

Maximilian Hell's invitation to Norway

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On 28th April 1768 the Imperial and Royal Astronomer of Vienna, the Jesuit Maximilian Hell (1720-1792) left his workplace at the Vienna University Observatory to embark upon a strenuous journey to the extreme north-eastern corner of Norway. He brought with him a massive array of scientific equipment, including a 6 feet gnomon, two pendulum clocks, quadrants $2\frac{1}{4}$ and 6 feet in diameter, telescopes 10, $10\frac{1}{2}$, and $8\frac{1}{2}$ feet long, mural telescopes, micrometers, barometers, thermometers, declinometers, an electric machine, at least one microscope, as well as equipment for mounting and repairing these instruments (Hell 1770a; ArchS 1a; 1b). In addition came a number of books, heaps of paper, pens, ink, olive oil, chocolate, wine, coffee, tea, and other necessities of the urban savant. All this had to be brought along by ship and wagon, partly from Vienna, partly from Copenhagen, Christiania, and Trondheim, to the destination Vardø, a small settlement close by the Arctic Ocean. Two scientific assistants (as well as a servant and a dog) were Hell's travel companions for most of the journey. When he finally reached Vardø on 11th October, in the midst of a storm which nearly drove his ship away to be lost forever in the merciless *Eismeer*, Father Hell had been travelling indefatigably for almost six months. Nevertheless, he immediately started constructing a modest observatory into which he would bring all his equipment and spend most of the winter and spring doing research in multiple disciplines. On his way back, Hell stopped in Copenhagen for several months, presenting the main results of his expedition. Not until 12th August 1770 did he return to Vienna (ArchS 1c).

The entire expedition was financed by the authorities in Copenhagen, and Hell had been invited in the name of the King himself. But why, one may ask, did a world-famous astronomer leave his high standard observatory in Vienna to go to a remote corner of the civilised world? And how did it come about that he, a Jesuit, was invited, and sponsored, by the Protestant King of Denmark and Norway, whose laws forbade the presence of Jesuits?

The key to answer both these questions lies in the 18th-century transits of Venus. On 5th June 1761 and 3rd June 1769, the planet Venus passed in

front of the Sun as seen from Earth. This rare phenomenon attracted massive interest from the entire world of learning. The principal reason was that transits of Venus could be used to compute the distance between Sun and Earth, and indeed the scale of our entire Solar system. A prerequisite for success was that skilled astronomers observed the event simultaneously from stations far apart. This would reveal tiny shifts from which the astronomical unit could be deduced (e.g. Woolf 1959, Sellers 2001, Verdun 2004, Marlot 2004).

In 1761, hopes were that a few temporary stations in Siberia, the southern Atlantic, and the Indian Ocean, combined with the traditional European observatories, would provide the necessary data to settle the problem. For various reasons, however, the expected accuracy could not be attained. First and foremost, the crucial stages at the beginning and end of the transit turned out to be more difficult to determine than expected. This meant that, in 1769, observers should spread themselves even further apart. Conditions were better this time. The 1761 transit had taken place in the midst of the Seven Years' War, in which the leading nations of astronomy, France and Britain, were opposing each other. In 1769, peaceful conditions made travelling easier. Besides, the astronomical community had achieved valuable experience from the previous transit, and was prepared to face observational difficulties that had come as a surprise the last time. However, the transit of 3rd June 1769 was predicted to take place in the middle of the European night. Accordingly, it was necessary to travel to the realm of the Midnight Sun in order to catch the entire duration of the transit from European soil. This gave Denmark, along with Sweden and Russia, strategic advantages.

Denmark was a country with proud traditions in astronomy. It had, after all, hosted Tycho Brahe on the island Hven in the 16th century, during those years when he lay the foundations for modern astronomy. And already in 1642 the world-famous Rundetårn (Round Tower) Observatory was erected in Copenhagen, one of the first permanent observatories of Europe, decades before Paris and Greenwich. Denmark's strategic position in the North, with Norway in its possession ever since 1380, should have given occasion to some very interesting observations in 1761. That year, at least 120 individual observations from more than 65 places contributed to the project of finding the solar distance (Woolf 1959, pp. 135-149). Of these 120-odd successful observations, at least 20 were made in Sweden (including modern Finland), but only 3 in Denmark-Norway. Furthermore, the publicity of the Swedish observations was very high. Reports were published not only in Swedish (and German) in the proceedings of the Royal Academy of Stockholm, but appeared also in French, Latin, and English in the leading scientific journals abroad (see the issues of *Kongl. Vetenskaps Academiens Handlingar*, *Knigl. Schwedischen Akademie der Wissenschaften Abhandlungen*, *Histoire de l'Académie Royale des Sciences*,

