Women in the History of Philosophy and Sciences 7

Jos Uffink
Giovanni Valente
Charlotte Werndl
Lena Zuchowski *Editors*

The Legacy of Tatjana Afanassjewa

Philosophical Insights from the Work of an Original Physicist and Mathematician

Springer

Women in the History of Philosophy and Sciences

Volume 7

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Series Foreword

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Preface

This volume would not have come about without the generous support of many colleagues and friends. Firstly, we are particularly grateful to Ruth Hagengruber for the opportunity to publish this volume in the Women in the History and Philosophy of Science series. We would also like to thank all the authors who have contributed to this volume, many of which also acted as reviewers for other contributions. Harvey Brown and Michel Janssen kindly provided additional peer-reviews.

Jos Uffink would like to express a very special thanks to Tamara van Bommel, (Afanassjewa's granddaughter) for allowing me to browse through a box of Afanassjawa's papers and letters, and to Margriet van der Heijden for many helpful discussions and her assistance on this project. He also thanks the Vossius Centre for the History of Humanities and Sciences at the University of Amsterdam and the Descartes Centre for the History and Philosophy of the Sciences and the Humanities at Utrecht University, the University of Geneva, the Polytechnical University of Milano, The University of Salzburg, and the Erwin Schrödinger Institute at the University of Vienna, for financial support and hospitality, and audiences at these various locations for their feedback. He also is grateful to the University of Minnesota for a sabbatical leave, during which much of this project took shape.

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Minneapolis, USA — Jos Uffink
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Introduction

Tatiana Afanassjewa (1876–1964) was a Russian-Dutch mathematician and physicist, who made important contributions to the foundations and philosophy of physics. She was also a prominent voice in the didactics of mathematics and an active participant in some of the most influential intellectual debates of the earliest twentieth century. However, her legacy has received little attention from philosophers and historians of science: all too often she is remembered only as the lesser known co-author of the publications she wrote together with her husband Paul Ehrenfest (1880–1933) on statistical physics. While these influential collaborative works are part of her legacy (and will be discussed in this book), Afanassjewa's independent contributions, in particular to the foundations of thermodynamics and the didactics of mathematics, offer many visionary insights and deserve more exploration than has so far been accorded to them.

This book aims to provide an in-depth and comprehensive exploration of Tatiana Afanassjewa's legacy. We hope that it will (i) highlight Afanassjewa's independent work, thereby raising her profile in the philosophy of physics community and making sure that her achievements are not unjustly overshadowed by those of her husband, and (ii) analyse selected aspects of her works and demonstrate how they continue to yield insights into the foundations of physics and mathematics.

The book is an edited volume of original contributions from a diverse set of authors. A number of the papers collected in this book are based on contributions to the workshop *Tatiana Afanassjewa and her legacy: New perspectives on irreversibility*, which took place on June 17–18, 2017, at the University of Salzburg. However, we have also elicited additional contributions on aspects of Tatiana Afanassjewa's work and life that were not represented at the workshop. Furthermore, in order to make her work more accessible to physicists, philosophers and mathematicians, the volume will contain translations of key passages from publications that are currently only available in German and Dutch. The authors contributing to this book are all well-regarded experts in their relevant fields and we have been fortunate in attracting such a high-calibre field of contributors.

The book is divided into three parts: Part I (Chaps. 1–3) discusses Tatiana Afanassjewa's biography and independent works; Part II (Chaps. 4–6) presents

select aspects of her collaborative work with Paul Ehrenfest (in this introduction, we follow the usual naming convention for the authors of these joint works by referring to Paul and Tatiana as 'the Ehrenfests'); Part III (Chap. 7–8) contains translations of Tatiana Afanassjewa's work on the foundations of thermodynamics, which is currently only available in German, and her publications on the didactics of mathematics, which are currently only available in Dutch. In the following, we will briefly introduce each chapter.

