

PARAMETERS in a
calculation performed
by astronomer
Karl Bohlin.

$$\begin{array}{r}
 \text{lg } 9.8065 \\
 \text{g} \leftarrow 0.6405 \\
 \hline
 (\text{m}) + 0.3449 \\
 (\text{p}) - 0.1505 \\
 \hline
 \times + 0.1937 \\
 \hline
 \rightarrow \times 9.2871
 \end{array}$$

$$\begin{array}{r}
 (\text{m}) + 0.1866 \\
 (\text{p}) - 0.0596 \\
 \hline
 (\text{x}) + 0.0281 \\
 \hline
 \pi + 0.0831 \\
 \hline
 \rightarrow \pi 8.9196
 \end{array}$$

Calculation work

Gustav Holmberg

Calculation work at the typical astronomical observatory in the years around 1900 was largely performed by the younger astronomers. Astronomy has always been a calculation-heavy activity – observations must be reduced, comet courses calculated, theoretical models clothed in numbers – and these calculations were, to some extent, carried out by senior astronomers, but mainly by astronomers at the start of their careers. For many budding astronomers, basic studies in astronomy were followed by a few years' work as an assistant, a position that entailed managing many of the daily tasks at an astronomical observatory. Calculations comprised a significant part of this.

The Academy of Sciences ran an observatory that was typical of the times. In addition to the Academy's astronomer, who was also the observatory's director, a number of assistant astronomers worked there. A staff register for the years 1739–1915 includes 16 such assistant astronomers, working under the directorship of Hugo Gylden and Karl Bohlin. Of these, seven continued to work as astronomers, three went on to become academics in organisations and disciplines other than astronomy (observer at the Geographical Survey Office of Sweden, professor of geodesy, geophysicist/historian of science), and six went to work in schools. Most of the seven who remained in astronomy moved up through the hierarchy after a few years as assistant astronomers at the Stockholm Observatory – the exception is Ansgar Roth, who had a career as a type of science journalist. One became head of the Pulkovo Observatory, one of the biggest observatories of that time, three became professors of astronomy – in Lund, Uppsala and Stockholm – and one worked for many years as an astronomer at the renowned Mount Wilson Observatory in the USA. The pattern remains if the population is expanded: many Swedish astronomers worked as calculation assistants for a few years. It is clear that a position as an assistant at an observatory could be the final stop

before the person left astronomy, or a temporary stop before advancing. The work itself was perhaps monotonous – Vilhelm Carlheim-Gyllensköld consistently uses the phrase “calculating stooge” when he describes life as an assistant in his letters – but it was an important part of astronomical activities, and can hardly have been considered *déclassé* when so many of the era’s leading astronomers started their careers at the calculating desk.

But times change. While the Academy of Sciences’ observatory largely relied on assistants with an academic background when it came to calculations, Lund Observatory became a trailblazer in the modernisation of astronomical calculation practices. Historian of science Andrew Warwick has argued that the time’s calculation-heavy science was affected by techniques that had primarily been developed outside of science. New calculation technologies, such as mathematical tables and mechanical calculating devices, were not primarily developed for scientific purposes, but rather for reasons that must be sought in wider circles: in business and bureaucracy. Another non-scientific historical process that affected the modernisation of astronomical calculation technology was the changes to the labour market that came about when public bodies and private businesses began to employ women, for example as telephone switchboard operators and secretaries. It was this combination of mechanical calculating machines and inexpensive female labour that Lund Observatory took advantage of just after the turn of the last century. This was where the women in the picture on the next page, taken outside the observatory in around 1914, entered the history of Swedish astronomy.

In Lund Observatory’s annual report for the academic year of 1906–1907, its director, Carl Ludvig Charlier, discusses the observatory’s activities from the perspective of resources. The building from 1867 housed several telescopes, as well as workrooms, the library and other activities. There was a need for better and larger premises as well as improved staffing. Specifically, Charlier believed a new category of employees should be added to those already working at the observatory. He wanted to employ permanent computers, people who were not trained astronomers. Charlier emphasises that a large part of the work of astronomical research comprises “calculation procedures of purely elementary type, which every person with ordinary schooling can easily learn to do”. If these elementary calculations must be performed by an astronomer, work progresses very slowly, “and his interest in the performance of such investigations shall be greatly reduced. It is therefore an indefensible waste of effort if one neglects to make such elementarily trained computers available to the astronomers.” Charlier thus proposed the employment of non-astronomers as computers, pushing for funding for their wages; he also applied for funding for a new building that would encompass a “calculating bureau” and the observatory’s library. Charlier was very clear



about what the sex of such a “person with ordinary schooling” should be, when he argued that funding for these computers should be included in the university’s requests for funding from the Riksdag:

Fortunately, the recent invention of practical calculating machines allows the use of relatively cheap labour – women with ordinary school education and a propensity for numerical calculations could perform a great deal of the required work.

