Victorian Era Astronomy: On Land and In the Skies

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In 1899, Dorothea Klumpke boldly declared that astronomy "knows no boundaries, no rank, no sex, no age!"[1] Today one would say that Klumpke proclaimed a discrimination-free astronomy, which from a modern point of view is irritating, to say the least. Certainly, everyone can think of a female scientist of the 19th century, for example, Marie Curie, but it seems presumptuous to speak of an equal scientific enterprise of the time in terms of gender since it cannot be doubted that the number of male scientists far exceeded that of female scientists. The same applies with regard to the rank mentioned because within scientific institutions there was and still is a hierarchy that is also associated with a clear power imbalance, for example between professors and doctoral students. In short: Klumpke's assertion does not seem very tenable.

The question therefore arises as to how Klumpke came to assert completely egalitarian conditions in astronomy. Of course, we cannot exclude the possibility that to a certain extent, wishful thinking was the origin of the idea. But it also cannot be dismissed that her statement is probably based, at least in part, on the fact that there were few sciences in which there existed so many opportunities to contribute to current research for such a diverse group of people.

In this lecture, I would like to devote myself to two groups of such people, the so-called amateurs and women, two groups to which Dorothea Klumpke also belonged. I will argue that it was precisely the diversity of astronomical research of the time that opened up opportunities for participation for people who were otherwise outsiders in science - in a cornucopia of research approaches, beliefs about what astronomical research should ideally look like and who should be involved, but also opportunities to actually do astronomical research, several niches could be exploited. At the same time, it will become obvious that the astronomical world of opportunity promised by Klumpke was about to become a part of the past and the doors began to close steadily for those who had not followed the soon-to-be-standardised path of an academic career.

Klumpke's biography, which can be described as extraordinary in every respect, will serve as a central theme. Her parents were of German descent but had met during the gold rush in San Francisco, where the father had relatively soon realised that the big money was to be made from building and selling real estate rather than from the laborious and often futile prospecting for precious metals. The resulting fortune was used from the outset to give all the children an excellent education, including not only Dorothea, who was born in 1861 but all five of their daughters - at a time when few girls were allowed to enjoy more than elementary schooling, all five received an academic education; Dorothea's elder sister, Augusta Klumpke, probably the best known of the five, was to devote her life to medical research and later, in collaboration with her husband Jules Déjerine, lay important foundations in the emerging field of neurological research. Dorothea, like her sister Augusta, took up her studies in Paris, where their mother had settled after their parents divorced, ostensibly to live in a city where there were offers for the interests of all her children. But unlike Augusta, Dorothea chose to study mathematics, obtaining her degree in 1886, after which she turned to a new discipline: Astronomy.

Her career began at the Paris Observatory and in the following, we will confine ourselves to this phase of her life, even though she was to continue astronomical research for several decades afterwards, since the

[1] Klumpke, 1899b, p. 299.

essential points I would like to discuss today are already apparent here. We begin in 1886, the year in which Dorothea Klumpke, who was also to be awarded her doctorate about a decade later, received her university degree. In the same year, she began to use one of the telescopes at the Paris Observatory for her research. But Dorothea Klumpke was by no means employed at the observatory. Rather, she was on site as a so-called amateur, a term closely related to that of professionalisation, a process that permanently changed science and the way knowledge was generated.

Amateurs and the Professionalization of Science

It is hardly surprising that the professionalisation of the sciences and humanities over the course of the 19th century, as one of the most drastic changes on the way to the formation of the modern research community, has long been a much-discussed topic among researchers from various disciplines. Yet a review of the literature, not only on professionalisation in the natural sciences but in general, reveals one thing in particular: the term seems to have eluded a generally accepted definition so far. Coming from the so-called exact sciences, such a situation always causes a kind of discomfort. We assume that all the concepts we use can be determined by an exact, universally valid definition (unless they have been introduced axiomatically, of course), but this is only possible because in mathematics, for example, we have full control and can determine the setting (that is, the environment in which the definition is to be valid) if, for example, we restrict the domain of definition to the natural numbers or explicitly exclude some cases, such as dividing by zero.

