How Robert A. Millikan got the Physics Nobel Prize

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ABSTRACT: In 1923, R.A. Millikan was awarded the Nobel Prize in Physics "for his work on the elementary charge of electricity and on the photoelectric effect". Recently, historical research had a focus on Millikan's publication practice as well as on the role of his assistant, Harvey Fletcher. Several studies have raised doubts on whether Millikan can actually be taken as a role model for scientific practice. However, what has not been discussed yet is the question of how the Nobel Committee came to their decision to award Millikan's work. Based on archival material from the Nobel Committee, this paper discusses the nomination procedure as well as the evaluation process of Millikan's work.

KEYWORDS: Millikan, Nobel Prize, nomination, Nobel Committee.

Introduction

On November 13, 1923, the Royal Swedish Academy of Sciences announced Robert A. Millikan to be the Nobel Laureate in Physics for that year[1].

The aim of this paper is to illustrate the process that led to this announcement. In doing so, our concern is neither the scientific work of Millikan nor the general discussion of his work.[2] Instead, we will take a closer look at what went on in Stockholm at the Nobel Committee. In doing so, we will at first discuss some general aspects of the procedure in which the Prize is awarded. In the second part, we discuss the nomination procedure with respect to Millikan. In the

1 Private communication, Annika Pontikis - Public Relations Manager Nobelstiftelsen, The Nobel Foundation.July 1, 2008.

2 In this respect, our contribution has a different approach than Eshach (2008). Yet, we agree with him that stories focusing on scientists receiving the Nobel Prize could be very useful for educational purposes.

third part of this paper, we discuss the nomination as well as the decision process for the year 1923. In doing so, our aim is to show what factors may have influenced the decision to award the Nobel Prize to Millikan.

Setting the stage

Alfred Bernhard Nobel was a scientist as well as a successful businessman. Through his skill as industrialist and by his numerous patents he became one of the wealthiest men in the World. When Nobel died in Italy on December 10th, 1896, the Nobel Foundation was established under the terms of his second will, drawn up on the 27th of November, 1895. In part it reads as follows: *"The said interest shall be divided into five equal parts, which shall be apportioned as follows: one part to the person who shall have made the most important discovery or invention within the field of physics; …"* [3] – the other parts were appointed to chemistry, physiology or medicine, literature, and the Nobel Peace Prize.

The Nobel Prize in Physics is awarded by the Swedish Academy of Sciences in Stockholm. However, not all its members are initially involved in the decision process: According to §6 of the statues of the Nobel foundation, "… the prize-awarding body shall appoint a 'Nobel Committee', consisting of three, four or five persons, to give their opinion in the matter of the award of prizes".[4] However, according to §2 of the special regulations for the award by the Royal Academy of Sciences the Nobel Committees for Physics and Chemistry shall consist of five members each[5], all of whom shall be elected by the Academy. The members of the Committee were elected for a period of three years and could be re-elected. Consequently, some of the members remained in the Committee for more than 20 years, just to give two examples: Svante Arrhenius was a member in the Physics Committee from 1900 until his death in 1927; Manne Siegbahn was in the same Committee from 1923 to 1962. The Committee's members are prominent scientists from Sweden, particularly the Uppsala University and Stockholm Högskola dominated this Committee in the first half of the twentieth century.[6]

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3 Fant 1995, 441 - 443

4 Statutes of the Nobel Foundation [SNF] 1995, 3

5 SNF – Special regulations 1994, 9

6 For list of members and their working period as member of the Committee see Crawford et al. (1987, 6); Crawford (2002, 9-10). For other

The nomination procedure starts each year during the month of September with the Nobel Committee sending out invitations to persons considered to be competent to put forward proposals.

The special regulations for the prizes of the Academy of Science provided for two broad categories of nominators: those with permanent nominating rights and those invited to submit proposals for the prizes of a given year. Permanent entitlement belonged to:[7]

1. Swedish and foreign members of the Royal Academy of Sciences
2. members of the Nobel committees for physics and chemistry
3. previous winners of a Nobel prize in physics or chemistry
4. permanent and acting professors physics and chemistry at the universities and higher schools in Sweden and other Nordic countries that existed in 1900.

The category of ad hoc nominators comprised:

5. chairholders in physics and chemistry at six or more foreign universities selected by the Academy of Sciences to ensure a wide geographical representation
6. an unspecified number of scientists individually invited to nominate.

