Maria Goeppert Mayer:

Revisiting Science at Sarah Lawrence

Name: Jing Min Chia (2013)

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Professor: Dr. Scott Calvin, Faculty of Physics

Introduction

Maria Goeppert-Mayer is a name hardly heard of in high school and college physics classes. She does not appear alongside the 'scientific immortals' such as Einstein and Heisenberg. A preliminary understanding of her research and discovery can shed some light on her anonymity. Goeppert Mayer's Nobel Prize winning work was in developing the nuclear shell model of atomic nuclei, which is available in a sub-field of physics taught only at the college level. It is unfortunate that a scientist of her calibre has gone unrecognized by the future generation, because her story was one of triumph and perseverance in an age wrought with discriminatory and sexist beliefs.

My interest in her life is due to the fact that she taught at Sarah Lawrence for a number of years. I aim to provide more insight into her life here and how she changed the College. Due to the unique pedagogy of the school, it is a necessity that the paper will begin by providing a brief history and description of the methodology of the College to provide the context for a significant part of her life. Next, I will provide a short introduction to a history of her life before Sarah Lawrence. Finally, I will present historical documents to illustrate her experiences at Sarah Lawrence, including her links to the Manhattan Project during World War II.

A Brief History of Sarah Lawrence College

In 1924, real-estate mogul William van Duzer Lawrence approached Sir Henry MacCracken, President of Vassar College about the possibility of the founding of a new, progressive women's junior college in honour of his wife, Sarah Bates Lawrence. In 1928, Sarah Lawrence College was born. Initially a junior college serving as a stepping-stone to Vassar College in Poughkeepsie, Sarah Lawrence College terminated that

affiliation in 1931 when it was awarded an absolute charter to grant Bachelor of Arts degrees. Like many other women's colleges, Sarah Lawrence developed throughout the years from something akin to a conservative finishing school for ladies to a respected institution of higher learning for women. It adopted the concept of incorporating the arts into education, but slowly began to re-emphasise the need for scientific knowledge when it became necessary to revise what the liberal arts meant to society during WWII. The College officially became co-educational in 1969 after a stint of accepting male students under the GI Bill. As a small, Liberal Arts College that is part of the Progressive Movement, the College has managed to carve a niche for itself in higher education. Present classes are mostly interdisciplinary, with the absence of majors or exams. Instead, the College utilises the term 'concentrations' to indicate the fields a student plans to concentrate his/her studies in; major exams and finals week are substituted with class papers and conference papers (although exams are still utilised in the biological, physical and natural sciences as well as the small number of lectures offered). With that sort of pedagogy, it was never part of the mainstream educational paradigm. But as this paper will show, not being part of the mainstream doesn't mean it cannot work as well as the mainstream.

The Sarah Lawrence system

Since its inception, Sarah Lawrence College was already different. Its educational model was taken from the Oxford tutorial system, where students meet with their professors every other week to receive personal tutoring, mentoring or just a general revision of the materials. This applies to every student, regardless of what types of classes are being taken. However, a distinction must be made regarding the two types of classes

available to students. First is the seminar, which is a small class of no more than 15 students; the second, a lecture, with a maximum cap of around 45 students. This system allows for a more individualised and personal approach to education, but allows the professor more flexibility in teaching their courses, because consensus is easily sought among a room of 15 students, as compared to 100 in a lecture hall. But because the College's educational pedagogy is based on the ideas of John Dewey's Progressive Education, the Sarah Lawrence student is assumed and expected to be an independent learner. Thus, every student is required to undertake a conference project – regardless of class year – that is to be submitted every semester/year. Conference projects can take the form of performances, written papers, scientific posters or compositions, and are similar (but not identical) to a junior/senior thesis paper. This allows the student to pursue topics of interest outside the realm of the classroom.