In history, however, the circumstances in which certain phenomena occur at given times, in different geographical locations, institutions or other contexts usually differ so much that it seems impossible to find a universally valid definition, which takes all idiosyncrasies into account. Therefore, I want to cheat a bit in this talk by not aiming for a complete definition of professionalisation. Instead, I will mention some essential aspects of professionalisation, limiting myself as much as possible to those that will be relevant in the following and which at the same time give a good sense of what is commonly encompassed by the term.

Professionalisation in the 19th century led to what might naively be thought of as a dichotomy, namely that between professionals and amateurs. Professionals are people who are paid for the scientific knowledge they acquire, whether they have a job in research, or whether they teach at schools, or even universities such as the Grandes Ècoles in France or colleges in the U.S.A. or England, where, unlike at German universities, the appointments did not usually include a research assignment. This scientific knowledge, which in the sciences included an increasing mathematization of the disciplines and esoteric language, was acquired at universities, where students were now instructed in independent scientific research in laboratories that had previously only served to prepare experiments by professors, or in seminars, and was concluded by official certificates awarded by the respective scientific community, such as the bachelor degree in science that Oxford and Cambridge introduced in the early 1850s, or the German doctorate. Opposite these professional researchers were the amateurs, whose research, contrary to what is seemingly implied by the term, was by no means necessarily of an amateurish nature.

In fact, a large proportion of scientists before the 19th century had been amateurs, and time and again amateurs were to have a lasting influence on science, for the difference that exists between the two groups from the point of view of historiography is not the quality of the work, but rather the circumstances in which that work is produced. Professionals are defined as people who had paid employment that enabled them to conduct research, whereas amateurs were not paid for their scholarly investigations. For this reason, some of the most eminent scientists of all time fall into the category of amateurs, at least for a time, because some, if not all, of their most groundbreaking work, was done at times when they did not hold research positions, including Isaac Newton, Charles Darwin, Nicola Tesla, or Albert Einstein.

But through professionalisation, the amateurs were successively ousted and only the professionals among the scientists decided from then on which scientific methods were permissible, which results were significant and they alone had the resources to generate them according to the rules they prescribed. The amateurs became people who pursued science as a hobby, reproducing the findings of professional scientists in a simplified manner, equally without influence on the progress of the discipline, as someone with a passion for astronomy observing the night sky through a simple telescope on his balcony nowadays.

The prime example of such a development is chemistry. On the one hand, it was the high economic interest in this science and the standards demanded by industry, and on the other hand, the establishment of theoretical foundations of the discipline in the 19th century that led to the need for ever more extensive knowledge, which could ideally be taught at universities. This is also where the laboratories were found that

had the increasingly extensive and sophisticated equipment needed for the practical part of training as a chemist and for conducting cutting-edge research. Nothing illustrates the success of this model better than the chemical schools around Justus Liebig and Robert Bunsen that emerged in Germany in the 19th century and came to dominate chemical research for a significant amount of time. The establishment of various chemical associations reserved for chemists in research at universities and industry also reinforced the schism between professionals and amateurs, so that the number of the latter rapidly fell to zero. Other sciences withstood professionalisation for a relatively long period. The best-known example is ornithology, where amateurs dominated until the middle of the 20th century, and where they still play a much more important role in the increase of scientific knowledge than in other sciences (Greenwood 2007).

Somewhere between the developments in chemistry and ornithology stood those in astronomy towards the end of the 19th century, where professionalisation was clearly on the rise, but where there remained a fair share of amateurs, although much fewer than in the past. In the course of this talk, we will meet some of them, amateurs, who devoted themselves to research without employment and without salary and who received recognition from the scientific community for their results, even though it should not be withheld that this recognition declined significantly in the course of time and that the professionals would eventually claim sovereignty over research methods by which scientific knowledge was created. But first, I would like to touch on two important points related to Klumpke's time as an amateur at the Paris Observatory. Because, so far, one important question has not been answered, namely why she was allowed to use the equipment actually intended for professional astronomers in the first place. First, she specifically asked for permission to use a telescope that was hardly used due to its poor condition, as the lens was damaged, and it could only be moved with great effort due to an improper suspension. Moreover, she was already known to the astronomers of the observatory, having attended the Ècole d'Astronomie for some time, which brings us back to the subject of the still incomplete professionalisation of the astronomy of the time.