Every nominator can propose several researchers for different achievements and the proposals have to reach the Committee before January 31st of the year for which the Prize was proposed. All nomination letters that arrive too late are not considered but kept for the following year.

In the following months the Committee prepares a general report in which all nominated candidates are reviewed. Some general rules are applied, for example, self-nominations and nominations of scientists who already passed away are excluded. Short reports refer to the work of the nominated scientists. Detailed 'special reports' are prepared for those candidates the Committee considers to deserve the Nobel Prize. Finally, the Committee proposes the names of prize-deserving candidates to the Academy; this nomination is accompanied by the general and special reports of the candidates.

The proposal is discussed by the physics-class of the Academy, which consists of 25 members. Before the Academy makes the final decision, the physics-class has to comment on each of the Committee's recommendations. It communicates its opinion and decision about the

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case studies on the history of the Nobel Prize see e.g. Singh & Rieß (1998) and Nielsen & Nielsen (2001).

7 Crawford et al. 1987 1-2.

selection of the Nobel Laureate to the entire Academy. The Academy makes the final decision before mid-November. If there is a disagreement between the proposals of the Committee and the opinion of the Academy, the latter can overrule the Committee's proposal. According to the bylaws (§ 10) of the Noble foundation, the discussion and decisions should not be included in the record or otherwise divulged.[8] In contrast to the discussions of the Academy, the initial nomination letters and the reports of the Committee as well as its proposal are documented and become available to researchers after fifty years. Consequently, we know for example that in 1908, Max Planck was recommended by the Committee, but the Prize was awarded to the French Gabriel Lippmann. Likewise, in 1912 Kamerlingh-Onnes was recommended, yet Gustaf Dalén was announced to receive the Physics Nobel Prize.[9]

In case that no suitable candidate is found for a particular year, the Prize will be reserved and can be awarded a year later.[10] For example, the Prize for the year 1918 was reserved and awarded to Planck in 1919. However, this was not necessary in 1923 when, on November 13th, the Royal Swedish Academy of Sciences announced Millikan as the Nobel Prize Laureate in Physics.[11] He was awarded "*for his work on the elementary charge of electricity and on the photoelectric effec*t."[12]

Rehearsals

It is not surprising that when Millikan received the Nobel Prize in 1923, he was not nominated for the first time.

Actually, he was known to the Committee even before his first nomination, because he was part of what may be called the 'noble population': Holding a chair of physics at an invited university, he nominated Max Planck for the Nobel Prize in 1913.[13] Millikan received his first nomination in 1916 by J. B. Clark[14]: Being not a

8 SNF 1995, 5

9 Küppers, et al. 1987, 84-85

10 Crawford et al. 1987, 68-74

11 Private communication, Annika Pontikis - Public Relations Manager Nobelstiftelsen, The Nobel Foundation. July 1, 2008.

12 http://nobelprize.org/nobel_prizes/physics/laureates/1923/, last access June 25th, 2008.

13 Crawford 2002

14 John Bates Clark (1847 – 1938) was an American neo-classical economist and first director of the Carnegie Endowment, New York.

man of physics, he consulted colleagues who suggested two researchers. As a consequence Clark's nomination letter reads as follows:

> It is the judgment of those whom I have consulted that two men in this country have made such discoveries. Of these, the first is Professor R.A. Millikan, of the University of Chicago, whose recent contribution to science has consisted in the isolation of an ion and of making precision measurement of its charge. The other is Dr. Irving Langmuir of the General Electric Company,[…] who has made highly fruitful studies of thermionic currents and the phenomena of passage of electricity through highly evacuated space. [15]

But in the related general report of the Nobel Committee it is stated that Millikan's work had not achieved the required level to be rewarded with the Nobel Prize.[16] This is particularly remarkable as in that year, not a single nominated candidate seemed to deserve the Prize.

