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The Summer of 1954 and Paths to the Institut Laue-Langevin

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Historical research places scientific achievements in larger contexts that show how those achievements were possible. A history of the Institut Laue-Langevin by the first French Director, Bernard Jacrot, is valuable in this regard [1]. It begins primarily with the 1964 Geneva Conference, the third of the Atoms for Peace series, where a French research reactor proposal was met with interest by the German delegation and quickly developed into founding the international institute in Grenoble. Earlier aspects of this history, aptly termed pre-history, include work on thermal neutron scattering up to 1964. Here we present an addition to the pre-history, focusing on a unique event near Grenoble in the summer of 1954 and its role in the development of some of the scientists and science that helped make the founding of the Institut Laue-Langevin possible.

In the French Alps overlooking the Chamonix Valley, the Summer School of Theoretical Physics at Les Houches was in its fourth year during the summer of 1954. It was founded in 1951 by the truly remarkable Cécile DeWitt, who as Cécile Morette had done a doctorate under the direction of Louis De Broglie and worked under the direction of Frédéric and Irène Joliot-Curie in Paris, then was with the group of Walter Heitler in Dublin and was at the Niels Bohr Institute in Copenhagen when a cable from Robert Oppenheimer brought her to the Institute for Advanced Study, Princeton in September 1948. There, the idea for a French summer school began, becoming her dedicated project upon a marriage proposal from Bryce DeWitt [2]. With Cécile DeWitt as Directrice and administratively associated with the University of Grenoble, the school was already well known in 1954 as an especially valuable experience for European students and recent doctorates in physics. It provided what most universities could not: quality instruction on recent developments in physics and personal contact with some of the top scientists of physics during times of rapid development. Among the 30 students that summer was Bernard Jacrot. He had recently begun doing neutron re-

search at Saclay where France's second research reactor EL2 provided neutrons [3]. It is therefore significant that lecturers and seminar speakers for the school included several physicists prominent in neutron scattering theory and experiments. Foremost was Enrico Fermi (Chicago), together with Léon van Hove (Utrecht), Donald Hughes (Brookhaven) and Roy Glauber (Harvard).

In a review of the development of neutron scattering at Saclay [4], Bernard Jacrot emphasized how important it was that personal contact had been established between the Saclay group and Léon van Hove during the 1954 summer school, a recollection also expressed by Albert Messiah [5] who worked in theoretical physics at Saclay. Van Hove had just begun a professorship at Utrecht after several years at the Institute for Advanced Study, Princeton where he published papers on thermal neutron scattering, many with George Placzek. Van Hove's ever-important 1954 papers on space-time correlation functions [6] were in press at the time of the summer school. He brought both manuscripts to the school that summer. They are now in the school archives. The manuscripts came at an important moment. Hughes and Palevsky had published dramatic neutron scattering data from iron near the Curie temperature [7], and understanding it was a challenge. Van Hove's space-time correlations provided a valuable, model-independent approach [8]. Discussions had occurred at Brookhaven before van Hove's departure for Utrecht. Did they continue at Les Houches? Van Hove was certainly concentrating on neutrons at Les Houches. On July 8, he checked out from the school's bookshelves: "Theorie der Neutronen" by Werner Heisenberg [9]. Among the topics was "Neutron Distributions at $T < 100$ K".

The Saclay group was especially interested in magnetism, always a strong topic in France. Neutron scattering at Saclay proceeded in this direction [3,4]. Cold neutron sources were later developed with help from Peter Egelstaff who had started such work in England. The influence of Les Houches increased in 1955 when