Founded in 1878, the Ècole d'Astronomie served two purposes. On the one hand, the focus was on training future astronomers in the use of the latest instruments, because an important aspect of professionalisation had not yet been achieved. There was essentially no certified way to become an astronomer. Of course, astronomy had been part of the so-called quadrivium, the basic mathematical training that all students at the first universities of the Middle Ages had to complete for their bachelor's degree, and it has had a fixed place in the teaching canon at many universities ever since; at the Sorbonne, for example, there was a chair of both mathematical and physical astronomy at the beginning of the 19th century.

But this did not mean that fully trained astronomers left the university. In fact, around the middle of the 19th century, we still find numerous individuals, whom we refer to as "Quereinsteiger" in German, people who, according to the translation, complete a lateral career move, who change into a (possibly new) professional field without having gone through the classical training process, but who have acquired the relevant knowledge by other means. Take for example Urbain Le Verrier, who at various stages of his life held both of the aforementioned chairs at the Sorbonne and presided over the Paris Observatory, and who successfully predicted the existence of Neptune in the mid-1840s based on calculations of Uranus' orbital perturbations before it had even once been seen through a telescope, had spent some time at the Ecole Polytechnique but received his degree from the Ècole des Tabacs, where he had prepared for work in the tobacco industry (Lequeux 2021). Among the renowned American astronomers of the time are many who had only a bachelor's degree, as well as those like Samuel Langley, who headed several well-known observatories in the USA and later also made a name for himself in the field of early aerodynamics research, but who only had a high school diploma (Lankford 1997). Friedrich Wilhelm Bessel, who was Professor of Astronomy at the Königsberg Observatory from 1810 and whom none other than Alexander von Humboldt described in 1850 as the greatest astronomer of the 19th century, had even dropped out of school at the age of 14 because of his dislike of Latin lessons.

Although the number of astronomers who came from at least related fields such as mathematics, physics or engineering increased over the course of the century, they too had often heard no more than the odd astronomy lecture (and this did not imply that they had necessarily looked through a telescope themselves even once). At the Ècole d'Astronomie, such people could be taught how to use telescopes and other astronomical instruments, which is why we can understand it as an institution of professionalisation, a place where education within a discipline was to be standardised in an academic way.

Interestingly, the second task of the Ècole d'Astronomie was diametrically opposed, namely to also give the public, more precisely, "people who wish to teach science, for travel or who have a taste for astronomy" the

opportunity to acquire the basic knowledge and skills in the use of astronomical instruments."[2] It was possibly her visit to the École d'Astronomie in the 1880s that established the first contact between Dorothea Klumpke and the astronomers of the observatory. In any case, she seems to have left a lasting impression, because in the last months before the school closed for financial reasons in 1885, she taught there herself. Three years later, she was given permission by the observatory to use the aforementioned telescope, which was only functioning in a very limited way, as an independent scholar from the astronomical school ("élève libre de l'École d'Astronomie").

From a historical perspective, it seems almost inconceivable that Dorothea Klumpke was given this permission. There were indeed a significant number of women who made their own observations, but these were found almost exclusively among the amateurs. Not infrequently it was fathers, husbands or, as in the case of Caroline Herschel, her brother, William Herschel, who taught the women how to use telescopes. Allegedly, Herschel, who was best known for his discovery of Uranus, gave her a simple telescope because she was bored with him watching the sky in secluded Bath, whereupon she immediately made discoveries of her own. Mary Acworth Orr Evershed made the acquaintance of the Australian astronomer John Tebbutt and was thus caught up in the enthusiasm for astronomy, later publishing not only the first star catalogue of the southern hemisphere but also the astronomical references in the work of the medieval poet Dante (Alighieri). Let me mention Maria Mitchell as a final example, who received her first instruction in the use of astronomical instruments from her father, an amateur astronomer. While she began her career as an amateur, she later directed the observatory at Vassar College that bears her name today. And indeed, this made her one of the few women who were actually paid for astronomical research.

In the United States, just as in the UK, women's studies had taken a different route than in the co-educational universities of continental Europe. At the women's colleges that had been specially established there, women were indeed occasionally employed as lecturers, a position on the lowest rung of the hierarchy ladder that was generally understood to be only a teaching position. A major exception was the observatory at Vassar, where first under Mitchell, who had been hired there in 1865 as the first female astronomy professor, and then under her former student Mary Watson Whitney, numerous women pursued astronomical research with ocular in hand and published their results in scientific journals.

