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NEWSLETTER

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Carolyn Beatrice Parker: A Life in Physics

by Ronald E. Mickens and Charmayne E. Patterson, Clark Atlanta University

Carolyn Beatrice Parker (CBP) [1] grew up in a family in which both parents had college and professional degrees. Her five siblings, except for one, earned degrees in the sciences and mathematics and all acquired at least one master's degree. Carolyn graduated from college with a bachelor's degree in physics, taught at several public high schools and two colleges, was a scientist with the Manhattan Project (Dayton, Ohio site), earned two master's degrees, one in mathematics, the other in physics, and worked as a technical analyst at a large military research laboratory. Yet, in spite of these remarkable accomplishments, few have heard of CBP. This hiddenness may result from her being an African American female scientist.

The main purpose of this short bio-essay is to introduce CBP to a general audience which includes not only non-scientists, but also those who have an interest in the history and sociology of science. The hope is that someone in the latter group will find an urge to write a proper, full-length biography of this fascinating woman. Note that knowledge of her upbringing, family life, social connections, academic career, and technical contributions could serve as motivating factors for young women to train and become members of the scientific community. Furthermore, CBP's story is important because she had a productive life in science during a time when few African American women or men could realistically hope to achieve this goal.


Portrait of Carolyn Beatrice Parker at her graduation from high school (1933).

In recent years, several articles have appeared in newspapers, public relations materials, and books which briefly discuss CBP. However, these offerings tend to contain inaccurate information. Generally, no thoughtful interpretation is given of CBP's life and career in science. One of our tasks in this bio-essay is to correct some of these errors and provide a limited understanding of what may have motivated CBP to seek a career in science. We have also located several documents related to her employment and used additional sources to clarify some issues concerning where, when, and in what disciplines she earned her two academic master's degrees. Other sources have allowed us to gain insights into her personality and life outside of her employment situations.

Parker Family

Carolyn Beatrice Parker was born in Gainesville, Florida on November 18, 1917. Her father, Dr. Julius Augustus Parker, was a physician and pharmacist who graduated from Fisk University and Meharry Medical College, both in Nashville TN. Her mother, Delia Ella Murell Parker was an elementary

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Isaak Khalatnikov – Essential Singularities: Essential singularity is where a function exhibits extreme behavior

by Margarita Ryutova, Lawrence Livermore National Laboratory

In August 2009 I received a letter from Dr. Claus Ascheron, then Executive Physics Editor at Springer -Verlag. By that time Springer stopped publishing memoires, and Dr. Ascheron wrote to me:

"… We are in discussion concerning the publication of a historically interesting book. dealing partly with the history of the Landau institute…Because you are very familiar with this topic as I learned from your article in Physics Uspekhi on ''There is the Scientific Council and the Wednesday seminar. That will do" [1] I would like to ask you as someone with insider knowledge to give a supportive comment to the publication of this book by Khalatnikov. You probably know him well.… I need such comments to get a book which is not in the core of the Springer program approved by the editorial meeting."

I was flattered and happy to receive such a request and quickly got down to business. Springer published the book with the title tailored for a Western reader: "From the Atomic Bomb to the Landau Institute. Autobiography. Top Non-Secret" [2] The original title of the book is in the spirit of the Landau school: "Dau, Centaur and others (Top Non-Secret)" [3]. Dau is Lev Landau, Centaur is Pyotr Kapitsa. Others are those with whom Isaak Khalatnikov, Khalat, lived, laughed, worked and coexisted carrying his dignity and determination during the war as a regiment commander, as a leading scientist in high-priority atomic and nuclear projects, in the ruined post-war Russia and as a member of the National Committee approving the final hydrogen bomb project, and, as a creator of an extremely successful Institute of Theoretical Physics, carrying the name of Landau. He was a key member of the school created by Kapitsa and Landau, and tried his best to preserve the traditions of the school for future generations.

Brilliant scientist and a great organizer, Isaak Khalatnikov obtained fundamental results in various fields of physics from superfluidity and superconductivity to cosmology (see e.g. [4,5]). This includes series of works on inflationary stages in cosmological models of universe and the nature of singularity - the conjecture, which up to now remains as one of the most outstanding open problems in theory of gravitation.

After Landau's tragic car accident Khalatnikov became the head of the Theoretical department at the Kapitsa

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The articles in this issue represent the views of their authors and are not necessarily those of the Forum or APS.

Editor
Donald Salisbury
Department of Physics
Austin College
Sherman, TX 75090
dsalisbury@austincollege.edu
(214) 405-6188

Reviews of *What Stars Are Made of: The Life of Cecilia Payne-Gaposch* and *Portrait of a Binary*

Reviewed by David Whelan

What Stars Are Made of: The Life of Cecilia Payne-Gaposch
by Donovan Moore
(Harvard University Press, Cambridge and London, 2020), 300 pages
and

Portrait of a Binary
by Sylvia L. Boyd
(Penobscot Press, Penobscot, 2014), 507 pages

It became evident after reading the introductory chapters of Moore's book that this is not a novel piece of scholarship. It does not offer a new perspective on the life and work of Cecilia Payne, and virtually all of the information that it contains can be found in the written record elsewhere. Instead, it is an organizing of that record, a story crafted to engage and educate a wider readership. It has a forward by Jocelyn Bell Burnell and its dust jacket has quotes of praise by the likes of Billie Jean King and Scott Kelly. There is clearly an expectation by Harvard University Press that this book will have some "reach."

Moore's book excels at painting a picture of what life felt like for Cecilia Payne, particularly when she was young and ambitious. Relying heavily on her own memoir, his vivid descriptions give us an eye into both her difficulties and her joys. Her struggles for acceptance and recognition, as well as her own natural humility in the face of the greatest astronomers of the day, are touching and sometimes heart-rending. Her recollections about struggling to break down the social barriers that impeded her, and the conversations that ensued when she succeeded, will ring true for other introverts. And never have I been so aware of how middle-class life in the first half of the twentieth century felt for a woman, particularly one who bucked all trends of the time and eventually chose to maintain both a family and a professional life.

What Moore's book is missing, and what any biography must naturally struggle to gain a hold on, is a glimpse of the wider world that surrounded our heroine. While it is true that Moore drops most of the big names in the field at the time, and includes anecdotes about their interactions with Cecilia Payne, including such gatherings as Shapley's "Hollow Squares" in which these same big names "treated her as their equals" (p.174), the reader may be left with the opinion, particularly after reading Chp. 19, that Payne's greatest and most controversial findings stood alone in a field of much more modest pursuits, and that much of the astronomical community gave her short shrift on account of their own ignorances and prejudices. Prejudices, yes; but the history of the discovery of the composition of the stars is far more complicated than he presents, and the reader is given little information about it beyond the ill feelings Cecilia Payne initially felt towards Donald Menzel.

Astronomical knowledge was in its greatest throes for the first four decades of the twentieth century, and old currents of thought were becoming disused regularly. Such a time of upheaval is hard to describe. We are luckier, however, with this time period than with earlier ones, in that much that was written has been preserved and is now available digitally. Among the most important discoveries published while Cecilia Payne was at university, we have digital access to Henry N. Russell's words about the profound heat contained within the stars (Russell, 1919: p. 208), and Arthur S. Eddington's inspiring surmise that the mass deficit between hydrogen and helium atoms discovered by F. W. Aston is the energy source of starlight (Eddington, 1920: pp. 353-5). Or we can read about the interferometer built on the Hooker 100-inch telescope, and its first-ever measurement of the angular size of a star, Betelgeuse (Michelson & Pease, 1921).

During the years that Cecilia Payne was working towards her thesis (1923-1925), there is a plethora of discoveries that can be investigated easily using the NASA/ADS , and that we can be confident were known to her, at least peripherally. I provide the barest of highlights here without citation (the interested reader will be able to find the requisite papers without too much trouble), and in no particular order. There is George E. Hale's and Seth B. Nicholson's seminal paper on the magnetic nature of the sunspots. Then there's A. E. Douglass' growing realization that the solar cycle influenced weather on Earth. There was Edwin B. Frost, who was hard at work determining the radial velocities of stars using spectrograms. Donald Menzel was using the Fowler-Milne modification to Saha's theory to measure the temperatures of stars, and to compare the temperatures of dwarfs to giants. Edward A. Milne was taking a number of steps forward that we now take for granted in stellar astrophysics, including studies of rotating stars, limb darkening, applying the photoelectric effect to ionziation equilibrium in stellar atmospheres, and the determination of the Rosseland mean opacity coefficient. Walter S. Adams confirmed that Sirius B, now known to be a white dwarf, has extraordinary surface density, discovered a number of single-lined spectroscopic binaries, determined that there was a difference in brightness for B-type stars that are fast rotators and slow rotators, and calculated the radial velocities of a large number of stars, with obvious consequences for understanding stellar dynamics.