Journal des Sçavans, *Philosophical Transactions of the Royal Society of London*, and *Ephemerides Astronomicae ad Meridianum Vindobonensem* from this period). In contrast, apart from vernacular reports, only a tiny two-page notice on Danish and Norwegian observations appeared in the *Mémoires* of the French Academy of Sciences and an anonymous Norwegian observation was included in the *Philosophical Transactions* of London (Lalande 1763, Short 1763). Not much to boast about!

As the 1769 transit approached, Sweden again made large-scale preparations. The Swedish King granted extra financial support to the Academy of Sciences already in February 1767, $2\frac{1}{2}$ years ahead of the transit. Observations were to be made from three sites in the northernmost parts of Sweden and modern Finland, where two stations had been manned in 1761 (Nordenmark 1939, pp. 175-192).

On the Russian side, activity had been limited in 1761, with only two expeditions sent into Siberia and a handful of observers observing from private homes in St. Petersburg (Woolf 1959, pp. 118, 188-189). This picture was changed for the 1769 transit. In March 1767, the Russian Empress Catherine the Great ordered the Imperial Academy of Sciences to participate extensively in the international project (Rumovskiy 1771, p. 5). Eight expeditions was the result. Four of these were to be sent to the North-East of the Russian Empire, close to the borders with Norway and Finland (in the final event, only three sites in the north were reached; Rumovskiy 1771, pp. 21-23, 35-36).

Thus, the Swedish and Russian preparations were already well advanced in the first part of the year 1767. Leading astronomers abroad, such as Joseph Jérôme de Lalande in Paris and Nevil Maskelyne and James Short in London, became involved as encouragers, advisors, and intermediaries for placing orders at the instrument makers' (Nordenmark 1939, p. 186; Rumovskiy 1771). It is not known whether similar letters of encouragement were received at the Royal Academy of Sciences in Copenhagen, whose archives from this period are sadly incomplete. However, we may assume that the academicians did notice what was going on around them. Already Edmund Halley, who had presented an elaborate plan of how the transits of Venus could be used to determine the solar distance back in 1717, had pointed to northern Norway as ideal for observations (Halley 1717). And early in the 1760s, Lalande had issued a mappemonde for the transit of 1769. In the graphical lay-out of the mappemonde as well as in an accompanying memoir, northern parts of Scandinavia emerged as an ideal region for observations (Lalande 1760; 1764). In 1766 a similar paper of the British astronomer Thomas Hornsby appeared in the *Philosophical Transactions* of London, in which a few places in the north of Scandinavia were explicitly mentioned - among them "Wardhus" (Hornsby 1766). France and Britain were already planning to send expeditions into America and the Southern Seas, plans

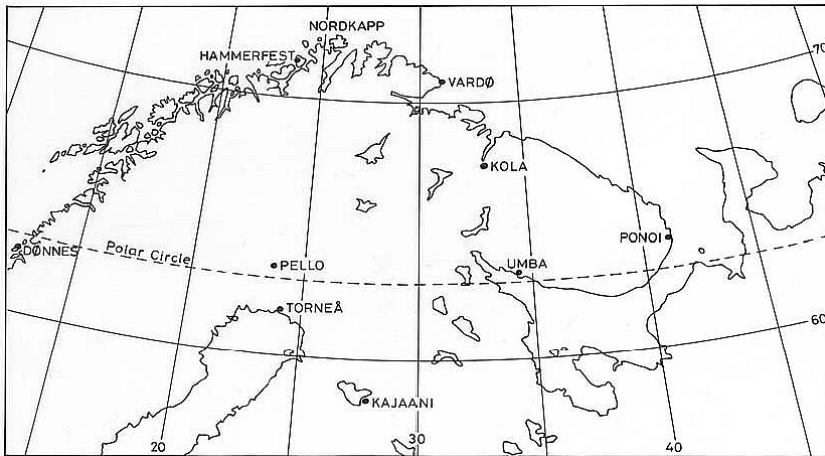


Fig. 1: Stages of the transit would be visible

which were to result in Captain James Cook's famous expedition to Tahiti, among others. Combined with observations from the Far North of Europe, these should settle the problem of the size of the solar system once and for all.