Part I: Tatiana Afanassjewa's Life and Forgotten Legacy

In Chap. 1, Margriet van der Heijden provides a biographical sketch of Tatiana Afanassjewa's life. Afanassjewa studied mathematics and physics both at the *Bestuzhev* courses for women and later at the 'regular' university in St Petersburg. In 1902 she went to Göttingen to study under Felix Klein, where she met Paul Ehrenfest, who shared her ideals, and who she married in Vienna in 1904. When the couple moved to St Petersburg, she became a prominent participant in debates on mathematical education there. Her life changed again when she accompanied Ehrenfest to Leiden, The Netherlands, in 1912, where he became a full professor of theoretical physics, as the successor of H. A. Lorentz, while laws and unwritten rules prevented her from obtaining an academic position. It demonstrates Afanassjewa's strength that she soon initiated a fierce debate on mathematical education—it led to the foundation of the academic journal *Euclides* for Dutch mathematics teachers—while also designing a house that would provide a welcoming household where Einstein, Bohr and at least a dozen of other Nobel laureates and many more academics and students participated in lively debates.

In Chap. 2, Marianna Antonutti Marfori explores Afanassjewa's work on the pedagogy of mathematics, in particular geometry, and discusses Afanassjewa's views on the teaching of geometry in the context of the early twentieth century debate on mathematical education. Afanassjewa holds that the educational value of geometry lies in its method and its quest for utmost clarity. By learning to process spatial images in their mind by representing them visually, filling in gaps, and identifying contradictions, the student can make the method of geometry their own, and go on to apply it to new problems, both inside and outside geometry. Both of the dominant approaches at the time, on Afanassjewa's view, fail to recognize this essential aspect of geometry. According to the first of these, geometry should be taught by laying out rigorous, discursive proofs in the style of Euclid. According to the second, geometry should be taught by developing insights arising from concrete examples. Since a rigorous, axiomatic presentation of the results of geometry does not show the thought process that brought it about, the student cannot understand or appreciate the importance of a logical presentation of geometry until they have already attained a certain mastery of the subject matter. On the other hand, the untrained student cannot generally be expected to make the correct generalizations from concrete examples. Afanassjewa argues that the correct

approach is to develop the student's reasoning about spatial relations and their presentation, thereby also training the student's ability to reason logically. Once space has been studied systematically in this way, the student will be able to recognize the axioms of geometry as evident and appreciate the value of an axiomatic presentation of the subject. The chapter discusses the points of contact between Afanassjewa's views on the roles of logic and intuition in geometry and those of Poincaré, Klein, and Hilbert.

In Chap. 3, Jos Uffink and Giovanni Valente discuss crucial aspects of Afanassjewa's (1925, 1956) original work on the foundations of thermodynamics. First, they focus on her treatment of reversibility in thermodynamics and her introduction of 'quasiprocesses' in this treatment and show how closely this discussion relates to some current discussions in philosophy of science and show how her approach resolves a paradox put forward by Norton (2013, 2016) that allegedly plagues thermodynamically reversible processes. Another issue raised by Afanassjewa is whether, owing to the formal analogy between temperature and pressure as integrating divisors for heat and work, respectively, one could formulate the Second Law not just in terms of entropy, but also in terms of volume non-decreasing processes when no work is performed on a system. Yet, she pointed out that one can construct examples where the analogy breaks down, unless some extra axiom is added. Finally, Uffink and Valente take up her discussion of the alleged logical equivalence between Kelvin and Clausius formulations of the Second Law, which Afanassjewa questioned in light of the possibility of absolute negative temperature, 30 years before Ramsey (1957) made that possibility more widely known to the physical community.