But at continental European observatories in the long 19th century, the instruments were only available to professionals, i.e., permanently employed astronomers, and the odd rich amateur stopping by for a visit, and all of them were invariably men. I don't think it surprises anyone when I state that science at that time was as hegemonic as it was patriarchal and that, with a few isolated exceptions, women were not given jobs for research in professional science. In terms of astronomy, this meant in particular that women were only allowed to observe under special circumstances, which in my opinion included the women's colleges in the USA. At the Paris Observatory, as far as I know, it was Edmée Chandon who was the first woman after Klumpke to gain access to the telescopes, and here, too, extremely special circumstances had a favourable effect, more precisely the outbreak of the First World War. Due to the lack of male astronomers, which was also prevalent in the years after the war, as many graduates of the grandes ècoles, from which new astronomers were normally recruited, had died on the battlefields, she was also employed for observational work, together with Rose Bonnet, who had come to the observatory as a trainee in 1919, by the then director Benjamin Baillaud. Baillaud was enthusiastic about the abilities of both women, so Baillaud was promoted to astronome adjointe in 1927 and Bonnet even became the first woman at the Paris Observatory to become astronome adjointe in 1924. Regrettably, however, she had to give up this post in 1941, as the Vichy government was pushing women out of the profession and had decreed, among other things, that women over 50 were not allowed to work. Her position went to Baillaud, who was nine years younger, in 1945.

It would therefore be presumptuous to speak of a specific point in time when women gained access to formal research positions at observatories, but it can be stated with certainty that this was hardly possible during the long 19th century. But outside of research, there was indeed a certain position, especially at observatories, where women were not infrequently among the preferred candidates and for some of them this opened up unforeseen opportunities.

[2] ("personnes qui se destinent à l'enseignement des sciences, aux voyages ou qui ont le goût de l'Astronomie") (Mouchez, 1879, quotation on pp. 18-19).

Women as Computers at Observatories

A fundamental change in astronomical research in the 19th century was the introduction of astrophotography. Photographs made observations possible under much worse conditions. They were also much more efficient, as a photo was taken faster than it took to note all the objects seen by hand. Moreover, photographs also showed objects that remained hidden during ordinary observations. Due to these advantages came a renewed interest in the creation of star charts, essentially directories listing the positions of stars in certain regions of the sky with the advent of astrophotography. One of these projects was the *Carte du Ciel*, launched on the initiative of the Paris Observatory and involving numerous observatories. Every night, numerous photographic plates were produced with images of the night sky, which then had to be evaluated and the data thus obtained was subsequently massaged so that the positions of the stars could be calculated. This task fell to personnel who, following the medieval tradition, were often called computers, a term stemming from the Latin word for “calculator”, although other names were also in use.

While mathematics, that is, mathematics involving axioms, theorems, and proofs, was understood to be a purely male discipline, women were seen as ideal candidates for such tasks. According to classical stereotypes, it was assumed that the entire nature of women was designed for motherhood and that they were therefore endowed by nature with the skills needed for it. Hence, it was assumed that women would exercise the same care, patience, and concern in calculating the positions of stars as they would in bringing up children. Since the job was also poorly paid, very repetitive, and not infrequently boring, astronomers were glad to find in the form of women a group of people who were also grateful to be offered it because of the otherwise poor job prospects in the scientific community. In Paris, Dorothea Klumpke headed the office specifically set up to evaluate photographic plates for the Carte du Ciel and at observatories in Toulouse, Helsingfors (now Helsinki), Greenwich, Adelaide, Sydney, Melbourne, Perth, Potsdam, the Vatican, and the Cape of Good Hope female computers were now tirelessly bending their heads over the glass plates on which the data, produced exclusively by men and finally interpreted by men, could be seen. In Paris, Dorothea Klumpke led this specifically for the evaluation of photographic plates for the Carte du Ciel.