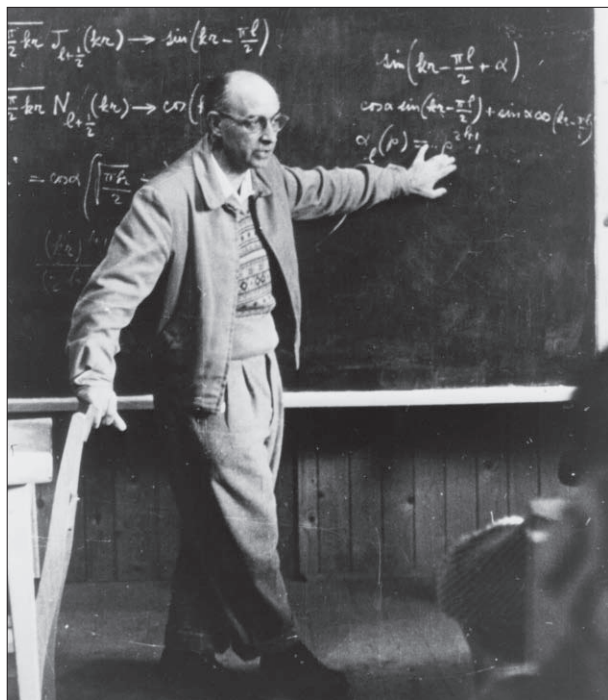


Figure 1. Enrico Fermi lecturing on partial wave analysis at Les Houches, July 1954. Emilio Segrè included this photo in his book “Enrico Fermi, Physicist” (1970) without indicating the location. Laura Fermi helped Segrè with the book and the photo had possibly been in her possession. Laura was with Enrico at Les Houches. Photo from Emilio Segrè Visual Archives, courtesy and © AIP. Reproduced with permission.

Pierre-Gilles DeGennes joined Saclay to work on theoretical aspects of magnetic neutron scattering for his thesis. DeGennes, together with Philippe Nozières had attended the 1953 summer school and appreciated the solid state physics lectures by Rudolf Peierls, soon published [10]. In his thesis, DeGennes acknowledges advice and discussions with Léon van Hove while at Saclay and has said of the 1953 school: “the most important two months of my life” [11].

The extent to which neutron scattering was discussed at Les Houches in 1954 is difficult to establish. Most topics focused on high energy physics, meson physics, the nature of nuclear forces and quantum theory of fields, especially quantum electrodynamics (QED). The founding of CERN was progressing rapidly just weeks from achieving treaty ratification. Ground breaking for buildings and an accelerator had already begun at Meyrin near Geneva. CERN was the center of attention. The summer school brochure sent out in May 1954 lists five lecturers and their topics: L. van Hove, Quantum Mechanics; E.

Fermi, Role of Isotopic Spin in Meson Physics & Statistical Model for High Energy Nuclear Collisions; R. Marshak, Problems in High Energy Nuclear Physics; F. Dyson, Quantum Electrodynamics; R. Glauber, Problems of Advanced Quantum Mechanics. These topics could change due to unforeseen circumstances, but would be kept close to the list. Many of the students went on to careers in these areas of physics.

The Fermi Archives at University of Chicago contain correspondence between Enrico Fermi, Cécile DeWitt (at Berkeley) & Jean-François Detœuf (Directeur adjoint, Paris) detailing preparation for the summer school, to determine lecturers, topics, level of instruction and how topics are spread among lecturers. The letters begin with Cécile DeWitt writing a letter of invitation to Fermi from Les Houches, July 14, 1953. Correspondence between Fermi and Robert Marshak provides an outline of Fermi’s lectures at Les Houches and how topics were divided between the two lecturers. Mimeographed materials for students were planned and Fermi got permission from Arthur Rosenfeld, who had just completed his thesis with Fermi, to have Detœuf mimeograph Rosenfeld’s thesis. The thesis consisted of two manuscripts that later appeared in *Physical Review* [12]. These course materials are much like van Hove’s two papers, but although van Hove’s manuscripts are in the Les Houches Archives, whether they were mimeographed for students is unknown.