Pure astronomy was not the only field that was producing results of astrophysical significance, but I am nonetheless sure that Cecilia Payne and her colleagues knew about these important findings, too. Theodore Lyman was busy chugging away at producing spectra of the elements, and between 1923 and 1925 wrote up his results for helium (which was the most influential), aluminum, magnesium, neon, and argon. H. A. Kramers' work

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The Quantum Century Project

Continuing an effort initiated by the FHPP under the leadership of Paul Cadden-Zimansky, the APS submitted a proposal to the International Union of Pure and Applied Physics (IUPP) asking for their support that 2025 be proclaimed as The International Year of Quantum Science and Technology. The proposal was endorsed on October 28, 2021 by the IUPP General Assembly. The APS is working in conjunction with the German Physical Society and many other international physics associations in preparing a resolution that will be presented to the 2023 General Conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO) asking that 2025 be so designated. See https://www.aps.org/newsroom/pressreleases/year-quantum.cfm for further information. The German Physical Society has also posted a press release, available here (in German): https://www.dpg-physik.de/veroeffentlichungen/aktuell/2021/2025-soll-internationales-jahr-der-quantenwissenschaft-und-technologie-werden

Quantum Century History White Paper, by Alex Blum, co-Chair with Michel Janssen of the Quantum Century Project History Working Group

Building on the international collaboration initiated by the Quantum Century working group, a committee was formed, consisting of historians of quantum physics from around the world. Over the last year, this committee has developed a number of historical research projects, all of which are designed to produce results that will enhance the Quantum Century's outreach activities and to further public understanding of the century-long history of quantum physics. It should be noted that, given the limited resources of the history of quantum physics as a research field, most of these projects (many of which require labor-intensive data collection and digitization) will presumably not be feasible without additional funding. The projects are:

1. Women in Quantum Physics -WiQP (Coordinator: Liu Jinyan, Chinese Academy of Sciences)

The project aims to foster international collaborations, rich interdisciplinary scholarship, and heightened awareness/education regarding women from around the world who importantly contributed to quantum physics in the last century, yet whose roles have been largely overlooked. The hope is that this will also inspire further work on – and by – an increasingly diverse set of educators, historians, physicists, and journalists. In addition to these long-term goals, WiQP is organizing two invited sessions at the APS 2022 Annual Meetings and running several independent workshops (e.g., a workshop on Grete Hermann to be held at University of Utrecht in July 2022). By 2025, the project aims to have assembled a wide (both geographically and in time) range of high-quality studies on Women in Quantum Physics, completing an edited academic volume on the subject, along with a related website designed for the general public.

2. Quantum Archives (Coordinator: Christian Joas, Niels Bohr Archive, Copenhagen, Denmark).

The project aims to digitize and make publicly available a large number of historical sources from the history of quantum physics. The project would collect sources from a large variety of archives and make them available on a central website, highlighting central documents of special interest to the public. It would draw on the holdings of a set of major archives, such as the Niels Bohr Archives (Copenhagen), the Niels Bohr Library&Archives (College Park, MD), the Nobel Prize Archives (Stockholm), the Albert Einstein Archives (Jerusalem), and the archives of the Italian Physical Society, but will also assemble documents from the papers of individual scientists, scattered in smaller archives around the world.

3. Understanding Quantum Mechanics (Coordinator: Olival Freire Jr., Universidade Federal da Bahia, Brazil).

Physicists have had difficulties to understand quantum mechanics since the days of its inception, between 1925 and 1927. The creators of this physical theory debated around issues: such as visualizability, causality, discontinuity, and wave–particle dualism. Since then, new questions, such as entanglement, measurement, decoherence, and quantum gravity, have been added to this pool of issues. The project aims to map the existing diversity of understandings of quantum concepts among physicists, as well as the historical and conceptual origins of such diversity, both through historical research and by systematically collecting views from physicists still in research activity. The project thus will provide both a map and a genealogy of this issue, which will be presented in a web portal highlighting the diversity of understandings.

4. Institutional Geography and Intellectual Trajectories (Coordinator: Kristian Camilleri, University of Melbourne, Australia).

As has been well documented, the development of quantum mechanics in the 1920s was not the result of the efforts of a single scientist, but rather the implementation of an active program of research to which many researchers contributed. Younger researchers flocked to the leading centres of quantum theory—Munich, Gottingen, Copenhagen and Leiden—to work with the great masters; Niels Bohr, Max Born, Arnold Sommerfeld and Paul Ehrenfest. By the end of the decade, this polycentric institutional network had expanded considerably. Zurich, Leipzig, and

Rome quickly established themselves as desirable destinations for those wishing to work on quantum theory. It was here that younger researchers acquired first-hand experience of the way quantum physics was done, through formal lectures, seminars and lively discussions, often spending short periods of time in one institute before moving to another. This pattern would continue well into the 1930s, and involved physicists from across the globe. This project aims to trace the movement of physicists in and out of these institutions, making use of the latest computer dataset and graphics software. By following the trajectories of those physicists who played a pivotal role in the development and dissemination of quantum mechanics, we gain a valuable insight into the social conditions that made the quantum revolution possible.

5. Genealogy of Quantum Textbooks (Coordinator: Michel Janssen, University of Minnesota, USA).

The basis for this project will be data collected via a questionnaire asking physics faculty what textbooks (including mimeographed lecture notes) they used to learn quantum mechanics as undergraduate and graduate students and what textbooks they have been using to teach their own students. In tandem with this effort, a sustained effort will be made to compile an exhaustive database of all editions of all quantum textbooks and circulating lecture notes since the old quantum theory gave way to modern quantum mechanics in the mid-1920s. The initial focus will be on the US and other English speaking countries but the goal is to expand the project to other regions and other languages. There is anecdotal evidence about the rise and fall of certain textbooks but the data collected in this project will allow us to reconstruct in detail and on the basis of concrete evidence which textbooks were used when and where. The next phase of the project is to focus on those textbooks that saw the most heavy classroom usage at various points over the past fifty years or so and evaluate what this tells us both about how the teaching of quantum mechanics evolved in one country or language and about differences between different countries and language areas. To answer those questions the data collected via the questionnaires will be complemented by detailed study of the various editions of the most prominent textbooks, with special attention to their pedigree, i.e., the courses and older textbooks out of which they grew.

Book Reviews

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using quantum theory to explain the fine structure lines due to hydrogen (Kramers, 1920) was being used by Jane M. Dewey to quantify the fine structure lines for helium (Dewey, 1926).

There were other developments – too many to count. But some names that might ring true for astronomically-minded readers include Paul. W. Merrill (using Halpha to identify emission-line B-type stars, as well as work on the infrared oxygen triplet), Meghnad Saha (applying his own theories to studying the ionization of elements, such as silicon), Jan Oort (stars of different spectral classes have different space velocities), Adriaan van Maanen (measuring proper motions of stars), and J.S. Plaskett (both he and Russell were actively working to understand stellar evolution).

Cecilia Payne's was a complex world in which many people were working on an array of problems and new, important discoveries were being made at break-neck speed. It is important to keep this in mind when considering one of the most difficult passages to read in Moore's book. After turning in her thesis and traveling home for a vacation, Cecilia Payne excitedly told Arthur Eddington that she had found evidence that hydrogen was the most abundant element in the stars. She was speaking to a man who stands head and shoulders above absolutely everyone else I have previously mentioned, as he was at the forefront of a large number of developments in astronomy and physics and knew the difference between a true discovery and a tell-tale sign. His response to her, that Moore quotes from Payne's memoirs is: "You don't mean in the stars. You mean on the stars" (Moore, p. 187). It felt chilling to read it, and she herself felt silly about having had a "burst of youthful enthusiasm" in front of him. But on reflection, I have come to see it from Eddington's point of view, too. His are the words of a cool-headed person, someone who would not jump the gun, and someone for whom there were other considerations. Therefore Eddington needed to be persuaded. And that illustrates very well, if anecdotally, what it was like to be a part of the scientific community in which the very greatest discoveries were being made at the time.