The British interest in the North of Europe is particularly revealing. The Royal Society of London at first contemplated sending observers all the way to Spitsbergen, but this idea was dropped, probably because the ice would prevent them from sailing anywhere near the island so early in the summer (Woolf 1959, pp. 168-169). What they did do instead was sending a naval frigate with around 100 men onboard, to bring two observers - and their observatories - to Hammerfest and Honningsvåg, a settlement in the vicinity of the North Cape (Bayley 1770, Dixon 1770; ArchS 2, letter from Hagerup dated Talvig 27th July 1769).

Figure 1 shows the stations in the part of Europe where - good weather provided - both the beginning and end stages of the transit would be visible. For the observers, it was ideal to be stationed as far north as possible, as the Sun would then be higher above the horizon, preventing vapours from disturbing the observation. The British observers, William Bayly and Jeremiah Dixon, have already been mentioned. The Swedish observers were Anders Hellant in Torneå, Fredrick Mallet in Pelleo, and Anders Planman in Kajaani (Wargentin 1770). The Russian Academy of Sciences organised expeditions by the Russian astronomer Stepan Yakovlevich Rumovskiy to Kola and the Swiss astronomers Jacques-Andr Mallet and Jean-Louis Pictet to Ponoï and Uмба (Rumovski 1770, Mallet 1770, Pictet 1770). Furthermore, the Danish observers Peder Horrebow the Younger and Ole Nicolai Bützow were sent out in spring with

orders of reaching Tromsø, but were forced to station themselves further south at Dønnes due to bad weather (ArchS 3; ArchS 1c, entries 30th June & 14th-20th August 1769).

The village Vardøhus (or Vardø as it is now called) lay on a small island on the extreme north-eastern coast of Norway. For ages a fortress and a Danish garrison had been situated here. It thus was a natural place to single out on the maps, more so than the larger towns of Tromsø, Hammerfest, and Vadsø today. There were, indeed, no proper towns in the entire region of North Norway at the time, the first communities to be granted township being Vardø and Hammerfest, in 1789. Vardøhus was an outpost of civilisation, so to speak, in the vast and sparsely populated region of Lapland. When planning how they were to participate in the international project, the government in Copenhagen obviously saw the importance of being present at this site. What they lacked, however, was a qualified observer of international reputation. The reasons why they chose Hell are not revealed in any known document. A brief glance at Hell's career prior to 1769 may, on the other hand, hint at some likely causes.

In 1755 Father Hell had been appointed Imperial and Royal Astronomer of Vienna. His first task had been to lead the construction of the Vienna University Observatory. From the year 1756 onwards he had been issuing the *Ephemerides Astronomicae ad Meridianum Vindobonensem*. This annual publication included not only tables for the rising and setting of the sun, the phases of the moon, and other standard elements of astronomical almanacs - it was also an international journal of astronomy, in which papers on various subjects were published in the form of appendices. In the volume for the year 1762 Father Hell included a paper of 123 pages, with the title "Observation of the Transit of Venus in front of the disc of the Sun on 5th June 1761, and an Appendix of Several Other Observations" (Hell 1761). The paper describes not only the Venus-transit observations of Father Hell and his colleagues in Vienna. It also gives an impressive overview of observations made by astronomers in other parts of the Austrian Empire and abroad. Letters and printed reports had reached Father Hell from St. Petersburg to Madrid, from Paris and Rome to Göttingen and Heidelberg. This paper was published only months after the transit, and it is intriguing to notice that it was compiled by a man who had been named court astronomer only six years previously. In fact, for many of the approximately 120 successful observations of the 1761 transit, Maximilian Hell's *Ephemerides Astronomicae* is now the only source of information. Another publication worth mentioning in this context is Hell's excellent refutation of the so-called "moon of Venus", published both separately and as an appendix to the *Ephemerides Astronomicae* (Hell 1765). The series received a good press abroad (see for example the review in *Journal des Sçavans*, Octobre 1761), and was no doubt the main vehicle for spreading Father Hell's reputation. As the

Berlin astronomer Johann Bernoulli exclaimed (Bernoulli 1771, p. 154), "Quel est l'astronome qui ne connoisse pas les excellentes Éphémérides de Vienne?"

