Summary Atomism and individualism

In the last quarter of the nineteenth century, Dutch science suddenly became one of the world’s leaders, after many decades of very poor achievements. The term Second Golden Age was coined to describe this period of scientific successes. The historiographical view on this remarkable revival in Dutch science has been laid down in studies of Dutch science from a national perspective. In contrast to this view ‘from above’, this study of Amsterdam physics affords a look at ‘daily life’ in the Second Golden Age. The approach ‘from below’ provides new insights into this important era of Dutch science. The presence in Amsterdam of Nobel Prize laureates like Van der Waals and Zeeman puts Amsterdam physics squarely in the middle of the Second Golden Age and thus allows for a good case study. In particular, a new view is presented on the emergence of the so-called research university, the type of university in which research became an important task, side by side with education.

1877-1900 Physics as a supporting science

The study begins with the foundation of the University of Amsterdam in 1877. After a long period of discussion, Dutch parliament had passed a new law on higher education in 1876. One of its provisions was permission for the city of Amsterdam to convert its Athenaeum Illustre, an earlier form of higher education, into a full-fledged university. At the time of the foundation of the University of Amsterdam a chair in physics was also created. J.D. Van der Waals, as the first appointee to the physics chair, was to lead Amsterdam physics through its first decades.

In historiography, the change in the university’s function - from primarily an educational institution to an institute of research - is traditionally attributed to the same law on higher education of 1876 that created the University of Amsterdam. After this law went into effect, many new laboratories and chairs in the sciences were created, which then, according to this view, enabled the university to carry out its new research task.

The situation at the University of Amsterdam, however, does not corroborate this view, as its administrators did not particularly focus on research in the discipline of physics. They mainly viewed physics as a supporting science for medical students, who began their studies with a Propaedeuse at the faculty of science. The laboratory that was built for physics attested to this attitude. The Natuurkundig Laboratorium, as it was called, was inaugurated in 1882 and was a typical teaching laboratory. In correspondence between Van der Waals and the administrators of the university, the latter only showed an interest in the needs of physics teaching.

The student population more or less justified the administration’s view, since the vast majority of Van der Waals’ audience consisted of medical students (rising from about eighty in the first years to 120 at the turn of the century). In his first years as a professor, Van der Waals offered his advanced lectures to only four students: the total number of advanced students in mathematics, physics and chemistry taken together. Towards the end of the nineteenth century, this group numbered only about twelve students. Until 1891, when W.H. Julius was appointed as an extraordinary professor, Van der Waals remained the only professor of physics. He must have had his hands full, preparing courses, lecturing, and giving
oral examinations. His research activities can almost be considered a leisure activity.

There are good reasons to view the situation of Amsterdam physics as representative for Dutch science up to the turn of the century. In fact, the only large-scale research laboratory founded before 1900 was Kamerlingh Onnes' cryogenic laboratory in Leiden. Therefore, the interpretation that the law on higher education created the research university and was thus an important factor in the rise of the Second Golden Age must be reconsidered.

1900-1923 Physics as a mature discipline
Since the beginning of the twentieth century, Van der Waals was assisted by two extraordinary professors: R. Sissingh and P. Zeeman (Julius had already left Amsterdam in 1896). Sissingh assumed a heavy teaching load, but Zeeman became the first pure blooded research scientist in Amsterdam physics. The experimentalist Zeeman - who, as an assistant in Leiden, made the discovery in 1896 of what was later called the Zeeman Effect - began collecting equipment for his magneto-optical research and systematically deployed his students in his research-program. Zeeman's activities culminated in the creation of the Physica laboratory for optical research in 1923. This marks the symbolic end of this second period during which physics evolved into a mature discipline.

Research could also gain a firmer foothold in Amsterdam because of a change in the way physics was perceived by the university's administrators. Gradually, they discovered that Van der Waals and Zeeman had a huge reputation in international scientific circles. The two physicists were rewarded with a myriad of awards and honorary memberships and especially Zeeman received a number of interesting offers from other universities. The university administration began to consider research an important part of the physics discipline, since it apparently contributed to the university's fame. It is not clear whether, and to what extent, this changing perspective reflected a changing view on research and on professorships in society at large.

1908 was the year in which Van der Waals retired. He was succeeded by his son, J.D. van der Waals jr, who became professor of theoretical physics. At the same time, Ph. Kohstamm was appointed to a new extraordinary chair, created to preserve the Dutch tradition in thermodynamics and molecular physics based on Van der Waals' scientific views. Zeeman was appointed ordinary professor, while Sissingh had already been raised to that status a year earlier. In all, physics grew substantially in this period, materially and in terms of personnel, though the number of students did not rise dramatically until the beginning of the 1920's. This development seems to reflect a general trend in Dutch science too.