Two years later, Millikan was nominated for the Physics Nobel Prize of the year 1918 by eight different American scientists. H. Crew[17] nominated him "*for his well known researches on the electronic charge and photo-electric effect, summarized in his volume, 'The Electron'. (University of Chicago Press, 1917*)".[18] It should be noted that Crew proposed four scientists, placing Millikan third.[19] E.B. Frost[20] wrote to the Nobel Committee stating that he passed over the names of Max Planck and Johannes Stark as they may have received the reserved Prize, which had not yet been announced. Instead, he nominated Charles Fabry from France, but added that if Fabry was already considered for the Noble Prize then he nominates Millikan *"for his isolation of the ion by the balanced-drop method, and the determination of e, as fully described in Millikan's book entitled 'The Electron, Its Isolation and Measurement and the Determination of Some of Its Properties', Chicago, 1917.*[21] Millikan's third supporter

15 J.B. Clark to the Nobel Committee, letter dated Nov. 5, 1915.
16 Report of the Nobel Committee, 1916.
17 Henry Crew (1859—1953) was Fayerweather Professor of Physics at Northwestern University Evanston, Illinois.
18 H. Crew to the Nobel Committee, letter dated Dec. 12, 1917.
19 H. Crew's other candidates were: Hugh L Callendar (UK), Theodore Lyman (Harvard University Cambridge), Alfred Perot (France).
20 Edwin Brant Frost II (1866 –1935) was an American astronomer and appointed director at the Yerkes Observatory of the University of Chicago at Williams Bay, Wisconsin.
21 E.B. Frost to the Nobel Committee, letter dated Dec. 13, 1917.

was T.W. Richards[22] referring to his paper *"A New Determination of e, N, and Related Constant"*.[23] Richards held the opinion that *"… this paper seems to me to be one of the most important which I have read for a long time. It is the climax of a long and careful study of the magnitude of the unit of charge of electricity (the electron)."*[24] G.E. Hales[25] wrote a short letter on December 3, 1917, nominating Millikan for his work *"on the electron and related subjects"*. C.R. van Hise[26] supplemented the statement of the members of the National Academy of Sciences[27] as follows: *"We consider him as already second to no man in physics in the United States."* [28] W.W. Campbell[29] sent another nomination that was seconded by the Nobel Laureate A.A.

22 Theodore William Richards (1868-1922) was Chairman of the Department of Chemistry at Harvard, appointed Erving Professor of Chemistry, Director of the Wolcott Gibbs Memorial Laboratory (Cambridge, Massachusetts), and Nobel laureate for chemistry in 1914 for measuring atomic weights.

23 R.A. Millikan (1917), "A New Determination of e, N, and Related Constant", Philosophical Magazine, vol.34, July 1917

24 T.W. Richards to the Nobel Committtee, letter dated Jan. 2, 1918.

25 George Ellery Hale, (1868 - 1938) was Chairman of the Committee on Research in Educational studies, Member of Executive Committee for the National Research Council.professor at the University of Chicago, and Director of Mt. Wilson Observatory.

26 Charles Richard Van Hise (1857 – 1918) was Professor and President of the University of Wisconsin in Madison.

27 In a letter of December 1, 1917 Benjamin W. Snow – Department of Physics, University of Wisconsin wrote to Charles R. van Hise and recommended Millikan. About Millikan's scientific achievements he wrote, "The great work which professor Millikan has accomplished, by a method entirely original with himself, is the determination of the value of e, or the charge of electron. This quantity is at the basis of nearly every piece of modern physical investigation, and is, indeed, the very foundation upon which physical and electrical science of the present day is built. I think perhaps it is the most important and fundamental investigation in physics that has been carried out in this country since the great work of Rowland."

28 C.R van Hise to the Nobel Committee, letter dated Dec. 7, 1917. Van Hise added that Millikan is still a young man and will probably do even more important research.

29 William Wallace Campbell (1862 - 1938) was American astronomer, and Director of Lick Observatory (University of California).

Michelson.[30] Campbell nominated Millikan for his *"investigations in Radiation and Atomic Structure"*.[31] Finally H.F. Osborn[32] pointed out that Millikan *"has been working with ardor and real genius."* [33]

Only Frost's and Crew's letters reached Stockholm in time, the others were considered by the Committee for the following year 1919.[34] The Committee's report of 1918 discusses the achievements of the nominated physicists W. Crookes, C.T.R. Wilson and R.A. Millikan.[35] It stated that Crooke's work belonged to an era that lay too far in the past to be awarded with the Nobel Prize. Though the work of Wilson was considered honorable, it had not the impact that was required by §5 of the statutes of the Nobel Foundation.[36] The same holds true for the works on electricity by Millikan. As a result, the Prize for 1918 was not awarded but reserved for the next year.