Regardless of how Cecilia Payne's own words make us feel toward her, there is absolutely no question that she was discriminated against throughout most of her career and was not given deserved recognition. But the actions of the Harvard leadership do not represent the entire astronomical community. The eminent astronomer Otto Struve was one who took pains to read her book on stellar atmospheres (Payne, 1925) in great detail. It is generally known that he thought it brilliant – perhaps the best ever written in astronomy. It is less well known that he had specific and honest criticisms that, when taken at face value, shows that he noticed the overstatement of several conclusions (Struve, 1926). Struve was a man who took Cecilia Payne's work seriously, and so gave her criticisms of value that I can only imagine she took seriously in her turn – she was too conscientious not to. The fact that she was highly sought after as a guest lecturer after publishing her book also illustrates that the gender discrimination she suffered was not universal.

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March 2022 FHPP Sessions

Wednesday, March 16 | 15:00 Central Standard Time (Chicago)

Physics at Small Colleges and Universities, Eric Landahl (Chair),

- The historical importance of women's colleges, Joanna Behrman
- Physics in post-world war II black colleges (1945-1955), Charnell Chasten Long
- Building a community of physics majors, Jennifer Docktor
- From program chair to division: Building the next generation of physics programs, Taviare Hawkins

Thursday, March 17 | 15:00

Pais Prize Session: Women in Quantum Physics, Elise Crull (Chair), City College of New York

- Patricia Fara - Pais Prize winner [in person]
- Breaking the glass ceiling: Maria Lluïsa Canut between Spanish and American Physics, Marta Jordi
- Jane Dewey: The seeking of trust and credit of a woman in experimental quantum physics, Adriana Minor
- Chien-Shiung Wu and her contribution to experimental physics, Jinyan Liu

April 2022 FHPP Sessions

Saturday, April 9 13:30 Eastern Standard Time (NYC)

The Century of Physical Cosmology – Paul Halpern (Chair), University of the Sciences

- The social construction of physical cosmology, P. James E. Peebles
- Theoretical cosmology in the 1960s, Dennis Lehmkuhl
- Observational cosmology in the 1960s, Christopher Smeenk

Sunday, April 10 | 8:30

History of Astrophysical Visualizations – Tiffany Nichols (Chair),

- History of black hole visualizations, Emilie Skulberg,
- History of visualizing the cosmic microwave background, Connemara Doran
- History of visualizing Einstein's general theory of relativity, Matthew Stanley

Monday, April 11 | 13:30

Women in Quantum Physics – Michel Janssen (Chair), University of Minnesota

- Laura Chalk and the Stark effect, Daniela Monaldi
- Beyond beta: Unpacking the 'personal and political' in the Life of Chien-Shiung Wu, Michele Frank
- Lucy Mensing - Forgotten pioneer of quantum mechanics, Gernot Muenster

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school teacher. Julius and Delia Parker had seven children, with Carolyn being the oldest. One child died at age 9.

Within the Parker family education played a major role in the life of its members. As Joan Murrell Owens, Carolyn Parker's maternal first cousin, states [3, pp. 208]:

> In my family - and I mean this in the extended sense - it was understood that you would go to college… My generation of family and friends was indoctrinated early [with the idea] that education was the only path to "freedom" … The [community] expected you to excel and you responded to their loving pressure."

It should be noted that Joan Murrell Owens' father, William Murrell, graduated from Meharry Medical College with a degree in dentistry. Further, his sister, Delia Murrell, married Dr. Julius A. Parker, and was Caroline's mother. One of Joan's sisters, Williette Murrell received a degree in mathematics from Fisk University in 1951 and had a long career with the United States Weather Bureau working on problems related to long range weather forecasting [3].

Thus, as a consequence of her family and community, all of Caroline's siblings, cousins, and close friends attended college. Remarkably, most majored in and received both undergraduate and graduate degrees in the sciences and/or mathematics. In summary, Carolyn and her siblings achieved the following degrees:

Carolyn Beatrice Parker - BA, Physics Fisk University 1938; MA, Mathematics, University of Michigan, 1941; MS, Nuclear Physics, MIT, 1953.

Mary Parker Miller - BA, Mathematics, Talladega College, 1938; MS, Mathematics, New York University, 1957.

Juanita Parker Wynter - BS, Mathematics and Chemistry, Saint Augustine College, 1945; MS, Counseling New York University, 1957.

Julia Leslie Parker Cosby - BS, Chemistry (?), Fisk University, 1947; MS, Medical Technology, Meharry Medical College, ca 1950.

Julius Augustus Parker, Jr. – BA, Chemistry, Fisk University, 1949; MS, Chemistry, University of Michigan, ca 1951.

Martha Parker Anderson - BS, Social Sciences, Tennessee Agricultural and Industrial State College, 1943; MS, Sociology, Temple University, ca 1946.

The major reason for the educational success of the Parker and Owens families, "despite the lack of proper books and laboratory equipment in the segregated public schools [that they attended]" was that as students they had both dedicated and competent African American teachers [3]. As Joan Murrell Owens put it, "between them and my parents, I was well prepared when I entered college" [3].

Carolyn Beatrice Parker: The Person [2]

CBP stood five feet, two inches tall, with thick curly hair, which she often wore at shoulder length. With a thin body type, brown eyes, and "skin the color of coffee with lots of cream," she readily stood out in any situation where she was present. Most of the time, when with others, she had a slightly devilish smile, superimposed on a facial expression indicating acute curiosity. All of these physical attributes were enhanced by her mild, pleasant, and even voice. However, Carolyn was also self-assured, i.e., very confident in what she said, did, and believed, and seldom, if ever allowed herself to be placed in an inferior position, either socially or intellectually.

CBP enjoyed engaging in both conservational and physical activities. She was also a conservative, but stylish dresser, as can be seen in photos of her. Her active sports included tennis, swimming, baseball, and volleyball, and her two major hobbies were taking photographs and collecting coins (pennies). There is in the Parker family lore the suggestion that CBP may have taken flying lessons. This may have occurred in either Nashville, Tennessee, Dayton, Ohio, or Boston, Massachusetts. However, there is no evidence that she actually obtained a pilot's license.

Family members considered Caroline to be "very independent, very headstrong." These characteristics and her status of being the oldest sibling often placed her in charge of the Parker household during her teenage years. Her niece, Dr. Leslie Carolyn Edwards, states that CBP "raised her youngest sister… Julia Leslie Parker."

Caroline was very popular in both high school and college (Fisk University), but never had any known serious boyfriends. "No one serious enough to bring home." She never married. During the latter part of her life, while employed in the Boston area, CBP often sent letters, postcards, and gifts to her family. For the younger members these items often consisted of toys and written materials related to rockets, aviation, and scientific topics. The Parker family had always been members of

This Parker family portrait was taken in 1949 at the graduation of Julius Parker,Jr. from Fisk University (Nashville, TN). At the time CBP was a member of the Faculty of Physics. Pictured, (L to R) are: Leslie Parker Crosby; Julius Parker, Sr. (father); Julius Parker Jr.; Martha Parker, Juanita Parker; Carolyn Beatrice Parker; Mary Parker Miler(?); Delia Parker (mother) the Methodist Church, however, late in life Caroline converted to the Catholic faith and remained an active congregant until her death.

Fisk University

Carolyn Beatrice Parker graduated in 1933 from Middleton High School in Tampa, Florida. She then became a secondary school teacher in Rochelle, Florida to earn and save money for college [5]. She selected Fisk University, the school from which her father graduated. Fisk University was a Black college, but the academic training, professional standing, and scholarship production of its faculty, as well as the overall quality of its student body, made it competitive with many of the outstanding majority white liberal arts undergraduate institutions in the northeastern United States. Fisk required, at the completion of the freshman - sophomore years, it's students to pass a rigorous multi-day series of examinations to advance to the third year of college. Similarly, comprehensive final examinations were to be passed before one could graduate from the University. In 1934, CBP entered Fisk University and selected physics as her major. This major may have been chosen because the Department of Physics was chaired by Dr. Elmer S. Imes, the second African American to receive the doctorate in physics and well known for his experimental research on the spectroscopy of hydrogen-halide diatomic molecules [6]. While the department was small in terms of its staff and number of majors, it maintained close ties with the Chemistry Department and its research activities. Another advantage of this situation was that most upper level courses were done in the fashion of essentially individual tutorials and/or instructor guided projects.

Physics instruction at Fisk was taken seriously and based on many hours of work in the associated course laboratory. For example, the General Physics course was worth five credit hours per semester, broken into three hours of lectures, and two separate laboratories, each two hours per week.