Maria Goeppert Mayer

Born on June 28, 1906 in Katowitz, Upper Silesia (Germany; now Poland) to a 6th generation university professor, Maria Mayer's life began as somewhat privileged. Her father was Freidreich Goeppert, a Professor of Paediatrics at Göttingen University. As a child, her father was extremely specific about the sort of environment she was to be exposed to. He frequently brought her out on walks, and it was on those walks that she developed her intellectual and scientific curiosity[i]. After a short period of uncertainty due to the absence of proper routes for women to enter higher education, Maria enrolled in Göttingen University in the spring of 1924. She had initially planned to study mathematics, with Max Born as her adviser. However, she eventually changed her mind and took her Ph.D exam in theoretical physics in 1930. While at university, she met

Joseph "Joe" Mayer and they were married in 1930[ii]. Joe was soon offered a job at John Hopkins University in Maryland, and in 1930 they left for America. There, Maria – as a woman anywhere at that time – was treated as a second-class citizen. Nepotism policies forbade the hiring of both husband and wife in universities. Therefore, although technically employed by the university, she was neither given an office, nor a title, nor a salary. But it didn't seem as bad as it sounded. Maria was youthful and more intent on learning more science and speaking to scientists rather than her lack of rank amongst the men. However, her intellect carried her through, and many respected her[iii]. In 1939, Joe learnt that he would not receive tenure at John Hopkins, which led him to accept an offer from Columbia, as a tenured Associate Professor[iv] - which came with fewer complications than John Hopkins. At Columbia, Maria encountered a deeply conservative and traditional all-men's university. Maria stuck out like a sore thumb, a woman with intellect and credentials that equalled any professor. But once again, nepotism policies prevented her from going any further than minor research. Her presence was famously resisted at a dinner held after a science colloquium, which caused her to stop attending them altogether[v].

Sarah Lawrence: A New Start

In 1941, two years after Maria arrived in Columbia with Joe, she was offered a position at Sarah Lawrence. It was to initially replace Mr. Belcher, who had left at the end of the first term[vi]. This was her first official paid position, where she was formally recognized as a faculty member – a professor in Mathematics. This was unique in itself, because Sarah Lawrence had no hierarchy system of Lecturers and Associates. Though the position was only part-time, all efforts – perhaps even having a personal faculty

mentor – were made to ensure she was willing to take on the challenge of teaching undergraduates – something she had never done before.

But her appointment was not without concern. During the selection process, her interviewers were primarily concerned about her lack of experience with the methodology of progressive education and undergraduate teaching[vii]. However, they considered her more than qualified for the work[viii]. What was interesting in respect to her field of choice was how she was described. One recommender, Mr. Miller, described her as a theoretical physicist, another, Dr. Hoff considered her a physical chemist[ix]. This is perhaps a reflection of her scientific interests, as Maria started out as a mathematician, before converting to theoretical atomic physics, and with Joe's help, became interested in physical chemistry[x]. Her broad-based approach to the sciences suited the college well, because the students at that time were more interested in applied mathematics, rather than for the sake of studying pure mathematics. She emphasised that her students needed to understand mathematics for astronomy, physics and chemistry, especially students in physics[xi]. This approach was crucial to the role the College would play in providing a labour force during the war in the form of its students[xii]. Apart from that, the College would also undergo changes to adapt to need for more vocational courses, such as scientific knowledge to work as technicians or as war researchers[xiii].

At present, little is known about her involvement with the college environment, since Maria was only on campus for one day a week to take over from mathematician Mr. Belcher, who had left to do research at the Rockefeller Institute of Medical Research[xiv]. She taught his general mathematics class – as she would for the next few years – for the rest of the semester[xv]. From the course catalogues, Maria would certainly have had to

teach students whose primary interest was in Chemistry or Physics but needed some classes in mathematics to understand their material. Apart from that, little is known about the extent of her classes, as no syllabi or class schedules were kept from that time. However, knowing the seminar conference system, Mayer would most certainly have had to engage with her students every other week. Considering her previous record and the College's nature as a progressive, experimental and all-women's college, it wouldn't be unusual to wonder how she would've felt teaching undergraduates for the first time in those months. Archival research provided no indication as to her personal feelings about undergraduates. However, we know later that she did appreciate the students in SLC, as she, "hated to give up a group of bright and interesting girls" (as she left for SAM work)[xvi]. She had enjoyed teaching undergraduates enough to continue teaching undergraduates at the University of Chicago[xvii]. She wrote to Constance Warren about the chance to meet "developing personalities"[xviii], further proof that though inexperienced, she did enjoy the novelty of teaching young, untouched minds that were ready to receive the knowledge she was about to impart.