It should not come as a big surprise, then, that Maximilian Hell was seen as an ideal candidate for the Danish authorities. A Jesuit, yes, but Jesuit astronomy was known to be at the very top level, and in this case, that counted more than the letter of the Law. On 18th August 1767 a message was sent from the government in Copenhagen to Johann Friedrich Bachoff, the Danish ambassador in Vienna. The astronomer Hell was to be invited to travel to Vardøhus in order to observe the transit of Venus on behalf of the King of Denmark and Norway. The meeting between Hell and Bachoff took place 5th September. Two days later, Bachoff sent a message back to Copenhagen that "le Père Hell" had accepted the invitation and would indeed travel to Vardøhus, provided the Empress Maria Theresia and the General of the Jesuit Order would allow him to do so (ArchS 4). In his own writings, Father Hell says the invitation came as a total surprise. He had already declined two similar offers to go abroad to observe the transit of 1769. But why should the authorities of Denmark, a Protestant country of the North, invite a member of the Jesuit order to witness the transit? This could be nothing other than the work of Divine Providence. Placing his fate in the hands of God, Maximilian Hell decided to say yes during the very first meeting with the Danish ambassador (ArchS 1d, second draft, § IV).

The journey took Father Hell away from Vienna for 2 years and 3 $\frac{1}{2}$ months. It was a long and strenuous journey, but Hell made it even longer by staying in Vardø the whole winter before the transit took place, from 11th October 1768 to 27th June 1769. Immediately upon his arrival in Vardøhus, Father Hell started constructing a small observatory as an annex to the building he was to live in for the next 8 $\frac{1}{2}$ months. The observatory was constructed entirely by wood. But there were no trees growing on the Vardø Island, nor on the mainland nearby. The necessary timber had to be collected from the Norwegian inland, approximately 100 km to the south. After several practical problems, the little observatory was finally ready for use just ahead of Christmas (ArchS 1c). Father Hell and his assistants could spend the rest of the winter and spring making research in various fields as well as preparing for the transit itself.

There is no room here to describe all the activities of Hell and his assistants during their stay in Vardø. The aurora borealis was one branch of their research, and Father Hell later published a "New Theory of The Northern Lights" based entirely on his experiences from Vardø (Hell 1776). Meteorological observations with thermometers and barometers were also scrupulously noted from their arrival until they left the island (Hell 1792). Marine life was investigated and plants collected. The plants were delivered to Copenhagen, and contributed to the work *Flora Danica*, an inventory project of all the plants growing in Denmark and Norway which had just started (Kragemo 1968). Furthermore,

theories on whether the sea level was rising or sinking were tested (Kragemo 1960). The declination of the magnetic needle from true North was recorded repeatedly (ArchS 1b, Aspaas & Hansen 2007). Hell's Hungarian-speaking assistant, Johannes Sajnovics, interviewed the indigenous population and found striking affinities between their language and his own vernacular. The result was published as "Demonstration that the Hungarian and Lappish Language is the same", now a classic of Finno-Ugric linguistics (Sajnovics 1770). When travelling through Norway on their way back and forth, Hell and his assistants conducted research in many of the same fields. Father Hell also did a series of latitude determinations during the journey, which contributed to a project of cartography that had just started in Denmark and Norway (Hell 1770b; 1790). Even though Hell did not manage to publish all the results of his expedition (cf. Hell 1770c), it should be obvious that had he missed the transit of Venus, he would in any case have made a large contribution to the knowledge of the northernmost parts of Europe. It is worth noting that his observatory was actually the first of its kind on Norwegian soil. After Hell's expedition it was used for some years by Danish astronomers - the above-mentioned Btzow and his assistant Ole Nicolai Giørup - but nothing comparable to the achievement of Father Hell was produced (Kragemo 1968).