Other courses with a similar format included Electrical Measurements; Sound, Heat and Light; Advanced Laboratory Techniques, and Modern Physics. One semester offerings were available in subjects such as Elements of Radio, Elements of Photography, and Electronics. Also, during the years of World War II, a number of air-flight related courses were included in the physics curriculum: Theory of Flight, Meteorology, and Aircraft and Engines. Carolyn Beatrice Parker graduated from Fisk University in 1938 with an undergraduate degree in physics, receiving the honor of magna cum laude.

Public School Teacher and College Instructor: 1938-1943

After CBP graduated from Fisk University, she wanted to attend graduate school to obtain an advanced degree in either physics or mathematics. Her advisor at Fisk, Dr. Elmer S. Imes suggested the University of Michigan, where he had obtained his doctorate in physics in 1918. However, no funding was available for her from Michigan and neither she nor her family could support her for this endeavor. At this point, Carolyn decided to work and save money for future graduate studies. She also applied to the Graduate Program in Mathematics at the University of Michigan and was accepted. While she was eager to be in the Graduate Physics Program, she joined the Mathematics Department because it did not require the writing of a Master's thesis. Therefore, she could be employed away from the university during the academic year and be a full-time student during the summer terms. Thus, she could finish the master's degree in mathematics faster than the corresponding degree in physics.

Carolyn taught in public schools between 1938 and 1942: in Rochelle, Florida from 1939 to 1940; and in Newport News, Virginia from 1941 to 1942. For the summers of 1939 and 1940, she took courses at the University of Michigan and spent a full academic year on that campus to complete the requirements for the MA degree in Mathematics, which she received in May 1941.

In the summer of 1942, Carolyn received an offer to teach at Bluefield State College in Bluefield, West Virginia. She went there as an instructor in the Department of Science and taught a variety of mainly introductory courses in physics and mathematics. However, her stay at Bluefield would only last for one year.

Dayton Project

On December 7, 1941, Japan attacked Pearl Harbor. The next day, the United States declared war on Japan. Several days later, Germany declared war on the United States and this declaration was reciprocated soon after by the US government. The fear that Germany might construct an atomic bomb and use it to help win the war led to the creation of the Manhattan Project [9]. This effort represented United States research and development activities that produced two different types of working atomic weapons that were eventually dropped on the Japanese cities of Hiroshima and Nagasaki [9].

Since Carolyn had skills in the use of electronic testing equipment, infrared spectroscopy, and advanced applied mathematical techniques, she was soon recruited from her teaching position at Bluefield State College in West Virginia to begin work as a scientific employee with the Dayton project. This top-secret site was located in Dayton, Ohio and was a research and development project to produce the element polonium, Po-210, as part of the overall and much larger Manhattan Project [10,11]. This element was employed to create "polonium-based modulated neutron initiators which were used to begin the chain reactions in the atomic bombs…The fact that polonium was used as an initiator was classified until the 1960s…" [12]

CBP standing before a bank of testing instruments, taken at Wright Field, near Dayton, Ohio, ca 1945.

It should be noted that while CBP is listed in both "Manhattan Project People" (along with Vannevar Bush, Leslie Groves, and J. Robert Oppenheimer) [13] and "Women on the Manhattan Project" [14], her cover story during her work with the Dayton Project was that she was involved with the testing of radio antennae at the Air Technical Service Command which was headquartered at Wright Field, near Dayton [15].

Carolyn's listings in the tabulations [13, 14] also indicate that she was considered a scientist and not a technician or laborer. These distinctions, i.e., how one was identified in terms of their "work", played important roles within the context of the Manhattan Project hierarchy, especially after the end of the war.

The critical importance of the Dayton Project, in conjunction with its top secrecy, made it very difficult to determine exactly what CBP did at the site. All of the "recruits" had to sign on to the Dayton Project without knowing the nature of the work. Everyone hired had to sign the Espionage Act and their backgrounds were investigated by the FBI [16]. Further, at Unit IV (where CBP worked), a large number of armed guards kept the "unauthorized out and maintained an eye on the employees" [16]. The Dayton Project had the strictest security of any other Manhattan Project sites, a fact confirmed by Major General Kenneth Nichols, who was General Groves' deputy [16].

George Mahfouz, a process engineer with the Dayton Project in his discussion of the problem of worker contamination states:

> "You weren't allowed to smoke or eat in the area and every time you left you had to wash your hands … we used a very diluted hydrochloric acid, a good solvent. We had a counter at each washstand. You would put your hands underneath to make sure you had gotten rid of everything. We showered at the end of the day. Every week, we took samples and if your urine level was above so many counts, you couldn't go into the processing area…I was more worried about the nitric and hydrochloric acid than I was about the polonium" [16].

A key scientist in the polonium processing at the Dayton Project was W.C. Fernelius. He recalls "how one female employee at Unit IV had unruly hair, some of which became contaminated. When she did her hair, she would put the bobby pins in her mouth. She had the highest urine count in the place" [16]. This person was almost certainly Carolyn Beatrice Parker. The building that housed Unit IV, where CBP worked, was so contaminated that at the end of the war it was destroyed [10, 11, 16].

During the last year, 1946-1947, of her work with the Dayton Project, she enrolled in physics and mathematics courses at Ohio State University located in Columbus, Ohio. Since the distance between Dayton and Columbus is approximately eighty miles, this may indicate that her work on the Dayton Project was winding down and she now had time to begin her academic studies anew. In any case, she was ready and available for other opportunities and these came by way of an offer to teach at Fisk University.

Return to Fisk University

Elmer Imes, the founder of the Physics Department at Fisk University and its first Chair, died in December 1941. The President of the University, the renowned sociologist Dr. Charles S. Johnson (Ph.D., University of Chicago, 1917) immediately contacted Dr. James R. Lawson [18] as a replacement for Imes.

Lawson was Imes' first student to graduate from Fisk with a bachelor's degree in physics, doing this in 1935. (Note that CBP and Lawson knew each other since she arrived as a freshman in the fall of 1934.) Just as Imes had done, Lawson went to the University of Michigan and received his Ph.D. in physics in 1939, in the same area as Imes, namely infrared spectroscopy.

Lawson arrived at Fisk in 1942 and quickly began efforts to create a research program in infrared spectroscopy with the aid of the Chemistry Department. "With the help of former colleagues in the Michigan Physics Department's instrument shop, he ordered an infrared spectrophotometer like the one the department was having made for its own use. By 1948, when the instrument was shipped to Fisk, Lawson had recruited five Fisk physics majors, then seniors, to stay on to do their MA theses in infrared spectroscopy on the new instrument. That was the beginning of the Fisk Infrared Research Laboratory (FIRL)" [18].

To enhance and carry out his plans for research, Lawson needed additional faculty. This led to extensive correspondence with Carolyn Beatrice Parker on her interest in returning to Fisk as a faculty member and researcher. He clearly understood the significance of her work with the Manhattan Project and how her experimental skills could greatly benefit the research he intended to do, along with her, the graduate students, and other faculty and staff. In a letter dated August 30 1947, President Johnson made an offer to CBP [19]:

> "Dr. James Lawson of our Physics Department informs me that he has been discussing with you a position on our Physics faculty and that you have indicated your interest in this post… We have agreed that it would be desirable to offer you a position of Assistant Professor of Physics at a salary of $3600 per year. To permit Dr. Lawson to complete his plans for the department at the earliest possible time, I am enclosing a contract in this letter. With best wishes, Sincerely yours, Charles S. Johnson"

Carolyn Beatrice Parker accepted the offer and started her teaching and research duties in the fall semester of 1947. While there is no known documentation of which courses she taught or exactly what research she was engaged in, it is reasonable to assume that she was involved in at least one general and/or college physics course and taught or directed one or more graduate courses in modern physics and electronic instrumentation.

After four years at Fisk, Carolyn realized that if she was to realize her full potential as a teacher and researcher, she would need to acquire the doctorate degree. Using her contacts from the Dayton Project and with the help of Dr. Lawson, she applied to the Graduate Physics Program at the Massachusetts Institute of Technology. She was accepted, but without financial support.

MIT [20]

Carolyn Beatrice Parker officially entered the Doctoral program in the MIT Physics Department on September 17, 1951 and received the MS in Physics on September 13, 1953. Her work was supervised by professor David H. Frisch [21], an alumnus of the Manhattan Project at the Los Alamos site. His research was on measuring neutron-plutonium cross sections with a Van de Graaff accelerator. Therefore, it is of no great surprise that CBP's thesis was on the problem of the "Range distribution of 122 Mev (pi+) and (pi-) mesons in brass" [22].

Interestingly, while Carolyn was admitted as a doctoral student in 1951, she switched to a MS seeking graduate student in March 1952. Further, the MIT registrar has her listed as a full-time graduate student from September 17, 1951 through January 29, 1954, and then again from September 20, 1954 through January 28, 1955.