1923-1940 Consolidation period
The choice of Van der Waals' successors was not a complete success. The younger Van der Waals turned out not to have the passion and single-mindedness required for important scientific achievements. He preferred to travel in philosophical and literary circles. After 1920, he seems to have lost the connection with current developments in theoretical physics altogether. This was the kiss of death for theoretical physics in Amsterdam, which did not recover until after the Second
World War. Kohnstamm was also increasingly diverted by other activities, but he faced the consequences and resigned from his chair of physics in 1928.

Kohnstamm’s successor was the dynamic A.M.J.F. Michels. With funds Michels managed to obtain from companies interested in his experimental work, he was able to create unparalleled high-pressure facilities in the thermodynamics department of the Natuurkundig Laboratorium he inherited from Kohnstamm. In 1935, his dynamic approach was rewarded with the creation of an independent laboratory for high-pressure research, the Van der Waals Laboratorium. Around the time of Kohstamm’s resignation, Sissingh died and was succeeded by J. Clay. In the Natuurkundig Laboratorium, of which he became the director, Clay created a school for cosmic ray research. Thus, by the end of the interbellum period, Amsterdam physics had three laboratories, each with its own research program.

Dutch historiography speaks of a decreasing appreciation of science in society at large after World War One. However, this period of Amsterdam physics attests to the contrary. The appreciation of science and the reputation of scientists had never been greater. University administrators granted physicists more money than ever before and the general public yielded to the romantic lure of the lonely scientist in his laboratory. The papers reported amply on all important events in Amsterdam physics, like the opening of the Physica laboratory, the succession of Sissingh, the expeditions Clay had organised for his cosmic ray research, the retirement of Zeeman and the five years of tumult it took to appoint his successor.

The numbers of students also reflect the popularity of physics at the time. In a period when the University of Amsterdam was not nearly of the size to which it grew after World War Two, physics attracted students in numbers that would inspire jealousy in present-day departments of physics (in 1938, there were for example more than 150 physics students in Amsterdam).

Given this appreciation of science, it is understandable that the professors put all their time and energy into research. With the help of an abundance of students and apparatus, more research than ever was conducted. However, this focus on research was to the detriment of physics education: the professors increasingly neglected their classes for medical students and first-years science students.

The research
Paradoxically, scientific results in Amsterdam physics did not improve throughout the whole consolidation period, even though the circumstances for research had improved greatly, compared to the earlier years. Van der Waals sr., in spite of his heavy teaching load, still managed to do pioneering research in the field of molecular science and thermodynamics in the first decades of physics in Amsterdam. Characteristic of his work were the ideas of unity and continuity, his intuitive approach, and his strongly geometrical methods. Also remarkable was Van der Waals’ atomistic view, whose prominent role was also the mark of other Amsterdam physicists. Among Van der Waals’ great achievements were the ‘law of corresponding states’ (1880), his study on capillarit (1893) and his studies on the thermodynamics of mixtures (1891). This last study gave rise to the ‘Dutch School’ of thermodynamics.

Zeeman was able to introduce experimental magneto-optical research, as early as the turn of the century. All during the first decade he worked on the Zeeman Effect, particularly from the phenomenological point of view of W. Voigt, using the
inverse Zeeman Effect. Over the next ten years - while waiting for his new laboratory - Zeeman continued by working on the theory of relativity.

Kohnstamm initiated yet another experimental school of research. His main activity was to build an apparatus for experiments under high pressure, in order to test Van der Waals' theory of thermodynamics. From the mid 1910's, however, Kohnstamm ceased his research activities.

Van der Waals jr. carried out research in the field of molecular science and statistical physics. His research often aimed to support the theory of electrical monism, to which Van der Waals subscribed. When his work as well as electrical monism turned out to be unsuccessful, he stopped his research activities.

In the 1930's Amsterdam physics saw the existence of three experimental schools of research. At Physica, the emphasis lay on the measurement of spectral lines and the use of the Zeeman Effect as an analytical tool. In Michels' department - and later in his laboratory - various thermodynamical and electrical properties of materials were tested and measured under high pressure. The cosmic ray research of Clay and his co-workers concentrated on geographical studies, at least in the early thirties. After 1935, it is more difficult to distinguish a central theme in the group's very diverse studies on cosmic rays.

Characteristic of Amsterdam physics research in the thirties - and partly responsible for the lack of important results - was the concentration on precise measurements, which became almost an object in itself. As a result, there was too little room for imagination and inventiveness. Another cause of the sterility of Amsterdam's research was the individualism of the physicists involved. Because they did not seek cooperation with other scientists, they were deprived of impulses from other points of view and other fields of research.

Van der Waals was capable of great achievements in his time because of his strong and independent personality. Zeeman became an important experimentalist because he was at his best working all alone, in full concentration, in his laboratory. Thus it is clear that individualism plays a role both in the success and the decline of Amsterdam physics.