The Fermi Archives also contain correspondence with Giovanni Polvani, Gianni Puppi, Francesco Giordani and Bruno Rossi about lectures at the Italian Physical Society’s 2nd summer school at Varenna on Lake Como, where Fermi lectured after departing Les Houches July 17. Fermi corresponds with Edoardo Amaldi (Rome) to arrange some time after Varenna with the Fermi and Amaldi families together again enjoying the Dolomites. Amaldi lectured at Varenna on the status of CERN. Both schools succeeded at obtaining the participation of top scientists, many of whom had conferences or other activities to attend. The 1954 Glasgow Conference on Nuclear & Meson Physics, July 13–17, was a major international event and several scientists at Les Houches managed travel to make presentations at Glasgow: Marshak (with Maurice Lèvy), Hughes, Dyson, Araki and Watanabe [13]. The schools at Les Houches and Varenna associated closely. For the Varenna inaugural year of 1953, Cécile DeWitt gave a welcoming address to the sister school [14]. Students sometimes attended both schools. In 1956 Bernard Jacrot attended the Varenna school on magne-

tism [15]. Walter Marshall was also there, from Harwell. After Fermi's death in November 1954 the Varenna school was named the International School of Physics "Enrico Fermi".

Although published volumes of Les Houches lectures are now prominent in science libraries, publication began only in 1958. Typed copies of some lectures prior to 1958 are in the Les Houches Archives [16]. For 1954: F. Dyson, Supplement to Advanced Quantum Mechanics; R. Glauber, Quantum Theory of Collisions; R.E. Marshak, Present Status of the Two-Nucleon Interaction; P.O. Löwdin, Non-relativistic Quantum Theory of Many-Particle Systems; M.A. Tonnelat, Le But et la Methode des Theories Unitaires. These copies were often from notes by students, a physics tradition. For Marshak's lectures, notes were by Bhalchandra Udgaonkar and Bernard Jacrot. For Dyson, notes were by Jean Lascoux and Jacques Mandelbrojt. These took on new life recently, translated from French and published in a second edition of Dyson's legendary Cornell lectures (1952) on QED [17]. Such lectures soon became valuable to solid state

physics as methods of quantum field theory were used for condensed matter problems. In 1956, Dyson published on spin wave interactions using methods of QED [18]. The same year he invented the ultra-safe TRIGA research reactor.

The lectures by Enrico Fermi are not in the Les Houches Archives. He lectured on high energy scattering experiments, his current research after overseeing construction of the Chicago cyclotron. He was measuring the production and scattering of pions by nucleons and analyzing scattering by the method of partial waves to investigate the nature of nuclear forces and whether a resonance was observed at 1230 MeV. The lectures by Fermi at Varenna are available. Edited from student notes and recordings, they are published in *Nuovo Cimento* [19]. Mainly on pion production and scattering, they include items from neutron work such as the Fermi chopper.

Albert Messiah has written compelling comments in support of neutron scattering course material at Les Houches in 1954 [5]. He mentions van Hove's course on Quantum Mechanics at the 1951 summer school (these



Figure 2. Enrico Fermi and students at Les Houches, July 1954. Left to Right: Rosanna Cester, Daniel Amati, Enrico Fermi, Bhalchandra Udgaonkar. Photo from the Ecole de Physique des Houches archives, courtesy of Leticia Cugliandolo (Directrice). Reproduced with permission.

lectures are in the Les Houches Archives). Then, noting that by 1954 van Hove's work on pair correlations is in press, he states: "Now was the proper time to give a comprehensive account of the theory of neutron scattering by systems of interacting particles. This was the subject of his course. It exactly fitted Jacrot's needs." Support for Messiah's comments is found in a report on the 1954 summer school by Roy Glauber, written just after the school [20]. Glauber lists the lecturers and their topics. Van Hove's is "advanced approaches to quantum mechanics". This cannot be the "Quantum Mechanics" of van Hove's 1951 lectures. Indeed, van Hove's space-time correlation functions are a good match to "advanced approaches to quantum mechanics".