One possible reason for this action was that she lacked funding from MIT and her personal resources were such that she could not continue to pay for her MIT expenses. Thus, the switch from being a doctoral student to MS degree status would allow the obtaining of a degree from MIT, even if it was not the initial desired doctoral degree. The documents available to us do not provide any resolution to this set of issues. Clearly, her past positions and associated work performance are consistent with her having the interest and ability to complete the doctorate degree at MIT.

Information from the MIT Student Directories from 1951 to 1955 indicate that CBP lived at 11 East Newton Street in Boston, Massachusetts during her time at MIT. This building, in Boston's South End, served as a dormitory for women students when otherwise there would be few safe and affordable housing options for them. In 1955 and 1961, CBP's name appears in the Registers of Former Students and Alumni Directories, listed as residing at 303 NW 4th Street in Gainesville, Florida. However, on those dates she was still living in the Boston metropolitan area and she may have used her hometown address as a convenient location for anyone wishing to contact her.

Carolyn Beatrice Parker on a ship, ca 1962.

After MIT

The discussion of the last section suggests that Carolyn did not continue on at MIT to complete the requirements for the doctorate degree in physics because of financial difficulties. "Family lore" suggests that one year after entering MIT, she began part time employment as a physicist in the Geophysics Research Division at the Air Force Cambridge Research Center [23], located near the MIT campus. Further, her absence from MIT during the interval January 29, 1954 to September 20, 1954 may have been related to the need to work to obtain funds to return to the Institute. She did enroll for the fall term, September 20, 1954 to January 28, 1955, but this was her last time as a student in the graduate physics program. There is currently no documented evidence that CBP completed the research and course requirements for the Ph.D. degree. Consequently, accepting the truth of this statement, it follows that she was never in a position "to complete the process of defending her doctoral dissertation and graduating because she contracted leukemia" [24]. However, again based on "family lore", she remained in the Cambridge area and continued her work at the Air Force Cambridge Research Center for another decade [2].

Probably beginning in the mid-1950s, Carolyn began to experience the early symptoms of illnesses which worsened with time. The after effects of exposure to organic solvents and radioactive materials from her involvement with the Dayton project were now manifesting themselves. In the early fall 1965, her illness necessitated a return to the family home in Gainesville, Florida. Her condition was such that a wheelchair was required for physical movement. Carolyn Beatrice Parker died on March 17, 1966 and was buried in the Mount Pleasant Cemetery in Gainesville.

Honors and Recognitions

For essentially half a century, the name, career, and accomplishments of Carolyn Beatrice Parker were absent from public discourse. A large part of this was due to the almost complete secrecy of her work with the Dayton project. However, with the founding of the Black Lives Matter [25] Movement (BLMM) in 2013, this changed. One of the (maybe minor) consequences of the BLMM was the newfound interest in African American contributions to STEM areas, and importantly, how to enhance their numerical presence at all levels in these scientific fields. Thus, within this context, CBP's name emerge quickly and in a very noticeable way. Professional organizations, the Department of Energy, the Atomic Heritage Foundation, MIT, and various blogs began to (briefly, in most cases) present the details of her illustrious family, her education, and the fact that she was a "scientific participant" on the Manhattan Project.

Two major awards arose out of these activities. First, and elementary school and the adjacent park were named for CBP [26] in Gainesville, Florida. Second, Fermi National Accelerator Laboratory, located in Batavia, Illinois established the Carolyn B. Parker Fellowship for the Superconducting Quantum Materials and System Center [27]. In the near future, other honors and recognitions may come to fruition.

Finale

We have shown that Carolyn Beatrice Parker led an interesting and productive life. She was situated in a highly educated family, and she, her sisters, and brother continued along this path of becoming educated, highly skilled professionals in their respective areas of knowledge and practice. Caroline was not a "hidden figure". She was an "unknown to the general public figure" and the difference in meaning between these two concepts is huge. As indicated in the previous section, she has become in recent years well known to that segment of the population for which her life activities have some personal, social, or professional significance. Our hope is that someone will fill in the gaps and shortcomings of this brief essay and complete a full biography of both Carolyn Beatrice Parker and her family.

Acknowledgements

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Notes and References

[1] Throughout this essay, we will generally refer to Carolyn Beatrice Parker as "CBP" or as "Carolyn".

[2] From August 2020 to September 2021, R.E.M. corresponded (by email and telephone) with a niece of CBP: Dr. Leslie Carolyn Edwards. She provided a wealth of details on the Parker family and her aunt, Carolyn Beatrice Parker. Unless otherwise indicated, all quotes are from Dr. Edwards.

[3] "Joan Murrell Owens: Becoming a Scientist at Mid-Life", pps. 206-218, in W. Warren, Black Women Scientists in the United States, Indiana University Press, Bloomington, IN, 1999.

[4] Interviewee: J. Leslie Cosby, Interviewer: Joel Buchanan, Date: July 23, 1985. Oral History Program, University of Florida, Gainesville, FL.

[5] A number of letters were written by CBP and her father to the Dean of the College and the Registrar at Fisk University regarding Carolyn's enrollment and the financial difficulties experienced by the Parker family. These letters and responses cover the period from November 1933 to February 1938 and are located in the Special Collections, John Hope and Aurelia E. Franklin Library, Fisk University, Nashville Tennessee.

[6] Ronald E. Mickens, "The Life and Work of Elmer Samuel Imes", Physics Today, vol. 71 (2018), pp. 28-35.

[7] Fisk Catalogues, 1932 to 1938.

[8] Proceedings of the Board of Regents August 1939 – May 1942. Ann Arbor, Michigan: University of Michigan, p. 640.

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[15] "Woman Physicist Pioneers in Engineering Division at Dayton's Wright Field", Columbus Call and Past (newspaper), July 14, 1945, pp. 1B.

[16] H. Shook and J.M. Williams, "Building the Bomb in Oakwood", Dayton Daily News, Dayton, Ohio, September 18, 1983. https://www.dayton-historybooks/building_the_bomb_in_oakw.html.

[17] H.V. Mayer, editor, Polonium, Oak Ridge, TN: U.S. Atomic Energy Commission, Technical Information Service Extension, July 1956.

[18] R.E. Mickens, Obituary, "James Raymond Lawson", Physics Today, Vol. 50 (October 1997), pp. 128.

[19] Letter, dated August 30, 1947, from Charles S. Johnson to Caroline (?) B. Parker, in the papers of Charles S. Johnson, Special Collections, Fisk, University, Nashville, TN.

[20] This section is based on records/documents received from various offices at MIT: Academic Record Services, Document Services, Department of Physics, and Institute Archives and Special Collections.

[21] Obituary: "David H. Frisch", The New York Times, May 25, 1991, Section 1, pp.29.

[22] The link to this thesis is http://library.mit.edu/item/000689134.

[23] E.B. Altshuler, The Rise and Fall of Air Force Cambridge Research Laboratories, CreateSpace Independent Publishing Platform, January 2, 2013.

[24] Wikipedia: Carolyn Parker. https://en.wikipedia.org/wiki/Carolyn_Parker.

[25] Wikipedia: Black Lives Matter. https://en.wikipedia.org/wiki/Black_Lives_Matter.

[26] P. Macdonald, "The Hidden History of Carolyn Beatrice Parker: A New Namesake of One Gainesville's Oldest Schools", Gainesville Magazine, Spring 2021, pp. 12-15.

[27] https://news.fnal.gov/2021/05/fermilab-quantum-center-announces-carolyn-b-parker-fellowship-for-postdocs/

Continued from page 2

Isaak Khalatnikov tells the story, 2009. He is 90 here.

Institute. In 1965 he founded and directed the Landau Institute for Theoretical Physics - the unique organization that soon became the worldwide leading institution covering the wide range of science from mathematical physics to quantum field theory. Khalatnikov was born on October 17, 1919, and in October 2019 he was celebrating 100 years anniversary. On January 9, 2021 Khaltnikov died in his sleep.

> "On the day of my birth, the Makhno gangs were entering Ekaterinoslav (the city of Dnepropetrovsk, back then). It was known that although the bandits themselves did not really know whether they were for the Whites or the Reds, they could organize pogroms, just in case. So, my mother, grabbing the newborn me, ran to hide. And in the turmoil, she was carrying me head-down. Perhaps it was this shakeup that played a role in the subsequent development of my mental abilities" [2} - used to recall Khalatnikov. Another shakeup that played a major role in his abilities to organize science and, in general, to solve difficult organizational and everyday problems, Khalatnikov attributes to his "Army Universities".