In 1919, C.R. van Hise and H.F. Osborn repeated their belated nominations of the previous year.[37] Osborn brought up another reason of why Millikan should receive the Nobel Prize:

> The Members of your Committee are well aware of the ingenious, untiring and highly successful researches of Doctor Millikan upon the nature of the electron, … They are probably not aware, however, that he was among the first of the Members of the National Academy of Sciences to offer his entire service to the

30 Albert Abraham Michelson (1852 – 1931) was Professor of Physics and the first Head of Department at the University of Chicago, Nobel laureate for physics 1907.

31 W.W. Campbell to the Nobel Committee, letter dated Dec. 31, 1917.

32 Henry Fairfield Osborn (1857–1935) was Professor of Biology and Zoology at Columbia University, and President American Museum of Natural History, New York.

33 H.F. Osborn to the Nobel Committee, letter dated Jan. 7th, 1917. This might be misdated, according to the note of the Nobel Institution the letter arrived on March, 11th, 1918

34 See the nominee list in: Crawford et al. (1987, 76).

35 Report of the Nobel Committee [NC] 1918.

36 The report refers to the § 5 of statute of the Nobel Foundation, according to which a "work may not be awarded a prize, unless it by experience or expert scrutiny has been found to be of such outstanding importance as is manifestly intended by the will. If none of the works under consideration is found to be of the character here indicated, the prize money shall be reserved until the following year. If, even then, the prize cannot be awarded, the amount shall be added to the main fund" (SNF 1995, 3).

37 C.R. van Hise to the Nobel Committee, letter dated Nov. 12, 1918. E.H. Osborn to the Nobel Committee, letter (undated). It reached the Committee on Dec. 30, 1918.

> Government, that he suspended all his work, became a Member of the Council of National Research, and then Chairman of the Council, which has been highly successful in marshaling and coordinating all the scientific and technical ability of the United States in the cause of liberty and enduring peace. [38]

The Committee's report for 1919 admitted Millikan's measurements were made very diligently and with a subtle and sharp-witted method. Though the Committee did not deny his research had to be esteemed as being exceptionally worthy, the value of his achievements should not be esteemed equivalent to the work that was lauded by the Committee instead.[39] For the year 1919, the Nobel Prize in physics was awarded to Johannes Stark, the reserved one from 1918 was awarded to Max Planck.

For the year 1920, Osborn again proposed Millikan, again referring to his work 'The Electron'.[40] Likewise, Richards renewed his previous suggestion and nominated Millikan *"on account of his remarkable research on the Electrical Quantity of the Electron."*[41]

The Committee's report stated that Millikan's researches were of exorbitant interest and the Committee commissioned Arrhenius to compile an expertise.[42] This can be taken as an indication that the Committee short-listed Millikan for the first time.

Arrhenius detailed expertise is entitled: *"Millikan's work on the fundamental charge."* [43] This title is programmatic, as Arrhenius focuses mainly on Millikan's publication 'The Electron' and the experiments related to that publication. Toward the end of his expertise Arrhenius also referred to Millikan's criticism of Ehrenhaft's work as well as to Millikan's experiments on the photoelectric effect.[44] In particular, Arrhenius emphasized Millikan's

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38 E.H. Osborn to the Nobel Committee, letter (undated).

39 Report of the Nobel Committee, 1919.

40 Osborn to the Nobel Committee, letter dated Nov. 7, 1919. He also proposed Robert Williams Wood (1868 – 1955, professor of experimental physics at Johns Hopkins University) and Carl Barus (1868-1935, Brown University).

41 T.W. Richards to the Nobel Committee, letter dated Dec. 8, 1919.

42 Report of the Nobel Committee 1920.

43 This expertise is dated August 17, 1920.

44 In this respect Arrhenius stressed that Millikan's work is a striking proof of the applicability of the quantum theory by computing a value of Planck's constant nearly concordantly to Planck's own concluded value. In doing so, Arrhenius related Millikan's precision measurements to a work that had just been awarded with the Nobel Prize.

experimental abilities and appraised him as an excellent physicist, who could be recommended for the Nobel Prize.

Unfortunately for Millikan, Arrhenius' opinion differed from the one of the Committee: The report admits that Millikan's research was conducted with the highest precision and the implementation of sharp-witted methods. Moreover, it yields the conclusion that electricity has an atomistic nature by stating that Millikan's research gives the up to then best measurement of the smallest occurring portion of electricity, which turned out to be identical with the amount of charge one electron carries. However, the Committee's report also points out that Ehrenhaft in Vienna examined electrical charges of ultramicroscopic particles and came to different results, namely that electricity could be found in even smaller portions. The report concludes that although most physicists had the same opinion as Millikan, the Committee is not willing to recommend him for the award.[45]

This position gets even more understandable when Ehrenhaft's status for the Committee is considered – Ehrenhaft was also member of the 'Nobel population' as he had been invited as a nominator for 1916. Be this as it may, in 1920, Charles Edouard Guillaume received the Nobel Prize for physics.