Part II: The Ehrenfests' Work on the Foundations of Statistical Mechanics

In Chap. 4, Roman Frigg and Charlotte Werndl analyse the Ehrenfests' argument for the conclusion that the phase averages generated by Gibbsian statistical mechanics and Boltzmannian equilibrium values should coincide. The relation between the Boltzmannian and Gibbsian formulation of statistical mechanics is still a major conceptual theme in the foundations of statistical mechanics: therefore, the argument is still highly relevant today. The chapter fills in some important details the original argument skipped over and points out that the its scope is limited to dilute gases. This is not a shortcoming of their argument but an inherent limitation of the claim: it is not generally the case that Boltzmannian equilibrium values and Gibbsian phase averages agree. They then discuss the example of the six-vertex model and show that in that model the two values come apart and go on to offer a general theorem providing conditions for the equivalence of Boltzmannian equilibrium values and Gibbsian phase averages.

In Chap. 5, Patricia Palacios analyses the 'ergodic hypothesis' which the Ehrenfests prominently introduced and highlighted in their celebrated joint Encyclopedia article of 1911 as a crucial assumption of Boltzmann's approach to statistical mechanics. This article has been strongly criticized by historians of science as not providing an historically accurate account of Boltzmann's approach. However, Palacios also evaluates the role that the ergodic hypothesis of the Ehrenfests came to play in the subsequent development of ergodic theory in the course of the twentieth century and argues that the major constructive role of the Ehrenfest's discussion of the ergodic hypothesis in these developments stems precisely from those aspects about their formulation of the hypothesis that historians have regarded as historically inaccurate.

In Chap. 6, Joshua Lucasz and Lena Zuchowski highlight and discuss the Ehrenfests' use of toy models to explore irreversibility in statistical mechanics. In particular, the chapter explores their urn and *P–Q* models and emphasizes that while the former was primarily used to provide a simple counter-example to Zermelo's objection to Boltzmann's statistical mechanical under-pinning of the Second Law of Thermodynamics, the latter was intended to highlight the role and importance of the *Stosszahlansatz* as a cause of the tendency of systems to exhibit entropy increase. They also explain the sense in which these models are toy models and why agents can use them, as the Ehrenfests did, to carry out this important conceptual work, despite the fact that they do not represent any real system.

Part III: Translations from German and Dutch

Chapter 7 presents the translation by Marina Baldissera Pacchetti of one paper and four chapters of Tatiana Afanassjewa's book on the foundations of thermodynamics. The paper, published in 1925 in the journal *Zeitschrift für Physik,* is titled 'On the Axiomatization of the Second Law of Thermodynamics'. In this paper, Afanassjewa considers the axiomatic derivation of the Second Law of Thermodynamics by Carathéodory (1909) and argues that this derivation requires at least two more logically independent axioms. After 1925, she wrote many more papers on the foundations of thermodynamics and summarized her views in a book manuscript in the early 1940s. This book, entitled *Die Grundlagen der Thermodynamik* (The Foundations of Thermodynamics) was finally published in Leiden in 1956. This volume will provide a first translation of selected parts of this book in English. This translation includes the foreword, in which Afanassjewa clarifies her approach; the Chap. 1, in which she clarifies her use and understanding of fundamental terminology; Chap. 6, in which she discusses the distinction between processes and quasiprocesses and related issues—such as reversibility and entropy; Chap. 8, on the Clausius-Thomson principle and irreversibility; and, finally, the third appendix, in which she comments on the Bolzmannian H-theorem.

In Chap. 8, Pauline van Wriest translates Tatiana Afanassjewa's famous manifesto, *What can and should geometry education offer a non-mathematician?* (1924)

from Dutch, a manifesto which led to an intense dispute with E. J. Dijksterhuis on mathematical education which in turn led to the foundation of a new Dutch-language journal *Euclides*, devoted to the teaching of mathematics.