On Saturday, June 21, 1941, Khalatnikov passed his last, exit exam on theoretical physics at the Dnepropetrovsk University. The next day the war began. In the days following Sunday, June 22nd, all the university graduates were called up to the draft board. The Physics graduates were sent by the military enlistment office for education to the Artillery Academy in Moscow. Right from the beginning of the war, starting with training, serving his everyday duties during the bombing of Moscow, the cadet Khalatnikov by 1942 became Chief of Staff of his Regiment.

> "In 1942 I was appointed Chief of Staff. The Germans already tried to bomb our industrial centers... When we had to shoot down German planes or solve other problems, my Regiment Commander being a careful man quickly learned that I, as a former checker player and a university graduate, must think pretty quickly. So, he mastered just one charter command, which he gave me in almost any situation. The command was: "Chief of Staff, make a decision!" [2].

And the 23 years old Chief of Staff became the main controller who used to take full responsibility for solving the problem. And since then, throughout his life Khalatnikov used to make decisions in any situation without fear and reproach. And, of course, there were many difficult situations requiring optimal solutions. In a short article it is impossible to describe all, even the most important cases. I will therefore confine myself to a few of them.

Khalatnikov - Chief of Staff, 1943 (Family Archive of Elena Shchors, Khalatnikov's daughter)

Decision 1 – Physics, Landau

Back in school, Khalatnikov became the regional champion in checkers and a multiple winner of mathematical Olympiads. And a local newspaper wrote about his successes and his outstanding mathematical abilities. "The city was not too big and everybody knew me and envied my mother. She was very proud of me" [2]. Along his mathematical and checkers activities, Khalatnikov, as many of his age, was captivated by the books of Perelman and especially his problems in physics. Perelman, outstanding scientist who published numerous scientific books for entertainment, from arithmetic and astronomy to physics, was an extremely popular author since the beginning of 20th century. After the revolution he stayed in his native St. Petersburg, continuing to write his wonderful books. He died of starvation in 1942 during the siege. Perelman's cunning experiments and problems dominated the inquisitive minds of young people everywhere. Khalatnikov and his classmates once in a while resorted to the help of their physics teacher asking him questions from Perelman's books. "Most likely, he did not know the answers , but this fact never embarrassed him, because he had a universal answer to such questions: "This is none of your business"- recalls Khalatnikov [2]. He believed that it was this very answer that awakened his interest in physics.

In 1936, 17-years old Khalatnikov, already a convinced mathematician, in entering the Dnepropetrovsk university, changes his mind and chooses physics. Around that time, the great Russian physicist, Abram Joffe, opened branches of the Leningrad Institute of Physics. High-ranked physicists from the Leningrad Physics Institute used to teach classes there. Besides, stories about Landau, who was then teaching in Kharkov, were already circulating all over country. Landau, in his early twenties was already the most famous attraction for young people who wanted to be a physicist. There were so many willing to work with him that Landau decided to create a selection tool. The tool became known as Landau's Theoretical Minimum and was based on the results of passing 9 exams: two in high mathematics and seven exams covering the entire field of theoretical physics from Mechanics and Quantum Theory to Statistical Physics, Electrodynamics, and Kinetics. It is known that Landau saw theoretical physics as a unified science. This vision later laid the foundation for the creation of nie volumes of theoretical physics, the famous Landau - Lifshitz Course of Theoretical Physics. These exams were a severe test and, as history has shown, a very effective way of selecting talented young people. Khalatnikov, as a straight A-student was advised by his future diploma supervisor to take the Theoretical Minimum exams using the manuscript copies of Landau's lectures.

In September of 1940, carrying his letter for Landau, Khalatnikov arrived in Moscow to take the Mathematics-1. In the same month he passed another three exams. In February of 1941 he passed four more exams, and Landau sent him a recommendation to join Kapitsa's institute for graduate studies under his, Landau's supervision [2]: "Dear Comrade Khalatnikov! It would be highly desirable if you could, no later than in the first days of July, come to Moscow, to the Institute. During your visit to the Institute, you made a very good impression on me, and therefore I believe that you should continue to study theoretical physics as a post-graduate student" [2]. The letter is signed by Landau on May 26, 1941. Triumphant and happy, the 22-years old Khalatnikov was finishing his graduation and on Saturday, June 21, passed his final exam. The next day the war begun.

Decision 2 – The Army

Khalatnikov was free from the military training courses at the University due to his frail physique. Besides, and most importantly, he had the Landau letter which would allow him to go to Moscow to continue study at one of the most prestigious Institution. But he decides otherwise: together with all his comrades, who were drafted, he goes to the military enlistment office.

Dnepropetrovsk was bombed from the very first days of the war. All the graduate students of the Physics Department were sent for education to the military Academy in Moscow. Soon Khalatnikov became a student of the High Military School of Air Defense Forces, formed in 1941 within the Frunze Military Academy. "Our instructors - recalls Khalatnikov - were the troop leaders, many of them were the General Staff officers as far back as Imperial Russia. These were very intellectual people. It was clear to them that in a very short period of time they had to transform us, the complete civilians, into combatant officers" [2]. They were trained as officers to command units of anti-aircraft batteries when the time came to go to the front. Khalatnikov wrote a request to be sent to the front. It was time when the Stalingrad battle was unfolding. Many of those who were sent there did not return. Khalatnikov was appointed as a Deputy Commander of an Anti-Aircraft Regiment.

Decision 3 – Valya

Back in the university years Khalatnikov, as a straight A-student, was awarded a voucher to go to the resort near Kiev. There he met a girl, Valya. This meeting turned out to be fateful. Since those pre-war times and in the difficult war years young people used to meet. Valya was a Muscovite. Khalatnikov visited her every time he came to Moscow to take Landau's exams. During the war, Valya visited him near the disposition of Khalatnikov's Regiment, situated near Kaluzhskoe Shosse, the outskirts of Moscow.

Their warm relationship that started during those pre-war times and went through difficult war years led in 1943

Valya Shchors and Khalatnikov, 1943 (Family Archive of Elena Shchors)

Valya and Khalat with their elder daughter, Elena, Elena's husband Peter Volkovitsky and grandson, Alex, Fairfax, VA, 2000 (Family Archive of Elena Shchors)

to a simple decision to get married. Valya was the daughter of the Civil War hero Nikolai Shchors and Fruma Khaikina. 20 year old Fruma fought for the October Revolution from its first days. Soon she became an active Chekist, and then fought in the Civil War. There she met Nikolai Shchors. In the fall of 1918, they married. On August 30, 1919, Nikolai Shchors, while defending a railroad junction near Kiev, was killed. He was 24 years old. In April 1920, Fruma gave birth to a baby girl, Valya. Fruma never married again.

In 1940, Fruma, as a widow of the Civil War hero, received an apartment in the famous House on the Embarkment (see e.g. [6]) and lived there with Valya, Isaak Khalatnikov and two granddaughters, Elena and Eleonora. She died in 1977. Valya became a medical doctor. But her true life was her family - her mother, still very busy and active, two girls and, of course, her husband, whom she loved very much. Valya died in 2005 in Elena's and Peter's home in Fairfax, VA.

Decision 4 – Demobilization from Army

By the end of the war, Khalatnikov began to take serious steps to demobilize from the army in order to return to science. But as he already held a high army position at that time, demobilization became a big problem. Even though in 1944 Kapitsa organized for him a recommendation for post-graduate study under Landau's supervision, Khalatnikov was not released. It was in the summer of 1945 when all kinds of top authorities got together with members of the Academy of Sciences to discuss a new era brought by the atomic bomb. Kapitsa, who was never used to surrendering or losing, was sitting in the presidium next to the Marshal of Artillery. In his mocking manner, Kapitsa told Marshal, that now, after Hiroshima and Nagasaki, "artillery would no longer be the god of war", and "named me in passing, as a person who is more important to physics than to artillery" – recalls Khalatnikov [2].

Quite soon Khalatnikov was demobilized and already on September 2, 1945, began to work at the Institute for Physical Problems devoting himself to low-temperature physics, more precisely, to physics of superfluid Helium. And the year of "scientific fitness recovery" had begun. It was an endlessly difficult year for the entire institute, and most importantly for Kapitsa himself. In August of 1945 the committee for the development of a nuclear bomb in Soviet Union was formed. Kapitsa, who was included, complained to Stalin that he would not work with Beria, who led the Committee. Kapitsa described him as an incompetent and completely inadequate person for this task. Signing this letter, as well as his other letters to Stalin, Molotov and to other members of the government, Kapitsa knew that he was signing his own death sentence. And yet Stalin spared Kapitsa and did not let Beria destroy him. But Kapitsa had lost all his positions. The institute was taken away from him, he was removed from his high position as the head of general management of the oxygen industry and put under house arrest at his Dacha outside Moscow.