One year later, Osborn nominated Millikan as in the years before. But this time he additionally praised Millikan's research in the ultra-violet band that had to be estimated *"as a contribution of the first importance"*.[46] For the year 1921, the Committee asked Arrhenius to complement his report on Millikan.[47] Arrhenius argued in favor of Millikan stating that his results had been confirmed, whereas Ehrenhaft's peculiar results had been nullified.[48]

The Committee admitted in its report that Arrhenius' expertise clarified the contradictory results of Ehrenhaft and that Millikan's results seemed to be undisputed at that moment, however, the Prize could not be awarded until more experience about the relevance would be gained. But it was not only Millikan's work that appeared not to be prize-worthy: The Physics Nobel Prize was not awarded but reserved for the year.

For the Noble Prize of 1922, four American scientists nominated Millikan: E.B. Frost, G.E. Hale, and T.W. Richards renewed their

45 Report of the Nobel Committee 1920.
46 F.H. Osborn to the Nobel Committee, letter dated Nov. 24, 1920.
47 Report of the Nobel Committee 1921.
48 Expert Report July 11, 1921.

nominations of Millikan, who was also proposed by C.D. Walcott.[49] Frost referred to Millikan's isolation of the electron by the oil-drop method and the extension of the ultra-violet spectrum.[50] Yet, Millikan was not his only nomination; he also lauded C. Fabry for his various achievements in spectroscopy such as his study of the solar spectrum and his invention of the micro-photometer. Richards nominated Millikan without giving any particular reasons, but lauded also F.W. Aston for his work on the isotopes of elements.[51]

Walcott nominated Millikan for his work on the ionic charges, which led to the determination of fundamental constants with great accuracy. But he also nominated Hale, Aston and Coolidge, even though he admitted the difficulties of this recommendation, as he knew the work of the latter three were older and thus his nomination in contradiction to the rules of the Nobel foundation.[52] Under these circumstances, he also proposed C.G. Abbot for his recent work on the solar radiation as well as two observations stations Abbot had established in the United States and Chile.[53]

Hale nominated Millikan, mentioning a long list of his achievements such as the isolation and measurement of the electron charge, the photo-electric determination of Planck's *"h"*, the exact value of e, N and related constants, Brownian movement in gases and the extension of the ultra-violet spectrum. Moreover, Hale sent a copy of *"The Electron"* to the Committee.[54]

As in the two years before, Arrhenius compiled an expertise which was again expanded. He stated that Millikan's achievement concerning the electron had been nearly unaltered since the year

49 Charles Doolittle Walcott (1850 –1927), Professor of palaeontology, Cofounder of the Carnegie Institution and Secretary of the Smithsonian Institution

50 E.B. Frost to the Nobel Committee, letter dated Dec. 27, 1921, referring to R.A. Millikan "The Extension of the Ultra-Violet Spectrum" in Astrophysical Journal, Vol 52, p.47, 1920.

51 T.W. Richard to the Nobel Committee, letter dated Jan. 5th, 1921.

52 According to the § 2 of the bylaws: , "The provision in the will that the annual award of Prizes shall be intended for works during the preceding year`` should be understood in the sense that the awards shall be made for the most recent achievements in the fields of culture referred to in the will and for older works only if their significance has not become apparent until recently" (SNF 1995, 2).

53 C.D. Walcott to the Nobel Committee, letter dated Jan. 9, 1922.

54 G.E. Hale to the Nobel Committee, letter dated Oct. 18, 1921.

before. This expert report concludes that by judging Millikan's own statements his actual interesting research is not finished.[55]

The Committee followed Arrhenius', expertise and pointed out in its report that Millikan's valuable contributions by his work on the elementary charge and the photoelectric effect deserve merits. Moreover, Millikan recently carried out experiments on the spectral lines in the far ultraviolet spectrum. However, even though Millikan was considered to be among the most important experimental researchers, the Committee concluded that his work had to stand behind other researchers.[56] In the year 1922 the Nobel Prize in physics was awarded to Niels Bohr and Albert Einstein received the reserved one for 1921. And Millikan had to wait for another year.