Jos Uffink
Giovanni Valente
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Contents

Part I
Tatiana Afanassjewa's Life and Forgotten Legacy

Chapter 1
Tatiana Ehrenfest-Afanassjewa: No Talent for Subservience

Margriet van der Heijden

One tall house stands out at the end of Leiden's quiet and inconspicuous Witte Rozenstraat, just outside the city center. Its white-plastered walls, its size, and neoclassical design contrast with the modest appearances of the neighboring brick houses. A curious passer-by might notice the two plaques in the almost windowless wall on the street side. One is dedicated to the Austrian–Dutch physicist Paul Ehrenfest. "Here lived and worked professor Paul Ehrenfest," it says, simply. The white stone plaque was a gift from the *Christiaan Huygens Dispuut*, the debating society for students in mathematics and natural sciences in Leiden with a long and impressive history.[1] A second, similar plaque commemorates "His wife, Tatiana Afanassjewa who, ahead of her times, opened up this house for people and ideas."[2]

A more inquisitive passer-by will, after some further research, observe two more things. First, the plaque dedicated to Afanassjewa was placed there several years after the one for Ehrenfest, as if all other people living in the house, including Afanassjewa, as well as the house itself, were initially only considered to be part of the backdrop against which Ehrenfest performed his outstanding work. One could argue that this is how things are done: we remember and commemorate those who perform, not those who assist them in their performance. This would be a valid point, were it not for the fact that Ehrenfest is not remembered primarily for his research achievements in theoretical physics, though they are important, but rather for the role he played as a "knowledge broker" and "catalyst" within that field.

[1] The Dutch "Dispuut Gezelschap Christiaan Huygens" was established at the end of the nineteenth century and still exists today.

[2] Tatiana Afanassjewa herself always used this German transcription of her name when not in Russia, both privately and when publishing essays and research articles. It will be used in the current article as well.

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Critical, excellent in spotting high-profile and groundbreaking work of colleagues and, as his brother once wrote, "with a flair for recognizing outstanding personalities with whom you then quickly get in touch,"[3] Ehrenfest was for theoretical physics what a charismatic gallery owner can be for the arts.[4] Colleagues like Einstein, Bohr, Sommerfeld, and many others greatly appreciated his ability to evaluate their work, to recognize its weak and strong points, and to link it to old and new trends in physics in crystal clear language.[5] They valued Ehrenfest's large network, his helpfulness in bringing people from different places and backgrounds together, and his absolute and conscientious dedication to physics. They loved to visit the large house at the end of Witte Rozenstraat, which served as a meeting place and, in a sense, a gallery for physics.

What role did Afanassjewa play in all that? A second observation a passer-by might make is that, before her name is even mentioned, she is defined in relation to Ehrenfest: she was "his wife."[6] Does that imply that her role, in "opening up the house," was a traditional one? Was she the professor's wife who enjoyed being a hostess for the many—mostly male—scientists that came to the house with a mind full of ideas and with high hopes of sharing and discussing those ideas with other visitors? In the context of Dutch society, with its conservative stance on gender roles, it would be tempting to answer these questions affirmatively, especially since no further details on Afanassjewa's background, training, or possible public roles are given.

Yet, in spite of the good intentions of the *Christiaan Huygens Dispuut*, such an interpretation does not do justice to Tatiana Ehrenfest-Afanassjewa, who did indeed receive plenty of guests in Leiden and elsewhere, but who had no talent for subservience. Afanassjewa was an independent and successful Russian mathematician and physicist in her own right, with the extraordinary courage to trace out her own path under circumstances and in times and places that hardly allowed women to develop and use their talents. She not only opened up her home to outsiders, as the plaque commemorates, she herself designed this magnificent house which, to this day, shows a number of interesting "Russian" details.[7]

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[3] Hugo Ehrenfest to Paul Ehrenfest, 9 April 1924: Ehrenfest Archive, Museum Boerhaave Leiden (EA-MBL) 1.1.2.

[4] Ehrenfest himself inspired this notion, since he once compared Einstein to Holbein and Bohr to Rembrandt during a conversation with Robert Oppenheimer: Undated note from R. Oppenheimer to M. J. Klein, EA-MBL 12.1.

[5] Klein (1970).

[6] Marriage certificate, 21 December 1904: EA-MBL 2.2.

[7] Examples are thick walls that keep the house warm in winter and cool in summer; a heating system with horizontal pipes rather than radiators; double-glazed windows with large spaces between the inner and outer layers of glass; "lazy" stairs that are more likely to be found in Saint Petersburg than in Leiden. Sketches and building plans: Ehrenfest Family Archive (EFA).