On the evening of 3rd June 1769 Hell and Sajnovics, both trained astronomers, directed their telescopes towards the Sun. The third observer was the Norwegian Jens Finne Borchgrevink, a student of theology who had also studied natural history under Carl von Linné (Linnaeus) in Sweden. The odds were against them. The Arctic Ocean often produces thick fog when the Sun is shining in the summer months. What begins as a wonderful day can suddenly be ruined by thick fog, causing the temperature to drop rapidly and leaving no room for astronomical observations. 3rd June 1769 was another of those cloudy days. However, the Sun did peep through the clouds occasionally, and as luck would have it, two such periods of clear view to the Sun arrived exactly at the beginning and end of the transit. All three observers obtained complete observations of the key moments of second, third, and fourth contact of Venus with the limb of the Sun. By sheer luck, the sky continued to be clear the next day, when a solar eclipse was taking place. This event was almost as important as the transit itself, for by comparing observations of solar eclipses at different stations, the longitude could be deduced. With the exact data of the beginning and end of the transit as well as the latitude and longitude coordinates for his station secured, Hell's expedition had been a downright success.

Among the ten observational sites in the high north of Europe, there were only three where the beginning and end stages of the transit had been visible; clouds spoiled all the other observations. Rumovskiy and his assistants in Kola managed to catch the moments of contact between Venus and the limb of the

Sun through dim clouds, but Rumovskiy himself appears to have had his doubts as regards to the reliability of his observation (Rumovski 1770). Planman in Kajaani, however, observed the second and fourth contact, and was convinced of the accuracy of his data despite the fact that the Sun was very low at this latitude (Planman 1772). Both the Swedish and the Russian academy of sciences sent their data without delay to the person who served as the informal coordinator of the international Venus-transit project, Lalande in Paris. Father Hell, however, even though he was a corresponding member of the Paris Academy, refrained from reporting anything to Lalande until he had presented his observation to the King himself. The printed report "Observation of the Transit of Venus on 3rd June 1769, made in Vardøhus upon the orders of King Christian VII" (Hell 1770a) was finally presented to the King on 8th February 1770, more than 8 months after the transit had taken place (ArchS 1c). Only then were the data distributed to Academies abroad, among them the Academy of Paris. By that time, however, Lalande had already started computing the solar distance on the basis of the observations he had received so far, and could not get the Vardø observation to fit to the picture. We know today that the Vardøhus data were reliable, whereas clouds and other atmospheric disturbances had rendered the Kajaani observation inaccurate. But this was not obvious to contemporary astronomy. A long and arduous debate followed, with members of the academies in Paris, Stockholm, and St. Petersburg contributing (Lalande 1772, Planman 1772, Lexell 1772). Hell defended his data fiercely in two monographs (Hell 1772; 1773). He also sent numerous letters asking for support from colleagues abroad (Pinzger 1927; ArchS 5). In the end, even Lalande had to adjust his computation of the solar distance to a figure closer to the one computed by Hell. And in a publication written after the latter's death in 1792, Lalande describes the Vardø expedition thus (Lalande 1803, p. 722):

"l'observation du P. Hell [...] réussit complètement; [...] elle s'est trouvée, en effet, une des cinq observations complètes, faites à de grandes distances, et où l'éloignement de Vénus changeant le plus la durée du passage, nous a fait connaître la véritable distance du soleil et de toutes les planètes à la terre; époque remarquable dans l'histoire de l'astronomie, à laquelle se trouvera lié à juste titre le nom du P. Hell, dont le voyage fut aussi fructueux, aussi curieux et aussi pénible que ceux de la mer du Sud, de la Californie et de la baie d'Hudson, entrepris à l'occasion de ce célèbre passage de Vénus sur le soleil".

The Venus transit observation of Father Hell and his assistants in Vardø has been subject to studies by mathematically trained scholars over three centuries. After all the antagonists of the 18th century had passed away, the debate on Hell's contribution rose again (e.g. Encke 1824, Littrow 1835, Faye 1869a; 1869b), but ever since late in the 19th century the Vardø data have been established as entirely reliable (Newcomb 1883, Nielsen 1957). Both in the short run

and in the long run, therefore, the authorities in Copenhagen achieved exactly what they wanted - to gain publicity as proponents of science.

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