Glauber's report also gives the structure of the 1954 summer school, with morning courses given in July by van Hove, Fermi and Marshak and courses in August by Dyson and Glauber. During afternoons, instruction was by seminars and study groups, with additional instructors: Bernard D'Espagnat, Mme Marie-Antoinette Tonnelat, Donald Hughes, Shinzo Watanabe, Per-Olaf Löwdin, Szolem Mandelbrojt, Gentaro Araki, and Bernard Feld. Afternoon seminars were also given by course lecturers. The Fermi Archives contain a notebook Fermi prepared for his lectures and took with him to Europe. One page is headed "Colloquium Les Houches 7/7/54", with notes on cosmic ray showers containing "tight bundles of photons". Another, headed "Colloquium Les Houches 7/13/54", is on stellar structure and the Russell Diagram. These were topics of Fermi's theoretical work, especially cosmic rays and so it was appropriate that an excursion to the cosmic ray lab near Aiguille du Midi was arranged for 14 July. This excursion is well-described by Roy Glauber, including photos [21]. It has additional significance because the first major European collaborations in experimental physics were in cosmic ray research, due to development of improved nuclear emulsions by the Bristol group. These emulsions produced so many good exposures in mountain labs and balloon flights that exposed emulsions were sent to universities across Europe for analysis by participating research groups. This was an important example. CERN and much more was soon to follow.

The summer school at Les Houches succeeded remarkably and quickly. How this was possible is of interest. A partial answer is the dedicated effort to fulfill an important need, plus an interesting mix of chance, wisdom and tradition. By chance, Cécile Morette and Freeman Dyson both arrived at the Institute for Advanced

Study in September 1948 and quickly became friends. Dyson had just spent a year at Cornell and that summer travelled to Albuquerque with Richard Feynman, continuing to learn Feynman's new approach to QED. Then Dyson traveled to the University of Michigan to attend the summer school where Julian Schwinger lectured on his approach to QED. Dyson mastered both approaches and showed they were equivalent. He lectured on this at IAS that fall. Much has been written on this important moment in physics [22]. The significance here is that Dyson's 1948 experience at Michigan quickly led at IAS to Cécile's idea of a French summer school. Furthermore, Cécile had the wisdom to realize that an attractive, isolated location was needed, rather than a university setting. This was the new idea. It was later adopted by many new European summer schools in physics. Tradition was established by the successes of Michigan summer schools from 1928 to 1941 under the direction of Sam Goudsmit and George Uhlenbeck [23]. Traveling from Italy, Fermi lectured there often, beginning in 1930 on "Introduction to QED" which was soon published and is still an excellent introduction to QED [24]. Participation of top physicists at international summer schools was firmly established as a physics tradition by mid-1930s. Cécile's work at many research centers provided important contacts for continuing this tradition at Les Houches.

Some years after the summer of 1954, with neutron scattering a well-established technique and the Institut Laue-Langevin underway, Terry Willis at Harwell initiated the first summer school for neutron scattering [25]. With dedicated commitment, like that at Les Houches, the neutron scattering school continued and provided many participants with personal contacts and career opportunities. The Saclay group had greatly benefited from the 1954 summer school at Les Houches and their work progressed rapidly, to include the first observation of a vortex lattice in type II superconductors, published in 1964 [3, 26]. The paths to founding the Institut Laue-Langevin are many, but there is certainly one that leads from Les Houches.

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This work is dedicated to the memory of Cécile DeWitt-Morette and all she has done for the École d'Été de Physique Théorique at Les Houches and its students. Cécile assisted this historical work with interest but sadly did not see its completion. We thank Cécile's daughter Chris DeWitt for much assistance and guidance and Freeman Dyson for helpful recollections. We warmly ac-

knowledge the help of Isabel Lelievre, secretary of the school and Leticia Cugliandolo, Directrice of the school, for their hospitality and providing access to the Les Houches Library and Archives.

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