1.1 The Alarming Rectilinearity of Her World line

Who was Tatiana Afanassjewa? In a letter to her and Ehrenfest, written shortly after a stay in Leiden, their friend Albert Einstein wrote jokingly: "T will also join us [in appreciating Bach] despite the alarming rectilinearity of her intellectual worldline (an exception to the laws of motion?)."[8] Einstein is referring here to Afanassjewa's lack of willingness, at least until then, to attach a higher value to Bach's chorales than to those by Russian composers. In the same stroke, he also characterizes her entire intellectual development as rectilinear.

Grudging admiration seems to resound in the little joke. Afanassjewa was totally different from the women that surrounded Einstein at the time. Einstein had just spent years finishing the covariant equations of relativity, after years of work,[9] and was in the midst of formalizing his divorce from Mileva Mariç. In addition, his future family-in-law was putting pressure on him to marry Elsa Einstein, who had been taking care of him and had already been waiting for him for quite some years.[10] They unnerved him, "these women" who "always wait for someone to come along who will use them as he sees fit,"[11] as he once wrote in these gloomy months. Afanassjewa offered a striking contrast: she had an independent streak, an analytical mind, she strongly expressed her ideas about education, and she freely participated in the many discussions about physics that took place in the large study at Witte Rozenstraat. Partly inspired by Leo Tolstoy whose portrait had a prominent place in the study,[12] she was also a vegetarian and abstained from alcohol and smoking, just like her husband.

Tolstoy's books and ideas had been part of her upbringing. Afanassjewa was raised by her aunt and uncle: the respectable and childless Sonya Maslova and her husband Pyotr Afanassjew, who worked as a chief engineer for the tsar's railways. Her mother, Yekaterina Ivanova, had taken little Tatiana from Kiev to Petersburg when she was only two years old, after her husband, the engineer Alexey Afanassjew, had suffered a major mental breakdown and had been committed to a mental asylum. In this city of tsars, ice, and white nights, a city oriented toward the Western world, her aunt and uncle had treated Afanassjewa as their own daughter and had given her an excellent education.[13]

A good education was one of the things Afanassjewa shared with Einstein's soon to be ex-wife wife Mariç, just as Ehrenfest shared quite a few traits with Einstein himself. Ehrenfest and Einstein were almost the same age, had both been raised in a secular, Jewish, middle-class family, both loved to play music, and both strongly

[8] Einstein to Ehrenfest, 18 October 1916: *The Collected Papers of Albert Einstein* (CPAE) 8a, Doc. 268; Also cited in Klein (n.5) 304.

[9] The first detailed discussions of this work can be found in letters to Ehrenfest: CPAE 8a, Docs. 182, 185.

[10] See, e.g., CPAE 8a, Introduction.

[11] Einstein to Besso, 21 July 1916: CPEA 8a, Doc. 238.

[12] Senger and Ooms (2007).

[13] Biographical notes by son-in-law Henk van Bommel, undated: EFA.

disliked the German educational system. Afanassjewa and Mariç were raised in families that adhered to the Orthodox Church—in Russia and Serbia, respectively––both were a couple of years older than their husbands, they had completed the gymnasium (a kind of grammar school) before studying physics and math, and both went abroad to study at university.[14]

Yet, there was a crucial dissimilarity between the two women as well. The rebellious and fierce Mariç had been crushed by the immense talents and ambitions of her Albert. In their household with two small sons, amidst the laundry and the cooking, Mariç had become a somber shadow of her former self.[15] By contrast, Afanassjewa and her charismatic, insecure, and restless Paul had managed to organize their household, eventually including four children, in such a way that Afanassjewa could continue to study and work—though perhaps not as much and as freely as she would have liked. It made an impression on Einstein, as he wrote after another stay in Leiden, three years later, in 1919: "Not in any other house did I experience such a joyful family life; it stems from two independent people who are not bound together by compromises!"[16]