What initially began as a part-time substitute position became a long-term commitment. In June 1942, Maria Goeppert Mayer was reappointed to the Science faculty for 3 days a week, paid a salary of $2,100 ($28,000 in present terms – adjusted for inflation)[xix,xx] and made a don for the 1942-1943 academic year, a tremendous responsibility for someone who worked part-time. At this time, she was still giving occasional lectures at Columbia as a 'Lecturer in Chemistry'[xxi], but took up the offer anyway and went on to teach 4 courses in the new academic year: Introduction to Mathematics, Differential Integral Calculus, Introduction to Physics and Physical

Chemistry with Mr. Miller[xxii]. Although no official class schedules were retained, to teach 4 classes while only on campus 3 days a week was considered a heavy workload – even in present terms. This was due partly to the fact that she was the only Physics professor the College had - at that point – and Physics seemed necessary to face the increasing demand for physicists in the war and in industry. Her interdisciplinary approach led to faculty members of the Committee of Curricular Problems to consider the possibility of allowing science students to take 4 classes instead of the usual 3 to satisfy science requirements. The alternative was the possibility of allowing science students the option of studying science courses as a 'third' of their program[xxiii]. This change in emphasis on the sciences set the course for the development of the sciences in SLC today, with the establishment of a 'science third' in recent years[xxiv]. Nevertheless, an interdisciplinary science course was considered a step towards improving the integration of sciences into the curriculum. On top of planning and teaching classes, she would have had to coordinate the Physical Chemistry class with Mr. Miller, supervise laboratory sessions and meet with her donnees (which is explained in the next paragraph). On the issue of supervising student conference work, it is no different from the current seminar-conference format[xxv]. Every student in the class – in addition to class work – had to select a topic that interested them, and conduct independent research before submitting a written paper, similar to that of a junior or senior thesis paper. This is still expected of every undergraduate student at the College. Although no records of student conference papers were kept, according to the course catalogue, the students had been primarily interested in radio science, food technology and materials science[xxvi], which speak to a somewhat correct representation of the times.

The 'Don'

Perhaps this is the right moment to explain what 'donning' means. At Sarah Lawrence, a Don takes on the role of a faculty adviser, and is a member of the faculty who has taught a student in their first year. Academically, Dons meet with their donnees regularly to discuss class schedules, progress and conference papers. The Don's involvement in a student's life varies for each class year, but Dons also provide advice on future course choices, transitions to college and grad school applications. Because Dons are often chosen from a field the student is interested in, they also provide advice about career possibilities or post-graduation opportunities. The Don remains with the student for the four years that they are enrolled, provides written evaluations for their Donnees and is perhaps the person who understands the student best. This system of 'Donning' was taken from the Oxford tutorial system and was made possible due to the small size of the school, which set it apart from other colleges. Given the context of the donning system, it is interesting to point out that Maria was made a don even though there were no indications to her remaining as a long-term faculty member or being on track for tenure (her erratic schedule would've made it confusing to figure out her years of continuous service). It would seem that the College had expected her to remain much longer than the four years she spent there. Moreover as the College began to develop a stronger science to meet the demand of society and the students, it is not surprising that she was appointed a Don to oversee the students who planned to pursue scientific careers.

Sarah Lawrence in War

During the war, the college underwent a period of self-evaluation about how to face the new expectations of war. One of the methods used to replace the traditional

method – but one that still preserved the principle of the liberal arts – was to teach vocational subjects with specific objectives towards the preservation of the liberal arts. In line with this, Maria's courses departed from the traditional models of set equations, and were interdisciplinary in nature. In her Differential Calculus Class, she explicitly stated that the purpose of the course was to allow students to apply what they had learnt in Physics, Astronomy and Chemistry, three of the emerging sciences of the time[xxvii]. Similarly, her 'Introduction to Physics' course – perhaps included due to greater demand for physicists in the war – dealt with the standards of physics studies: mechanics, heat and sound; but she had stressed the study of physical optics, electricity, radioactivity and transmutation of elements[xxviii]. The introduction of the transmutation of elements suggested that she already had a hunch about what the next obsession of the world of Physics would be: Nuclear physics. The combination of elements from chemistry and real-life problems concerning physics was fitting as she also taught a joint course in Physical Chemistry with Mr. Miller. Together, they taught what would develop into Maria's *'Fundamental Science'* course, by combining Physics, Math and Chemistry in a course that would serve more practical uses to students[xxix].