To summarize, it could be argued that Millikan's status within the Nobel Committee improved significantly. He was nominated regularly, although all of his nominators were Americans even though his researches were also well known in Europe.[57] The two nominators Osborn and Richards proposed Millikan three times, several nominators played – like Millikan – an important role in the AAAS. Moreover, Millikan's status in the Committee had improved; Arrhenius prepared special reports for the last three years. Like Millikan's nominators, Arrhenius stressed in his reports particularly the experiments on the determination of the elementary charge, however, other researches of Millikan were also mentioned. The Committee came always to the conclusion that even though Millikan was among the most eminent experimentalists, his contributions were not (yet) sufficient to be awarded with the Nobel Prize.

On stage – at last

In 1923, things were slightly different from the years before. Actually, contrary to the preceding years, not a single American nominated Millikan. According to the documentation of the Nobel foundation, it was only the Swiss Meyer[58] who nominated Millikan. Consequently, when just looking at the nominations, it may seem a bit surprising that Millikan was awarded the Prize in that year, particularly, as

55 Expert Report, Aug. 15, 1922.

56 Report of the Nobel Committee 1922.

57 His monograph "The Electron" was translated in German (Millikan & Stöckl 1922), moreover, his work was referred to in textbooks (see Parlow 2006, Niaz & Rodriguez 2004).

58 Edgar Meyer (1879 – 1960) was professor of experimental physics at the university of Zurich since 1916. He was known due to his researches on radioactive decay and on ultraviolet radiation (Bömmel in DNB 331f.).

Millikan was by far not the only one who had been nominated. Therefore, it is necessary to take a closer look at the report the Committee prepared for the Royal Academy of Sciences. According to this report, 19 nominators proposed 17 different researchers. Additionally, there were another six nominations for 1922 which were belated and had therefore not come into consideration the year before. However, among these nominations were several that had to be rejected for formal reasons: Among the belated ones were nominations for Bohr together with Einstein and for Einstein together with Lorentz - all of them had already received the Nobel Prize in physics - as well as for Soddy for his discovery of isotopes – Soddy had already received the Nobel Prize in chemistry for this work. Ostwald was nominated twice – for 1922 and 1923, unfortunately, the nominator was identical with the nominee, therefore, these nominations were to be excluded according to the bylaws of the Nobel Foundation.[59] Likewise, the nomination of Eötvös[60] had to be rejected for formal reasons – he had passed away already in 1919.

Two other nominations that were not taken into consideration seem to be more interesting: Chwolson[61] had nominated Siegbahn, however, Siegbahn had requested already at an early stage of the procedure that this nomination should not be taken into consideration for the 1923 award.[62] Arrhenius nominated the *Verein Notgemeinschaft der Deutschen Wissenschaft*, an organization that was founded in 1920 and can be taken as the ancestor of the Deutsche Forschungsgemeinschaft.[63] According to the report of the physics commission, this organization had also been nominated in the field of chemistry. As a result, the Academy was asked to decide whether such a nomination was in accordance with the bylaws. In a report dated April 11th, 1923, the Academy decided that the *Notgemeinschaft* could only be awarded the Prize for achievements already made but

59 Actually, Wilhelm Ostwald (1853-1932) had already received the chemistry Nobel Prize in 1909, consequently, he was able to submit a nomination each year.

60 Lorand Eötvös (1848-1919) is best known for his experiments with a torsion balance that demonstrated the similarity of gravitational and inertial mass.

61 Orest Danilowitsch Chwolson (1852-1934) was physics professor at St. Petersburg University and is best known for his influential textbook (Chwolson & Schmidt 1902).

62 Siegbahn was awarded the reserved Prize for 1924 in 1925.

63 On the early history of the Notgemeinschaft see Marsch (1994).

not for potential ones. Consequently, its nomination was not considered any further.