Einstein had been equally observant when he had used the epithet "rectilinear" to characterize Afanassjewa's "intellectual worldline," as some persistent trends can be observed in her intellectual world. Guiding lines in her life were her rock-solid passion for mathematics and physics, particularly thermodynamics, the value she attached to independent, logical, and critical thinking, as well as her clear and strongly voiced ideas about education, especially about teaching geometry.[17] Another constant throughout her life was her attachment to things Russian: its hills and forests,[18] its music, language, and literature, as well as some of its traditions and many of its scientists.

1.2 Higher Women Courses for the Weaker Sex

What was Russia like while Afanassjewa grew up there? How did she end up in Leiden? Her link to this modest Dutch town was Ehrenfest, whom she met in Göttingen in 1902, ten years before he became successor to Hendrik Lorentz[19] at the University of Leiden. After finishing her studies in Russia, Afanassjewa had traveled to Göttingen, the German "Mecca of mathematics," with her aunt Sonya, hoping to deepen her knowledge of physics and mathematics. She was not the first Russian woman to do so. The two most important mathematicians in town, Felix Klein and

[14] Mariç went to Zürich immediately after high school. See, e.g., Popović (2003).

[15] See, e.g., CPAE 9, Introduction.

[16] Einstein to Ehrenfest, 9 November 1919: CPAE 9, Doc. 155.

[17] Ehrenfest-Afanassjewa (1960). Personal details: from the preface to this collection of essays by Dutch mathematician Bruno Ernst [pseudonym of J.A.F. [Hans] de Rijk].

[18] Personal communication T. van Bommel.

[19] Hendrik Antoon Lorentz (1853–1928). For a concise biography, see Kox (2018).

David Hilbert, had no objection to women in their field and in the years before Afanassjewa's arrival two Russian women, Lyubov Zapolskaya[20] and Nadezhda Gernet,[21] had finished their doctorates with Hilbert.[22]

Yet, Afanassjewa hardly received a warm welcome. German students in several cities had raised objections against the number of foreign students, and especially against *female* foreign students, for the most part Russian, who were taking up space and time in the already overcrowded lecture rooms. In response, the University of Leipzig and the medical faculty in Göttingen had decided not to admit women any longer and, although Hilbert and Klein did not follow this example, it is not surprising that the mathematics and physics students strictly adhered to the old policy of excluding women from their weekly colloquia.[23] "Women are invited during festivities only," was the reply Ehrenfest supposedly received, when he inquired why the new Russian student—Afanassjewa—had not been invited. Eventually, it was Ehrenfest who successfully challenged the unwritten rules. It marked the start of a long-term relationship between him and Afanassjewa.[24]

Afanassjewa was happy to participate, discuss, and learn, but: "There was a large difference between what the professors in Petersburg had taught us, and what was discussed in Göttingen (Klein, Hilbert, Minkowski)," she said, much later in life.[25] For women, nothing in the educational system was to be taken for granted and this was true as well for Afanassjewa, even though she had grown up in St Petersburg, where a feminist elite had advocated for higher education for women well before women in most European countries began to do so.[26] In St Petersburg, the first gymnasia for girls opened as early as the middle of the nineteenth century, and around 1860, many well-to-do citizens opened up their salons to women for free lectures on Sundays, while women also began to attend lectures at the university. After Tsar Alexander II had prohibited all these activities in 1862, an impressive number of Russian women went abroad to attend the universities of Zürich and Paris, which had just opened

[20] Lyubov Zapolskaya (1871–1943). Like Afanassjewa, she studied at the Pedagogical Institute, the Bestuzhev Institute, and then obtained her Ph.D. in Göttingen, with Hilbert (1901). In Russia, in Saratov, she then taught mathematics, among other subjects, and headed the department of Higher Mathematics and Mechanics at the Pedagogical Institute of Yaroslav. *she-win.ru/nauka/588-lubov-zapolskaya.*

[21] Nadezhda Gernet (1877–1943) first studied at the Bestuzhev Institute, and then obtained a Ph.D. with Hilbert in Göttingen (1902). She became a teacher at Bestuzhev, and went on to teach at the university, once its courses had merged with those at the Bestuzhev Institute. In 1930, she became a professor at the Polytechnic Institute in Petersburg: Editors A.N. Kolmogorov and A.P. Yushkevich, *Mathematics of the 19th century* (Basel 1998).