By the fall, her full course load would have kept her very busy, and perhaps even gave her a taste of what it would be like to be away from Marianne and Peter for long periods of time, and only to see them on weekends (which was what occurred later as she worked at the SAM Laboratories before returning to Sarah Lawrence full-time). At this point, it seems that she was beginning to develop her teaching methodology and it was here we could see that Joe's methods as an experimental chemist and her knowledge

of chemistry[1] have rubbed off on her. Yet, even though the College was undergoing drastic changes to accommodate the war; such as coal shortages, academic term changes[xxx] and a new emphasis on the integration of the sciences, the College – like many other all-women's colleges of the time – was still primarily focused on developing women who were eventually expected to marry and raise families instead of working. Although little is known about what Mayer though of this, it is interesting when we consider a famous line of her father's that is often quoted, 'Don't be just a woman.'[xxxi]

The Final Blow on the Old World

In the fall of 1943, Mayer was re-appointed to serve again on the faculty and as a don. She was supposed to teach Introduction to Mathematics, Calculus, Physics and Physical Chemistry once again with Mr. Miller[xxxii]. However, the Manhattan Project[xxxiii] had already begun, and Harold Urey requested Maria's expertise in August. A letter was written to Constance Warren[xxxiv], the President of Sarah Lawrence at the time, for Maria to work at Columbia's Substitute Alloys Materials (SAM) Lab to study the separation of uranium isotopes, a crucial piece to understanding and building a nuclear reactor. For this purpose, her knowledge of both physics *and* chemistry was useful in predicting the effects of uranium isotropy[xxxv]. First, she was requested to study the photochemical separation of uranium[xxxvi]. However, by late 1943, Urey decided to abandon those efforts and divert all research to gaseous diffusion through the study of the thermodynamic properties of UF_6 (Uranium Hexafluoride). This was a wise move on the part of Urey as gaseous diffusion (which Maria described as "nice, clean physics"[xxxvii]) was eventually

[1] Joe Mayer taught her physical chemistry when she had nothing much to do at John Hopkins from 1931-1939

adopted as one of the two primary methods of separating uranium at Oak Ridge, Tennessee to produce as much enriched uranium as possible[xxxviii]. Her leave from Sarah Lawrence, although necessary in view of the war (and since she felt it was her duty[xxxix]), was by no means easy. Maria certainly felt the stark difference between working at all-men's, conservative Columbia[2] and the all-women's SLC, and particularly enjoyed the 'human contact with developing personalities…'[xl]. This was perhaps motivation enough for her to recommend SLC alumna Susan Chandler Herrick[xli,xlii] - who had previously studied physical chemistry with Maria – to work on uranium separation in the Manhattan Project with her. Whatever doubts she had on leaving SLC for the Manhattan Project were undoubtedly superseded by what she felt was her duty to assist the Allies in defeating Hitler and the fear that the German effort (led by Heisenberg) would succeed first[xliii].

Maria was on leave from Sarah Lawrence from October 1943 to September of 1944, and was temporarily replaced by Dr. Veseslovsky and Mrs. Strodt in Physics and Mathematics respectively[xliv]. During this time, she was working full time at the SAM Laboratories with Urey and commuted between Leonia, New Jersey (where she lived) and Columbia in Manhattan. Though she was finally employed full-time to work on scientific research, this particular period of the war was particularly difficult for her domestic life[xlv]. Since 1942, Joe Mayer had been employed to work at the Aberdeen Proving Grounds in Maryland five days a week, where they were developing more sophisticated conventional weapons. It took a particular strain on their home and