According to the report, the majority of valid nominations were related to researches in experimental physics – and we will focus only on those scientists who were discussed in detail. These are – besides Millikan: Paschen[64] (together with Sommerfeld[65] for their work on the fine structure of spectral lines and also for the experiments on the Paschen-Back effect), Rutherford (for his scattering experiments as well as for the detection of a radiation that is more intense than L-rays)[66], Hale and Deslandres (for experiments with the spectroheliograph).[67] Moreover, some researchers that were considered to be theoreticians were also nominated and discussed. These were Sommerfeld (for the fine structure of the spectra as well as for his contributions to the atomic theory), Bjerknes (for his work on electrodynamics and on meteorology),[68] and Franck (for experiments on the interaction between electrons and mercury atoms).[69]

As already mentioned, Millikan was nominated only by Meyer. Thus, it could be questioned why he and none of the others was awarded the Nobel Prize. In order to develop a rationale for the decision of the Committee, we would like to sketch the reasons for not awarding the Prize to one of the others. Looking just at the nominations, the most promising candidate for the Prize was probably Paschen. He was nominated together with Millikan by

64 Friedrich Paschen (1865-1947) is well-known for his work on spectroscopy and became president of the Physikalisch-Technische Reichsanstalt from 1924 until 1933.

65 Arnold Sommerfeld (1868-1951) was among the leading theoretical physicists; however, he was never awarded the Nobel Prize (on Sommerfeld see Eckert 1993).

66 What was called L-rays in 1923 turned out to be protons that were emitted in the radioactive decay of artificial radioactive nuclids. At that point Rutherford was already a Nobel laureate in chemistry.

67 Henri-Alexandre Deslandres (1853-1948) was director of the observatories in Paris and Meudon and received the Gold Medal of the Royal Astronomical Society, the Henry Draper Medal of the National Academy of Sciences and the Bruce Medal of the ASP.

68 Vilhelm Friman Koren Bjerknes (1862-1951) was founder of the geophysical institute at the University of Bergen and is best known for his work in meteorology that focused on the foundations of weather forecasts (see Friedman 1989).

69 Franck was – together with Gustav Hertz – awarded the Nobel Prize for this work two years later.

Meyer, but also by the two Nobel Prize winners Planck and Wien. Moreover, Paschen was placed in the first place by Meyer and Millikan only in the second place. Furthermore, like Millikan, Paschen had been nominated previously.

However, according to the argumentation of the Committee, Paschen's experimental work had been important, but did not result in a significant progress in the sciences. Consequently, the Committee placed Paschen behind Millikan. Like Paschen and Millikan, Hale had been nominated in previous years for his work with the spectroheliograph, but the Committee came to the conclusion that Deslandres had contributed to the development of these experiments as much as Hale. When only Hale was nominated in 1923, Carlheim-Gyllensköld suggested a division between Hale and Deslandres, and prepared a respective report. However, even though it was admitted that their researches had opened a new field in physics and had contributed significant findings, they were declared to be insufficient to award the Prize. In case of Rutherford, the Committee came to the result that they had already awarded Bohr's "*services in the investigation of the structure of atoms and of the radiation emanating from them*"[70]. As Rutherford's work could be seen as a basis for Bohr's, he should not be awarded the Prize. With respect to the work on protons, it was considered unclear, whether Rutherford's findings were related to his work which had already been awarded with a Nobel Prize in chemistry.

To sum up, it can be argued that the nomination process of 1923 shows a lot of similarities with respect to the discussion of Millikan's work in previous years. Obviously, the phrases used in the Statutes of the Nobel Foundation (most significant discovery or invention in the field of physics) are not that sharply defined but required, and enabled, an interpretation through the Committee. Taking the report of the Committee literally, it appears that all candidates except Millikan had some deficits, however, this image would be an oversimplification: The Committee's report was intended to serve as a basis for the decision of the Academy. Yet, as already mentioned, in some cases the Academy did not follow the suggestion. Consequently, the recommendation had to be made in a manner that made it likely for the Academy to follow. Therefore, in order to understand the awarding of Millikan, it appears necessary to take a closer look at the detailed report prepared by an individual member of the Committee.

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70 http://nobelPrize.org/nobel_Prizes/physics/laureates/1922/index.html, last access Oct. 15th 2008.

In the case of Millikan, the report was not prepared by Arrhenius but by Siegbahn who had just become a member of the Committee. And in his report, Siegbahn used a different rationale as compared to that used by Arrhenius: Two aspects appear to be central in the report: First of all, he pointed out that Millikan's findings are no longer considered to be insecure – despite Ehrenhaft's work which initially was taken to raise doubts against the validity of Millikan's work. However, this had no longer been an argument in 1922. Consequently, Siegbahn could easily make this point. Moreover, he argued that Millikan's findings were interpreted as a description of electricity in terms of an atomic structure. Yet, only a minor part of the report was devoted to the oil drop experiment – most of Siegbahn's discussion focused on Millikan's work on the photoelectric effect.