[22] Klein received support for his policy from the Prussian minister for education. E.g., Thiele (2011).

[23] Bonner (1995).

[24] Afanassjewa to M. J. Klein, undated: EA-MBL 12.1.

[25] Ehrenfest-Afanassjewa (n.17). Strikes and unrest in 1899 may have had a negative effect on the courses.

[26] The cities were different from the rural areas in Russia, where the majority of the population was illiterate.

their doors to women students. In fact, of the 203 women who studied in Zürich between 1864 and 1872, 148 came from Russia.[27]

Afanassjewa's generation was the first one to profit from their efforts. Fearing that, after their return from abroad, women scientists and lawyers would oppose his policies and undermine his authority even more, Alexander II and his government relented and allowed for the establishment of Higher Women Courses, in other words, higher education for women. The Higher Women Courses in St Petersburg opened their doors in 1878, just before Afanassjewa first arrived in the city. They were soon referred to as the Bestuzhev courses, after their first dean, the historian K. N. Bestuzhev-Ryumin.[28] A private organization took care of funding for the institute, raising money through book sales, concerts, and by collecting gifts,[29] and not long afterward a large new building appeared on the Vasilyevsky Island, not far from the university.[30]

Large efforts were made to guarantee high-level lectures. Professors like Dmitri Mendeleyev and Alexander Borodin taught courses at the Bestuzhev for a small fee. Other scientists offered moral support: "If a woman receives an adequate education and training she can pursue culture in science, art and public life just as well as a man,", the brilliant professor and surgeon Nikolay Pirogov wrote to a baroness friend of his, in the year when Afanassjewa was born.[31] This intellectual climate, as well as having been raised in an academic environment (her uncle would soon become a professor of mathematics at the Polytechnic Institute in Petersburg,[32] while her aunt was in favor of modern education[33]) seemed to almost predestine Afanassjewa to attend the Bestuzhev courses. Yet, her uncle sent her instead to a pedagogical institute that trained teachers up to the lower levels of the gymnasium.[34] Was he afraid perhaps––with his brother in mind—that Afanassjewa's nerves would suffer from intensive studying? Or was he deterred by the reputation of the Bestuzhev Institute, which was

[27] Koblitz (2013).

[28] www.prlib.ru/en/history/619592. Women could study History and Philology or Physics and Mathematics. After 1906, a third possibility was Law.

[29] Stites (1978).

[30] Currently the faculty of Earth Sciences of the University in Petersburg.

[31] Hans (1963). These words were not empty: As early as 1864 9,000 girls were enrolled in 29 girls' schools of the first order (later called gymnasium) and 91 of the second order (later called progymnasium) and in 1869 another 32 girls' schools had been established.

[32] Van Bommel (n.13).

[33] Sonya had sent Afanassjewa to a new private gymnasium, in a large building at the Ulitsa Kabinetskaya, slightly south of the Fontanka. The director, Maria Nikolyevna Stoyunina, applied the innovative pedagogical principles her husband, Vladimir Stoyunin, had described in lectures and books: teachers tried to foster individual talents, pupils were allowed to jump, run, and talk for 15 min between classes to refresh their minds, and they had gymnastics classes every day. Latin and Greek were not taught; the curriculum was a watered-down version of what boys were taught, according to what Afanassjewa said later [n. 17], "but the pedagogical methods were such as I would like to see them everywhere."

[34] Called Pedagogical Courses of the Girls' Gymnasium and, from 1903 on, Women's Pedagogical Institute.