[2] Columbia University was an all-men's insitution, and due to the connection with Barnard (which was an all women's institution), remained all-men's until 1983. For more information please see: www.columbia.edu)

children, who were taken care of by an English nanny[3]. Although both husband and wife were working on the war, an interesting role-reversal had occurred. For so long, Maria had lived in Joe's shadow, but she now had the opportunity to work on a monumental project. Their positions had shifted. While neither knew exactly what the other was doing, with their individual affiliations, they could guess. Yet, like the rest of the world, Joe could not imagine that the end of the war would be achieved by an atomic bomb. He was known to have said to Maria, 'I'm working on this war, you're working on the next'[xlvi].

Return to Sarah Lawrence

In January 1944, five months into her work at Columbia, Maria wrote a letter to Constance Warren about her uncertainty regarding the end of the war[xlvii]. By this time, the Manhattan Project was well underway, but they were nowhere close to developing a bomb[xlviii]. Five days at the lab doing war research was beginning to take its toll and she wrote of her uncertainty of returning to teach at Sarah Lawrence for the 1944-5 academic year. Even though notes on the margins of her letters sent to the College indicated the necessity of her return, it was unnecessary, as she was determined to return to Sarah Lawrence[xlix] and was willing to 'fight her draft' – as she called it – if it were to jeopardise the possibility of her re-appointment at Sarah Lawrence. Maria made it clear that she was accepting the position with Urey at no personal advantage (the pay was the same), but the question that can be applied to all physicists in the Manhattan Project remains: Was her personal preference to stay in Sarah Lawrence due to her relationship with the school and

[3] For more information on her domestic life please see Dash's biography and Peter Mayer's paper: *Son of Entropy Squared*.

teaching or because her moral conscience resisted the possibility of her working continual participation on a bomb project that would not only have the possibility of destroying her homeland of Germany, but change the way war was to be fought in the world? For this purpose, other interviews and biographies needed to be consulted.

Why the Manhattan Project?

From the different sources, it does seem that Maria was wary of the possible ramifications of her work on Germany[l]. She had previously conducted a seminar on the scientists' role in the production of weapons of war in 1942 and in a roundtable discussion on a post-war world at SLC, Mayer said, "Man's scientific discoveries and inventions might very likely destroy him"[li].

However, her hesitation set her apart from the reactions of her fellow German scientists who emigrated to the U.S. during Hitler's reign. Many of them were forced to leave and believed that an atomic bomb in Hitler's hands was much more dangerous than one with the Allies. This was the justification used by Einstein and Szilard in their letter to President Roosevelt[lii], and that of many other scientists for working on the Manhattan Project (with perhaps the exception of Richard Feynman[liii], who just found it fun). For Maria, her reluctance to work on the Project was complicated and might have stemmed from her personal background and relationship with Germany. Unlike many of her German counterparts, Maria never had first hand experience with the tyranny of Hitler's rule[liv]. Her upbringing was mostly within the sphere of an upper-middle class family whilst the university town of Gottingen provided isolation from the politics of Berlin.

Like Lise Meitner[4] – she had lived in a mostly apolitical scientific environment, but unlike many German scientists, she had left Germany voluntarily in 1930 after marrying Joe Mayer. In this respect, her memories of Germany were not tainted by visions of tyranny and oppression that many Germans suffered in the late thirties. For a long time after she arrived in the US, Germany was still a time of happiness and it was home. In a biography of her, Robert Sachs, her former student at John Hopkins, wrote of her love for Germany and how she was "still Prussian" as she felt a certain sense of pride when the Germans achieved a swift victory in 1941[lv]. However, her nationalism was for the Germany of the past. Ironically, in 1933, just before Hitler began deporting Jews, Maria became an American citizen, so that her first-born, Marianne would be an American. She still loved Germany, and always reiterated to her children the distinction that America was *not* fighting the Germans, or Germany; they were fighting Hitler[lvi,lvii]. Hitler was the spectre that hung over Europe, and he had to be defeated.