Charlier’s funding applications were successful. The observatory received resources for employing five computers and, in 1911, the Riksdag also granted funding for a new building. This building, the exterior of which in no way reveals that it is an astronomical institution – it has no domes – had a large calculating section on the lower floor. This was an important scientific resource for the type of astronomy that was Charlier’s specialism: stellar statistics, work that analysed observations made at other observatories. A letter from Axel Corlin in 1921, when he had recently been employed as an assistant, provides a glimpse of the atmosphere in the calculating section. As an assistant, Corlin was to perform standard tasks, such as calibrating the observatory’s clock, alongside working on his licentiate degree. Throughout he uses terms such as “office”, “office manager” and “clerk” to describe the daily work of the section. Corlin and another younger astronomer worked in a smaller room with a door that “is open on the big room in which 5 women each sit at a desk and count and write – the discipline there is just like an office; they may of course talk to each other, but preferably not without due cause”. The calculator section, with its computers and mechanical calculators, had significantly increased the astronomical calculation capacity at Lund Observatory, but for Corlin, who had previously worked at Uppsala Observatory, it felt as if something had been lost: “the sense of a free student will slowly be reduced after some time here”. Charlier, Corlin writes, regularly checked the computers’ work and would reprimand them if they filled in the columns of figures incorrectly – a way of working and an atmosphere that also spread to the treatment of the assistants.

Unlike the assistant astronomers with scientific training, the computers were not recorded in any registers; they are more difficult to see up close, at least with the available material. In 1927, all five employees had completed degrees from teaching colleges – so they were better educated than the original plan’s computers with “ordinary schooling” – and three of them were permanently employed and placed on salary grade B4. Their monthly pay packets were 135, 131 and 114 kronor, plus “expensive time supplements”.

COMPUTERS at the observatory in Lund, around 1914.

The only name that occurs somewhat regularly in the material is that of Elin Bruzelius, who was the first computer to be employed. She worked there for a long time and had some overarching responsibility; Corlin calls her the “directress” in the abovementioned letter. The tone of the only letter from her to Charlier in his archive is extremely formal; at that time, they had worked at the same institution for 19 years.

Lund was first in Sweden to employ female computers in astronomy on a significant scale, but was hardly unique internationally. In some places there were female computers with academic qualifications; for example, the Harvard Observatory had a large number of assistants, some with doctorates in astronomy (unlike Sweden, in the second half of the 19th century there were women with doctorates in American astronomy), but often it was like Lund, non-academic labour. The women in the picture on p. 484 belong to the changed forms of work in Swedish astronomy, a century ago. Lund Observatory thus handled its numeric processing differently to the observatory at the Academy of Sciences. Without these women, some of Sweden’s biggest – in working hours – astronomical calculation projects in the early 20th century could hardly have been completed.

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Some interiors from the Academy of Sciences’ observatory and glimpses from Vilhelm Carlheim-Gyllensköld’s work as “calculating stooge” are found in Anders Carlsson & Gustav Holmberg, “Vilhelm Carlheim-Gyllensköld på Stockholms observatorium”, *Lychnos*, 1995. Andrew Warwick has discussed calculation work in “The laboratory of theory or what’s exact about the exact sciences?” in M. Norton Wise (ed.), *The Values of Precision*, (Princeton, 1995); the theme is also covered in David Allan Grier, *When Computers Were Human* (Princeton, 2005). Charlier’s stellar statistics research programme is discussed in Gustav Holmberg, *Reaching for the Stars: Studies in the History of Swedish Stellar and Nebular Astronomy, 1860–1940* (Lund, 1999). Archival material from Carl Charlier’s and Knut Lundmark’s archives in Lund University Library has been used.