Decision 5. The Bomb. Stay and work

Thus, the Kapitsa creation was beheaded. But the throne is never vacant. And it was given to Anatoly Aleksandrov, an amazing personality, who was at that time Kurchatov's deputy. Then he became director of the Kurchatov Institute and, finally the president of the Soviet Academy of Sciences. In this year of 1946 Aleksandrov brought with him to Kapitsa's Institute two laboratories oriented toward the creation of atomic weapons. "In December of 1946 I was transferred from postgraduate student to Junior Scientific Researcher, and Landau told me that I will be working with him on the nuclear bomb" – recalls Khalatnikov - "At that time Landau's Theoretical Department consisted only of two employees, Evgeny Lifshitz and me. The problem given to us by Landau involved a large amount of numerical computation. For this a Computational Bureau was created, which consisted of twenty to thirty young girls armed with German electrical arithmometers" [2].

"The first problem was to make a calculation of the processes that occur in the course of a nuclear explosion, which included (however blasphemous this sounds) its efficiency. That is to say, to estimate the efficiency of the bomb. We were given the input data, and one had to compute what happens during one millionth of a second.… Naturally, we did not know anything about the information given by the intelligence Service.…I took a great interest in my work. My task was to serve as a liaison between Landau and the mathematicians. Mathematicians were receiving the equations from me in such a form that one could not figure out the design of the bomb …Among the main parameters of the atomic bomb is the critical mass, the type of explosive material, and its shape. Nobody ever tried to solve this problem in general form before us, and I managed to obtain an exceptionally beautiful interpolation formula. The agreement between the calculations and the results of the first tests (in year 1949) was very good" [2].


The troubled Summer of 1953. Khalat and Valya (Family Archive of Elena Shchors)

And further: "The problem of the calculation of the hydrogen bomb happened to be several orders more complex than the atomic one. The fact that we managed to solve this problem "manually" was certainly a miracle"[2]. Tests of hydrogen bomb were started in the fateful year 1953. That same year, Stalin died. Landau, as a head of theoretical Department working on bombs and having an internal conflict, reacted to this simply: "That's it! He is gone, I am not afraid of him anymore, and I am not going to work on this again."" Soon I was invited to I.V. Kurchatov - recalls Khalatnikov- In his office there were Yu.B. Khariton and A.D. Sakharov, and three great men asked me to take over Landau's duties" [2]. Khalatnikov knew that Landau asked about it, and that Landau would not go back to the subject. Kapitsa was still in exile. And "I, naturally, could not refuse" – writes Khalatnikov [2].

Decision 6 – Kapitsa's Return

We know that in 1935 Kapitsa was forced to stay in the. Soviet Union, and then was allowed to build in Moscow the Institute as he saw it. In 10 years he achieved incredible results not only in science but in the Oxygen industry as well. Now, in 1946, isolated from the whole world and deprived of everything that he had built over these 10 years, Kapitsa set up a laboratory at his dacha in Nikolina Gora and continued to work. From Nikolina Gora he wrote letters to Stalin and Malenkov on a regular basis reporting to them about his work. Stalin, practically, did not reply to him, but he read all of Kapitsa's letters, including those addressed to Malenkov. He was so accustomed to reading Kapitsa's letters, including those addressed to Malenkov, that if the letters were delayed, he used to send his people to Kapitsa's dacha to find out if everything was in order. Kapitsa's long letters included description of his achievements and their importance for the country. By 1950 Kapitsa developed a concept of using powerful electromagnetic radiation to take down planes and other aerial targets. Quite long before the discovery of lasers. Here is a brief quote from one of his letters [7]:

> Nikolina Gora, 30 December 1950
> Comrade Stalin, Comrade Malenkov told me to write to you in detail about my current work in the field of electronics. On the work done in the past four years, I wrote the attached note for you… The scientific foundations of the problem of obtaining high-power energy beams for defense and the main results obtained by me, I set out in a note addressed to the President of the Academy of Sciences of the USSR dated May 5, 1950, and I am attaching a copy of this note..."

But he was not heard. It was not until July 1953 when one of his longest letters to Malenkov brought some results. Kapitsa was not set free from exile, but his Hut-Laboratory on Nikolina was given the official status of Physical Laboratory of the Academy of Sciences of USSR. This included some financial support and a few pairs of hands.

The question of whether to return the Institute of Physical Problems back to Kapitsa was discussed at the Politburo several times. The decision of the Central Committee was invariably negative. Even after Stalin's death and Beria's conviction, Kapitsa stayed in Nikolina Gora. "This is my confession – wrote Nikita Khrushchev in his memoirs - Now that I've told the story, I feel I've done penance. Some people might criticize me, saying, "Khrushchev was cold-hearted to Academician Kapitsa, a man who contributed so much to Soviet science." Well, I'm only human, and I ask the people to forgive me for the errors I've made. Kapitsa, too, is only human, and he made a mistake by refusing to work on military problems... I now ask Academician Kapitsa, whom I've always respected as a great scientist, to forgive me." [8]

Khalatnikov recalls: "It became clear that we had to act and act quickly if we wanted Kapitsa to return to the Institute and become its Director again" [2]. With this Khalatnikov went to Landau and offered to prepare a collective letter to the country leaders. Landau got to business immediately. Khalatnikov had to prepare a letter. Landau started to talk to the most influential members of Academy and asked them to sign the letter. Finally, the letter, signed by 12 members of Academy was ready. Khalatnikov and Abrikosov, a future Nobel prize winner, then young descendant of the confectionery dynasty supplying chocolate to the Russian Imperial Court, delivered two copies of the letter: one to the Council of Ministers and other to the Central Committee of the Communist Party. In the middle of December 1954 Kapitsa met with Khrushchev. On January 28, 1955, the Institute for Physical Problems was returned to Kapitsa, and he was officially appointed director. The Hut-laboratory, now called the Physical Laboratory, retained its autonomy.

Decision 7 – Appeal to Kurchatov, back to Kapitsa's Institute

With the return of Kapitsa, all activities related to the defense industry were transferred to other institutions, including the Theoretical department, which was headed by Khalatnikov. This department was transferred the Institute for Applied Mathematics. Leaving the Institute for Physical Problems Khalatnikov called a "personal tragedy". Khalatnikov complained about it to Igor Kurchatov, who promised to move Khalatnikov to "his place." Soon Khalatnikov and his group were moved to the Kurchatov Institute, and given a space in the building of Lev Artsimovich. After a month or two Khalatnikov wrote a letter to A.P. Zavenyagin, the Minister who was in charge of the Atomic Project. He was soon permitted to return to the Institute for Physical Problems.

Khaltnikov writes: "Stepping down from a high position as Head of Laboratory, and losing almost a half of my salary, I came to IPP as a Senior Scientific Researcher. I was completely happy that I could return to my institute to work again with Landau and Kapitsa." Ahead of him lay six wonderful years full of work, collaboration with Landau and his bright disciples, and regular collaboration with great experimenters carefully chosen by Kapitsa. These were years of creative struggle, success, joy and the happiness to be a part of the small Kapitsa's Institute.

The blow came on January 7th, 1962. On Friday, January 5th, Khalatnikov had with Landau his last scientific discussion. It was regarding his work together with Evgeni Lifshitz on cosmological singularities. Landau immediately liked the result. But farther discussion with Landau of these results and all other upcoming works, was not destined to happen. On Saturday, January 7, Landau got into a tragic car accident. The world community of medical doctors and scientists fought for Landau's life. And Landau's life was saved, but he could never return to scientific work.

Happy times: Khalatnikov is back to Kapitsa's Institute, 1956 (Family Archive of Elena Shchors)

Decision 8 – Without Landau. Head of Department

On January 17th 1962, I, then a student of Tbilisi State University, arrived to Kapitsa's Institute to do my diploma work. I got this happy opportunity thanks to two exams of Theoretical Minimum that I passed to Landau himself (the only girl ever) in July 1961 and then the Statistical Physics exam to Khalatnikov. But my luck to work under Landau's supervision was overshadowed by the disaster which had befallen the Institute and I lived by what everyone lived in those days –LANDAU.