Actually, this aspect of Millikan's work is the second part which is mentioned in the Prize announcement – Millikan is awarded the Nobel Prize for "*for his work on the elementary charge of electricity and on the photoelectric effect*".[71] Moreover, this work places Millikan in close relation to another Nobel Prize winner who was finally awarded the Prize for 1921 – Albert Einstein. As Friedman has shown, the Committee was very hesitant to award theoretical physicists. Things started to change in 1922, when Oseen became a member of the Committee. Oseen successfully started a campaign to promote both Einstein and Bohr; he "*himself successfully nominated Einstein for the discovery of the law of the photoelectric effect. … And having declared that the law of the photoelectric effect was a fundamental truth of nature, Oseen could argue for Bohr's quantum model of the atom*".[72] Oseen's strategy worked, Einstein was announced to be awarded the Nobel Prize for 1921, and Bohr received the Prize for 1922.

Taking this background into consideration, a different image of the reasons for awarding the Nobel Prize to Millikan can be developed. Millikan's work on the photoelectric effect was an experimental expansion of the effect that had been crucial for the two Nobel Prizes awarded one year earlier. Consequently, awarding the Prize to him could be taken as an option for justifying these choices

71 http://nobelPrize.org/nobel_Prizes/physics/laureates/1923/, last access June 15th, 2008.

72 Friedman 2002, 35, see also Friedman 2001, 135

once again.[73] Taking this context into consideration, it is therefore not surprising that Gullstrand, in his presentation speech, made an explicit reference to the photoelectric effect and its meaning for the two previously awarded Nobel Prizes: "*Without going into details I will only state that, if these researches of Millikan had given a different result, the law of Einstein would have been without value, and the theory of Bohr without support. After Millikan's results both were awarded a Nobel Prize for Physics last year.*"[74]

However, the central focus of Gullstrand's presentation speech for Millikan lay on the oil drop experiment and the notion of an atomic structure of electricity. Yet, this is not necessarily a contradiction to the interpretation we have developed as there can be two reasons why Gullstrand chose this topic in his public speech. On the one hand, Millikan had been nominated by almost every nominator for his researches on electrons, and these experiments were considered to be a valuable contribution by the Committee. Particularly referring to these experiments, Millikan could be characterized as a researcher who carried out precision measurements. Consequently, Gullstrand pointed out that "*…the charge of a single ion could be measured in a very large number of cases, and it was determined with an exactitude of one in a thousand*." Characterizing his researches on the electron like that, Gullstrand described Millikan as a representative of the traditional understanding of physics "*that placed precision measurement as the highest goal for their discipline*".[75] Therefore, awarding the Nobel Prize to Millikan can be taken as a decision that combined the traditional understanding of what research should be considered to be praiseworthy with the new understanding that included achievements in the field of theoretical physics.

Conclusion

As we have demonstrated, the reasons for Millikan being awarded with the Nobel Prize were not that simple. It did not only require excellent experimental skills and convincing results, neither was the support of other researchers sufficient to be proposed by the

73 In this context, it appears remarkable that Elzinga (2006, 161) suggests "Gullstrand's resistance [to awarding Einstein with the Nobel Prize] was probably weakened with a promise that Millikan might be awarded a Prize once Einstein and Bohr had been recognized."

74 Gullstrand, A.: Presentation Speech … on December 10, 1923. http://nobelPrize.org/nobel_Prizes/physics/laureates/1923/press.html, last access June 29th, 2008.

75 Friedman 2002, 34

Committee. Whilst these aspects are essential, they are not sufficient for an award. Other requirements are not that rational – as we have shown, political considerations played an important role within the Committee.[76] It is unclear, whether this was a particular situation in the early 1920s, a period that was certainly unusual in the history of science. As Friedman has pointed out in his study of the Quantum Theory and the Nobel Prize, *"to understand the 'whys and wherefores' of the Nobel prizes, insight into the committee and its Swedish context are essential"* (Friedman 2002, 38). Here, some more research with respect to the role of Millikan's Prize appears to be necessary.

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containing special regulations concerning the award by the Royal Academy of Sciences of Prizes from the Nobel Foundation etc. was decreed by the Government on April 7th , 1994 (abbreviated as SNF – Special regulations 1994). The information quoted in this section are taken from these documents.