were displayed in the Observatory Museum. In 1993 Enno Ruusalepp together with the restorers of the German museum in Munich restored and conserved copper parts of the large Fraunhofer refractor.

Vertikaalring.
Ertel & Son, Munic.
Kasutas F. Fjodorov ekspeditsioonil Araratile
1829-1830.a.

Verticl circle.
Ertel & Son, Munic.
Was used by F. Fjodorov on the expedition
to Mount Ararat
ÜAM 1146:51

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