Due to the combination of work stress and the responsibility of raising the children in Joe's absence, Maria suffered a series of illnesses before her return to SLC in the fall of 1944. She had written to Constance Warren about a gall bladder operation, which was followed by a bout of pneumonia. These illnesses had her incapacitated for while; so much so that Joe wrote a letter sent to Warren on her behalf[lviii].

On April 22 1944, Maria was contracted to return to SLC for the 1944-5 academic year as a *full-time* professor. This explained the decision of the administration

[4] Lise Meitner was a Austrian-born physicist whose un-credited discovery of nuclear fission has been a disputed issue of late. For more information, refer to Ruth Lewin Sime's biography of Meitner – *Lise Meitner: A Life In Physics*, University of California Press, 1997.

to make her a don in the past, as they were clearly looking for someone full-time for the long term[lix]. Contrary to most biographies written of her, it was this year (and not 1942) Maria was finally able to teach her 'unified science course'[lx]. On top of that, she was to teach Physics and Physical Chemistry (with Mr. Miller)[lxi]. Her Math course was formally turned over to Mrs. Strodt[lxii]. Her course description is particularly interesting, because it was drastically different from how the sciences had been described and taught in the past.

"The course presents man's knowledge of the universe and the atoms, which compose it. It deals, consequently, with subjects, which are basic to the sciences of astronomy, geology, chemistry and physics. Science is treated as a liberal art rather than pre-professional training. The course is, however, prerequisite for further study in either physics or chemistry. The laboratory work contains chemistry and physics as well as observation of starts. No previous preparation in mathematics or science is required."[lxiii]

Once again, the distinct lack of information about what exactly she taught is disadvantageous in making the comparison between her course and what is being taught today. However, in a letter to the Committee on Curricular Problems, Maria made it clear that her students had at least read George Gamow's "Mr. Tompkins in Wonderland" and "The Birth and Death of the Sun"[lxiv]. This was significant, because the practice of reading populist science and sci-fi books still exists today, with a First Year Studies in Physics class reading Richard Feynman's "Surely You're Joking, Mr. Feynman" and Gregory Bernstein's "Timescape".

This period between the end of her work at the SAM laboratories and the end of the war was another one that was particularly stressful. Apart from being a full-time faculty member, Mayer had trouble with the selection of her laboratory assistant for her

joint Physical Chemistry course with Mr. Miller. She felt that Eva King[5] was not qualified enough for the job[lxv]. However, King was eventually employed under the condition that Mr. Miller would coordinate all the experiments (which were in chemistry). This was not an unreasonable request, given her workload, and a new request to work for Urey once again[lxvi] - which eventually took up all her free time. In addition, the employment of Eva King also illustrated the lack of funds that the College suffered from which still persists. At the time, the College did not have sufficient funds to employ a full-time specialist in Chemistry, and with the war taking its toll on the supply of scientists; Maria had to accept that compromise[lxvii]. The situation with King showed the high standards she demanded of her assistants and colleagues, and she had to swallow a bitter pill to accept King's appointment as an irreversible measure forced by war. In August 1944, Mayer sent a letter to Constance Warren rejecting Urey's request to work on more war research for him a day and a half a week, citing her teaching commitments[lxviii]. This arrangement would have greatly affected her domestic life further, as Joe was still working in Maryland. A final compromise was reached with Maria travelling to Columbia for half a day a week[lxix].

The "rush job"

What is most fascinating about this work was the lack of substantive information regarding it. Preliminary searches at Columbia unearthed records of her having worked on war research, but not the nature of such research at the time. However, in her letters to Warren, she did mention the supervision of a graduate student, and that the work was

[5] King was a Sarah Lawrence alum who had just completed her studies at Mount Holyoke College, Massachusetts. Being a fresh graduate, she was considered inexperienced.