Based on their job description, these women were only assigned a very specific section of the research process, namely that of preparing the data for the final evaluation, a process that was unquestionably of utmost importance but played only a subordinate role in the later presentation to the outside world. The women were seen in a sense as helpers whose contribution was only a contribution and not real research in the understanding of the time. But even though they had only limited resources at their disposal, some of these women nevertheless found ways to do research based on the materials they had access to. As a representative, I would like to mention only the most famous of them, Williamina Flemming, a single mother who first worked as a maid for Edward Charles Pickering, the director of the Harvard Observatory, before he gave her a position comparable to the one Dorothea Klumpke held at the Observatory in Paris. The Harvard Observatory was also working on a project for positioning stars, the so-called Draper Catalogue, and here, too, it was a woman, Flemming, who was ultimately in charge of the office for evaluating the photographic plates, which, too, was essentially made up of women. Based on the photographs she evaluated, Fleming not only devised a spectroscopic system for classifying stars, later improved by Antonia Maury, she also discovered ten novae, more than 300 variable stars, and 59 gaseous nebulae, including the Horsehead Nebula (Barnard 33).

It should not be denied, however, that she had to pay a price for this, which was not unusual for a woman in the 19th century. Indeed, her discoveries were not necessarily published under her name, in some cases she was listed as co-author with Pickering, while other articles appeared outright under his name. Commendably, however, it must be mentioned that Pickering always gave her the credit she deserved within the papers. And of course, her scientific successes by no means meant a rise in the scientific ranks of the time, as would quite likely have been the case with a man.

Still, she was appointed Curator of Astronomical Photographs at Harvard, obviously not a research position either, but in some ways a breakthrough, for no woman had held that position before her. Moreover, this position gave her continued access to her favourite research material - photographs of stars. Indeed, she was to publish in this post until her death in 1911, including her work on white dwarfs, which, incidentally, she had also been the first to discover.

In summary, the situation at observatories was ambiguous for women. On the one hand, they were able to find jobs in the scientific field there, but on the other hand, the state and university observatories clearly show how well-advanced the professionalisation of astronomy had come at the end of the 19th century. Here, access to the instruments was essentially granted to professionals. Although there were not yet any fully

formulated criteria that distinguished a professional, especially since there was no formalised training to become an astronomer, it can be cautiously stated that the link between official employment and the status as a professional already existed. Even though the women who worked at the observatories were by no means necessarily less educated than the men who worked there as astronomers - Dorothea Klumpke had not only graduated from the Sorbonne, but later even earned her doctorate in the natural sciences, and indeed had in-depth knowledge of telescopes from her time as an amateur - it was impossible for women to obtain these jobs. Therefore, there were hardly any prospects for women to conduct research at such observatories, even though examples like Williamina Flemming show that there were always women who managed to find a niche and produce their own results. Another option was to be employed at an observatory and do research outside in other contexts. This was the path Dorothea Klumpke took, working together with a very different kind of astronomer than could be found at the Paris observatory.

Balloons, Eclipses and Popularisers of Astronomy

Up to now, I have always spoken of "astronomy" as if it were a homogeneous field of research that was investigated by amateurs on the one hand and professional astronomers on the other. While there were also women among the amateurs, the professionals were either exclusively or predominantly men, depending on whether the women like Flemming or Klumpke, who had jobs at observatories that did not include a research assignment and did research in their free time, were considered professionals or not. But in fact, astronomy of the time encompassed a cornucopia of fields and as already indicated by the fact that I referred to the research staff at observatories as professionals, at least some tentative statements can be made about which of these fields professionals and amateurs could be encountered. To this end, I would like to discuss two types of expeditions, that Klumpke took part in, not as an official delegate of the observatory, but only with its permission, both illustrating how diverse the astronomical research landscape was at that time.

Dorothea Klumpke took part. The first expedition was a trip to observe the total solar eclipse in Norway in 1896, and I do not want to say much about the importance of observing such events for astronomical research at that time, as we will hear a detailed lecture on this subject in a moment. I will only briefly discuss the different groups of people who were present and set up their telescopes during such solar eclipses, but this only after I have talked about the second type of expeditions in which Dorothea Klumpke took part and which represents a perhaps lesser-known part of the history of astronomy.