It was then when I heard Kapitsa for the first time and understood how deep is a calamity spoken of little and simply. He said: "Landau is in a bad state. The situation is very serious. The Institute is trying to do all that is possible to help the doctors. Everybody participates in this matter of their own will... We have to prepare ourselves for his absence and turn back to normal work ... . It is necessary to help Landau, but it is also necessary to work. At the suggestion of the theoreticians, the organizational work in their department will be taken up by Khalatnikov. The theoretical seminar should be continued, but the theoreticians themselves must decide" [1].

And Khalatnikov became a head of Theoretical department. The Department was small. Along Landau there were only six staff members: Khalatnikov, Evgeny Lifshitz, Lev Gorkov, Aleksey Abrikosov, Igor Dzyaloshinskii and Lev Pitaevskii. There were, of course, graduate students and physicists from various foreign laboratories and our institutes who used to come to work for a month, two months or a year. Now everyone had to get used to doing without Landau, who was the heart and spirit of a very special community of physicists. Unfortunately, it was clear that without Landau it was impossible to preserve what was created by him.

Decision 9–The critical mind of Landau

"Finally, I became convinced that an

Institute for Theoretical Physics had to be organized in order to save the school. Each of us, the Landau disciples, was a specialist of high quality in his own field, yet no one aspired to replace Landau. The point was that not only that Landau was an outstanding scientist, but he also possessed a uniquely powerful critical mind, which is so needed in theoretical physics. This suggested an idea to try to collect his brightest disciples in one place and create something equivalent to the critical mind of Landau" – writes Khalatnikov [2]. And Khalatnikov makes a decision to organize the Institute and by assembling "a group of, say, 12 to 15 disciples of Landau who actively worked in different fields, so that the collective critical mind could have worked as one Landau, by selecting and evaluating the works of theoreticians" [2].

Thus, Khalatnikov together with the devoted support of Aleksey Abrikosov, Lev Gorkov and Igor Dzyaloshinskij, got down to business. They had to go through the many expected and many unexpected obstacles from the government, from the Academy of Sciences and from other special Departments. Kapitsa was very supportive. With his simple conclusion, "When Children Get Married, They Do Not Consult the Parents"[7], Kapitsa used his power at all levels, be it the highest echelon of the government or the Academy of Sciences, to help in the organization of the new institute. A race with many obstacles was finished and in January 1965 the approval to open the Institute for Theoretical Physics was received. A place for the institute was allocated 25 miles from Moscow in the new scientific center Chernogolovka. Khalatnikov was nominated as a Director of the Institute. Later, the Institute was named after Landau.

Decision 10 - The last good idea which never worked

At first, there were three research employees besides the director himself: Abrikosov, Gorkov and Dzyaloshinskij. By the early 1970s a "Stellar set" of about 20 theoreticians were in place and it was they who later provided the world with several generations of first-class scientists. Just in a decade the Institute acquired a very high reputation, both in the Soviet Union (it was on the top of the 10 leading Institutes) and abroad. Over time when the borders opened and people could travel abroad, including young scientists, "it became fashionable to invite Someone from Landau Institute".

In the dashing 90s - the most difficult years for Russia - the brain drain had started. The high rating of the Institute had become its misfortune. "The Landau Institute was known all over the world, and as soon as the borders opened, a real hunt for our scientists began - recalls Khalatnikov. Many brilliant researchers left the country. Most destructive was that by 1991 two of three main musketeers of Khalatnikov, left the Institute, Aleksey Abrikosov for Argonne National Laboratory and Igor Dzyaloshinsky for UC Irvine. Now Khalatnikov's main goal became to save the Institute. And he makes a Decision. "In the early 90s, when I was trying to preserve the institute, I was running around with ideas to organize some kind of overseas branches, where our employees could spend part of their time" [2]. And Khalatnikov got some results. By a strict agreement some number of researchers could spend a few months in a "Foreign branch of Landau Institute". One was in France and another was at the Weizmann Institute in Israel. There was also a project to set up a European branch of the Landau Institute at the Institute for Scientific Interchange in Torino, Italy. These attempts only resulted in several rounds of trips by 10 -12 scientists per year. In the fall of 1990, Khalatnikov received the invitation to set up the branch of Landau Institute at the Texas A&M University. Together with Lev Gorkov, they went to Texas for negotiations. For their surprise, the vice-rector of the University already had the draft agreement and the generous budget plan for them ready to be signed. "I was about to accept the offer, but Lev Gorkov whose opinion was important to me, looked indifferent and uninterested. This solved it. It is beyond my abilities to describe the expression on the face of Vice-rector when we refused to accept his offer"[2]. And Khalatnikov writes simply: "In August 1991, I was told that Gorkov had accepted a permanent job in the USA… Thus, the last of my musketeers with whom I had started Landau Institute left the battlefield. It was the final signal that the Institute could no longer exist as it did before……The last good idea with affiliates never worked" [2].

During his long life, working at the limit of human capabilities, Khalatnikov created a rich soil for future generations. Along numerous awards High School №75 in Chernogolovka is named in his honor. There is also the Asteroid 468725 Khalat. And to top off a long list of high Orders, gold medals, state awards and scientific prizes, Khalatnikov received a somewhat belated one - the highest Order of Alexander Nevsky "for his fundamental contribution to science and participation in the creation of nuclear weapons". It was handed to our hero on September 4, a few weeks before he turned 101.

Acknowledgments

I was lucky to have Khalatnikov as my teacher and to work with him, starting with my diploma project. He encouraged me to publish the results and signed the paper as a coauthor [9]. And even now, in the 2020s, more than half a century later, this article is being cited. A trifle. But Khalatnikov was serious about everything, including the little things. I am grateful to Elena Shchors and Peter Volkovitsky for rare photographs from their family archives. They also read the draft and made valuable comments.

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Continued from page 5

These are the complexities within the astronomical community at the time that Moore's storytelling has largely left out. Knowing something about the world around Cecilia Payne helps to engender a deeper appreciation for her work – to see her as a driven woman in an unforgiving world, who made an important discovery at a time of important discoveries in spite of the gender discrimination, low pay, and lack of recognition to which she was subjected. It took courage; no wonder so many people remember her to be intimidating.

The highest praise for a book like Moore's is that it ignites one's desire to learn more. I now have such a desire to investigate this book's other unsung hero, Meghnad Saha, without whose theory of thermal ionization, Cecilia Payne's work would have been impossible. The reasons that this book is so excellent to read besides its engaging writing is that it also has plenty of pictures of the notable people being discussed, is very well edited (I have so far only found a single typographical error), and was thoroughly researched. I was only bothered by one minor aspect of the author's style, and that is the careless way that he sometimes deals with chronology. Relating the loss of two of Cecilia's closest friends, he begins with the death of Betty Leaf in May 1933. "And then there was another tragedy," he continues, before recounting the death of Adelaide Ames in June of 1932 (p. 209). His word choice, "And then," suggests a sequence that is backwards the actual order. The small mental reset that was required to read and understand passages such as these was, at most, an annoyance. The author obviously chose the order for emphasis, and I only quibble with how he described it.

Whereas Moore wrote about a serious subject in a manner that is palatable, Portrait of a Binary was written in almost the opposite fashion. It touts itself as a scholarly work, with a disquieting number of references and thick, black, inscrutable text for a seemingly endless number of pages. It is not even readily available – you will have to directly contact the author for a copy. However, it is actually, when you strip away the robe académique, a love story that follows Cecilia Payne's life with fellow astronomer Sergei Gaposchkin. I knew little about Gaposchkin before reading this book, probably because Cecilia Payne throws such an enormous shadow. But Boyd's love story is so touching that I cannot help feeling that the publisher has let us all down by keeping it hidden behind such an ugly façade. I would dearly love to say that it is a book worth reading. But it badly needs a good copy editor. Its two single photographs, one a simple headshot of Sergei (p. 311) and the other, thrown in after the Acknowledgements at the end of the text, a fuzzy picture of Cecilia while she is lecturing (p. 448), show us that selecting suitable photographs is not the author's forte. The book's redeeming quality, and the reason that I wish it were in better shape, is that it includes a number of details that are not easily found elsewhere. These include personal recollections by the author, and quotations and paraphrases from various interviews with people close to either one or both of the Gaposchkins.

Anyone with a budding or abiding interest in the early years of astrophysics and the heroic people who made it possible will enjoy What Stars Are Made Of. Anyone who is particularly in love with the Gaposchkins and wants to foster a deeper appreciation for them: well, you are probably stubborn enough to wade through Portrait of a Binary, regardless of what anyone has to say about it.

[1] https://ui.adsabs.harvard.edu/

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