'super secret…rush job'[lxx]. So what was this mysterious "rush job"? Realising that there have been mentions of her collaborating with Edward Teller at Columbia in biographies, the pieces finally fell into place when Teller's "Memoirs: A Twentieth Century Journey in Science and Politics" provided the evidence needed to explain this mystery[lxxi]. The rush job was her first collaboration with Teller on the Opacity Project. It was to be the first of many projects, but what is most interesting was the fact that she was working with Tellar, who was the most famous proponent of the continuation of the development of thermonuclear weapons[lxxii]. At this stage, the Opacity Project research had to be rushed because, as bomb construction went underway, Teller realised that escape of radioactive energy due to low opacities[6] would reduce the effectiveness of the bomb. The very purpose of the Opacity Project was to discover the opacities of uranium and in Maria's case, to specifically identify the opacities of uranium at very high temperatures – temperatures that would likely be reached during detonation[lxxiii]. According to Teller's and Maria's letters, Maria helped Teller's graduate student, Harris Mayer on calculations, but was not informed why they were specifically interested in opacity[lxxiv].

V-E Day

On May 8th, 1945, Adolf Hitler, Führer of Germany, committed suicide as Berlin was under siege and the Allies declared a victory in Europe[lxxv]. That day, Maria Goeppert Mayer stayed home and listened to the news of a victory over her homeland yet remained anxious for her family members still in Germany. She had felt somewhat relieved that the war in Europe was over, but perhaps also some sadness that *Germany*

[6] The ease or difficulty with which electromagnetic radiation can be transferred through a material. (Teller, 2001)

had lost. For Maria, there was little to celebrate[lxxvi]. But a new question soon emerged: Without a German enemy, where would the bomb be deployed – if deployed at all? She would find the answer to that question sooner than expected.

1945 marked another difficult year in Maria's time in New York. In February of 1945, Joe Mayer was asked to leave for the west coast to supervise the testing of the new weapons[lxxvii]. His complete departure, coupled with Maria's preoccupation with SLC and the Opacity Project took such a great toll on her children that her daughter felt a distance between her and her parents[lxxviii]. In July, Maria was invited by Teller to continue their Opacity research at Los Alamos[lxxix]. That trip has always been described as the proof of their sustained partnership that would carry on long after WWII. At Los Alamos, Maria was reunited with the Fermis, and experienced living in dormitories under strict surveillance[lxxx]. But the work was quick and she wasn't there for long, as news finally arrived that Joe would be returning to New York. Though there were complications about his return – she wanted to watch the Trinity Test in mid-July but also wanted to meet him at Albuquerque to return to New York together. Finally, they met up in New Mexico[lxxxi]. It was here that Joe, along with Urey and Fermi, received their job offers from the University of Chicago. Dissatisfied with Columbia, all three agreed immediately[lxxxii]. They were back in New York before the test. On July 16th 1945, attempts by Urey and Mayer to call Los Alamos were futile. They were testing the world's first atomic bomb in what is now famously known as the Trinity Test.

The war had taken a great toll on the family and they finally returned to New York, before leaving for Nantucket for three weeks[lxxxiii] for a well-deserved family holiday. As the story goes, Maria and Joe were walking to landlord's house the morning

of August 6th where the landlord asked if he heard of the atomic bomb being dropped on Hiroshima and if he had anything to do with it. This news evoked a duality of emotions for Maria[lxxxivlxxxv]. The first was mild shock and the other relief. It was mild shock because with the German surrender on V-E Day, Maria had known that the bomb would be redirected from Germany towards Japan, as the Japanese army was still well known for its aggression. It was inevitable. But more than anything, she felt relieved that the war was over. Historical accounts describe Maria as suffering from having to conceal the truth from Joe. With the bomb out and the Manhattan Project no longer concealed, she could finally tell him everything – from her involvement with the Division of War Research in Columbia to her collaboration with Edward Teller both at Columbia and Los Alamos. The scientists' fear about Hitler now transferred to the increasingly competitive use of nuclear weapons between America and the USSR[lxxxvi]. As new College President Harold Taylor later said to her, "Now that you scientists have succeeded in administering the final blow to the old world perhaps we can hope to have some of the young physicists back in the academic halls."[lxxxvii]