Ever since the Montgolfier brothers introduced manned flight via hot air balloons in the eighteenth century, scientists began looking for ways to exploit this new technology for purposes of conducting research at higher elevations. In what is often considered to be the first phase of scientific ballooning, this research focused primarily on the study of the atmosphere itself, especially with regard to a possible decrease in the magnetic field force and the composition of the upper air layers. Afterwards, interest in scientific ballooning increasingly waned and by the middle of the 19th century balloons were mainly used for public spectacles, where showmen's families ascended to the cheers of the crowd gathered on the ground, and so-called extreme rides, i.e., rides to maximum heights or over the longest possible distances.

A completely new use of balloons then emerged after the Franco-Prussian War of 1870/71. After the Parisians had used balloons to transport people, supplies, or messages across the occupation lines of German-surrounded Paris, governments around the world discovered the potential of air travel for military purposes. In contrast, the astronomer Jules Janssen saw a completely different potential, they wanted to conquer the sky in a completely different way. Due to his numerous impressive achievements, including the development of the so-called Photographic Revolver (not infrequently referred to as the Janssen Revolver), with which many photographs could be taken in rapid succession, even of moving objects, as well as the spectroscopic discovery of an element that later turned out to be helium, Janssen would be appointed director of the newly founded Observatoire d'astronomie physique in Paris in the mid-1870s. In 1870, however, he was still employed as a physics professor at the École d'architecture and thus still part of the amateurs when he climbed aboard the balloon Volta to leave besieged Paris and thus observe a solar eclipse in the Mediterranean basin. He then began to advocate the use of balloons for astronomical research, more precisely as an aid to observing special celestial events by eye, as it seemed hardly feasible to transport sensitive and heavy telescopes or other heavy equipment on board. While Janssen was a strong proponent of balloon rides for astronomical purposes, his flight from Paris seems to have left lasting impressions of the negative kind, as he never boarded a balloon again. Instead, he invited other astronomers to make the trips for him, including Dorothea Klumpke, who ascended in 1899 at his invitation to observe a spectacular meteor shower expected that night.

I probably would be going too far to call the ascent a disaster, but at least the results of the observation were clearly devastating. The expected meteor shower failed to materialise, and Dorothea Klumpke could only report a few shooting stars. Her second ascent a year later to observe a solar eclipse was similarly disappointing; her report contains essentially synonyms for the word "foggy". Since there were very few astronomers besides Jansen who were interested in balloon flights, it may well be speculated that these two unsuccessful excursions into higher spheres influenced the fact that in the following period, only very occasional balloon ascents seemed to have been made for astronomical purposes. For this lecture, however, it is more interesting to talk about the people who were directly or indirectly involved in her being on board the balloon.

We can only speculate about the reasons why Janssen invited Klumpke in particular. Possibly it played a role that she was a woman and Janssen also wanted to emphasise that such undertakings were safe, safe enough to ask a representative of the supposedly weaker sex on board, against the background that several scientific balloonists had died for various reasons during flights in recent decades. Possibly, however, Klumpke was the only female astronomer who had agreed to do so, for besides the showmen, it was mainly the popularisers of astronomy who had discovered ballooning for themselves. The most famous among them is certainly Camille Flammarion, whose *Astronomie Populaire* has sold more than 100,000 copies, in which, according to the preface, he presented astronomy without reference to mathematical formulae and with special emphasis on the beauty of astronomical phenomena. His other books, all of them addressed to the larger public, were also bestsellers, including his account of his balloon flights, the beauty of which he emphatically raved about. It was probably also Flammarion, who established the contact between Klumpke and Janssen, perhaps indirectly via Wilfrid de Fonvielle, president of the Société Française de Navigation Aérienne, who provided the balloon for Klumpke's ascent. Both had been friends with Flammarion since they had attended his public lectures on astronomy.

Perhaps it is a little too short-sighted in this context to speak of Flammarion as a populariser because the term might give the impression that his only concern was to communicate astronomical knowledge in such a generally understandable way. In fact, he was concerned with making astronomical research possible for as many people as possible, e.g., by making his own observatory, financed by the incredibly high sales figures of his popular science books, available to all interested persons. He was particularly suspicious of the increasing mathematization of astronomy, which from a retrospective point of view was above all a sign of advancing professionalisation. For Flammarion, however, it was a danger that astronomy would lose its soul, so to speak, and he railed against observatories that would produce results almost mechanically, like factories, instead of placing the emphasis on the beauty of astronomy, which he considered its true charm.