Leaving Sarah Lawrence

Not long after the bomb was dropped, Maria wrote a formal letter of resignation to Harold Taylor, the new College President. Joe had accepted the full-time professorship at Chicago (to head the Institute of Nuclear Studies[lxxxviii]) and Maria, never one to complain, followed to join the faculty as an Associate Professor in the Institute – an unpaid position once again. Perhaps it reinforced the reality that her gender was still a barrier to her sustained success. Maria wrote of how she 'had no choice' but to follow Joe to Chicago[lxxxix]. She was scheduled to teach the fall of 1945 and was keen on doing so,

but was willing to leave prior to September if it would allow the College to adjust to her departure (presumably academically). She finally stayed for the fall semester when Taylor observed that students who had chosen her courses were in actuality choosing her as a professor, a familiar practice even in present times[xc]. She remained for the fall of 1945, and taught Fundamental Physical Science, Physics and Physical Chemistry[xci]. However, there was a change. With her previously secret war research now out in the open, her profile on campus had been raised significantly and students constantly questioned her about the science of the bomb or nuclear physics[xcii]. It was a further extension of the application of physics from using it solely for household appliances to work on a much greater scale. Perhaps, to her former students, the inclusion of the transmutation of elements section in their syllabus in 1942 finally made sense.

In preparation for her departure, Maria had to help search for physicists and a new chemist, to replace Mr. Miller, who was also leaving. The search began to narrow and she was finally given the task of interviewing Dr. Rolf Aschtul – a chemist – from Bryn Mawr College. This turned out to be a puzzling situation as Maria was the only one to describe Aschtul as "quiet and uncommunicative"[xciii]. Perhaps she was more intimidating than many give her credit for – a physicist, tutored by Max Born, but a woman nonetheless. He was eventually hired and the search remained for a physicist. As Maria rightly noted, the war was over, and with that, the Manhattan Project, which had claimed so many young, talented physicists from academia. There was now an abundance of physicists, and she eventually recommended Charlotte Houtermans – ex-wife of Dr. Fritz Houtermans, a German physicist – to the position[xciv].

Maria was released from her contract with SLC in October and finally left SLC for Chicago in January 1946[xcv]. Although there are mentions of her returning to SLC after 1946, no physical documentation in formal channels remain of such visits, depriving us of the evidence of her continued relationship with the College and the role it had played in her life. She left for the University of Chicago and continued to teach undergraduates in Physics[7].

In 1963, Maria Goeppert Mayer became the 4th woman to win the Nobel Prize in Science[8] and the 2nd in Physics, after Marie Curie[xcvi]. She won it for her discovery of the nuclear shell structure. The prize was also jointly awarded to Hans Jensen and Eugene Wigner as well [xcvii] - Jensen, for having similar findings at approximately the same time; and Wigner for his similar discovery on the fundamental principles of symmetry in the atomic nucleus[xcviii].

Conclusion

This biography was first written to shed some light on a point of contention in several sources that arose from oversight and misinterpretation. The phrase 'where she was no longer considered a nuisance' in Dash's biography evidently referred to her time at Columbia, where she was maligned. However, quoted out of context, it seemed to have included Sarah Lawrence College, which according to historical records, was incorrect

[7] Physics 253: Thermodynamics and Statistical Physics; Physics 380-389: Theoretical Physics III.

[8] From records at the Noble Foundation, Maria Goeppert Mayer was historically the 4th woman to win the Nobel Prize in science (on the basis that the Prize for Physiology and Medicine was included in the calculation). The order of the earliest Prize winners are as follows: Marie Curie – Chemistry (1903); Marie Curie – Physics (1911); Irène Joliot-Curie – Chemistry (1935); Gerty Cori – Physiology or Medicine (1947); Maria Goeppert Mayer – Physics (1963).

and unjustified. However, as is the case with research projects, it quickly turned into much more than just setting the record straight.

Though generally unrecognized, her presence at Sarah Lawrence College changed the course of the sciences here forever. Although the college had encouraged the study of science during the war (for mostly practical purposes), it needed a scientist like her to transform and create a truly effective interdisciplinary science course. Her classroom experiences encouraged students to transition from learning science for practical purposes to allowing scientific curiosity to lay the foundation of a lifelong journey for knowledge. Though her classroom methods were unknown, I am personally indebted to her for providing me the opportunity to approach science in the same manner - the very manner that has allowed me to study her contributions here, and remember it forever.

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