It is certainly no coincidence that Felix Tisserand, for example, who had succeeded Mouchez as director of the observatory, had not travelled to the eclipse and had not sent an official delegation. Tisserand had no interest in spectacular observations, but his heart lay in the theoretical foundation of astronomy and in the standardisation of the processes by which astronomical research could be conducted. Flammarion, on the other hand, refused to accept any form of standardisation, striving for a plurality of research approaches in astronomy, astronomy which, in his opinion, should encompass not only professionals but also amateurs and the general public. This is precisely what he recorded in the statutes of the *Société Astronomique de France*, which he founded in 1887 and to which both theoreticians and practitioners, professionals and amateurs, popularisers and all those who considered themselves friends of science were invited to join.

In contrast to what was mentioned at the beginning in the case of chemistry, this society did not serve to exclude amateurs, but on the contrary to give them the opportunity to advance astronomy in exchange with professionals and popularisers. Indeed, he was not the only one who wanted to combat the ousting of amateurs from astronomy by founding new societies that were not only reserved for professionals. After the Royals Society began to exclude not only the amateurs, who had been welcomed as equal members only a short time before but also the attempts to have women elected as members for the first time failed, the British Astronomical Association (BAA) was founded in 1890.

The British Astronomical Association also brings us back to the solar eclipse of 1896, about which I would like to say a few words in conclusion. Even if the theoreticians like Tisserand were not there, professional astronomers had of course arrived, including Norman Lockyer, whose career shows remarkable parallels to that of Janssen. Both belonged to the representatives of the emerging astrophysics, which was decisively influenced by the introduction of the spectrometer in astronomical research and had discovered a new element, later called helium, during a solar eclipse in 1868 with the help of this technology, which was new in astronomy at the time. Both of them, like all early representatives of astrophysics, were still amateurs at the time but had now received official appointments as astronomers because of this spectacular result.

However, they were the exception among the early representatives of astrophysics, many of whom still made their living as popularisers, and it is not without irony that it was precisely the recognition of astrophysics as an independent subdiscipline in the early 20th century that contributed significantly to the complete professionalisation of astronomy. The knowledge required for astrophysics, both in terms of physical-theoretical fundamentals and in the laboratory field, led to astronomy being established as an independent subject of study at universities and thus to the emergence of a formalised education in order to become an astronomer, one of the major criteria of professionalisation that had been lacking so far.

There were also tourists who had come on cruise ships to witness a spectacular event, as well as amateurs, some with highly professional equipment, others with simple telescopes, waiting for the darkening of the sun. Quite a few of them had travelled together with the British Astronomical Society, and considering the premises made at its foundation, it is not surprising that there were also some women among them, who now unpacked their instruments and waited eagerly for the eclipse to occur. Dorothea Klumpke, too, had joined this expedition and even though the observation itself, as unfortunately so often in Klumpke's life, was not possible due to gathering clouds, this expedition was to change her life. Here she met the Welshman Isaac Roberts, who originally came from humble beginnings, but as a builder built up such a successful business that in retirement, he was not only able to devote himself to astronomy with full verve as an amateur but even to build his own observatory in his homeland, equipped with the most modern instruments. Roberts, who made it with his photographs of objects known as nebulae, most of which later turned out to be galaxies, and Klumpke married five years later, and she followed him there, where they researched together until his unexpected death a few years later. Klumpke was to outlive him by several decades and until shortly before she died in 1942, she was to devote herself in some sense to her roots and return to research as an amateur, her focus now being on securing for her late husband the place in the history of astronomy that she felt entitled to. At that time, she must be considered a kind of eccentric exception who, because of her great fortune, could afford the luxury of continuing to consider herself part of the astronomical community from which the amateurs had been almost completely ousted.

The solar eclipse of 1896 took place at the crossroads, so to speak. At this time and place, they were all still gathered together: The professionals and the amateurs, astrophysicists, only a few of whom had made it into established science, and women, including Dorothea Klumpke, who was employed at the observatory but still did research here as a private person. It was a snapshot of a science in which people could still participate in the generation of knowledge who had long since been excluded from other disciplines, and soon would be in astronomy, too.

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