

Alfred Kastler and the Atomic Physics Group at Ecole Normale in the 1950-1960's. Personal recollections (*)

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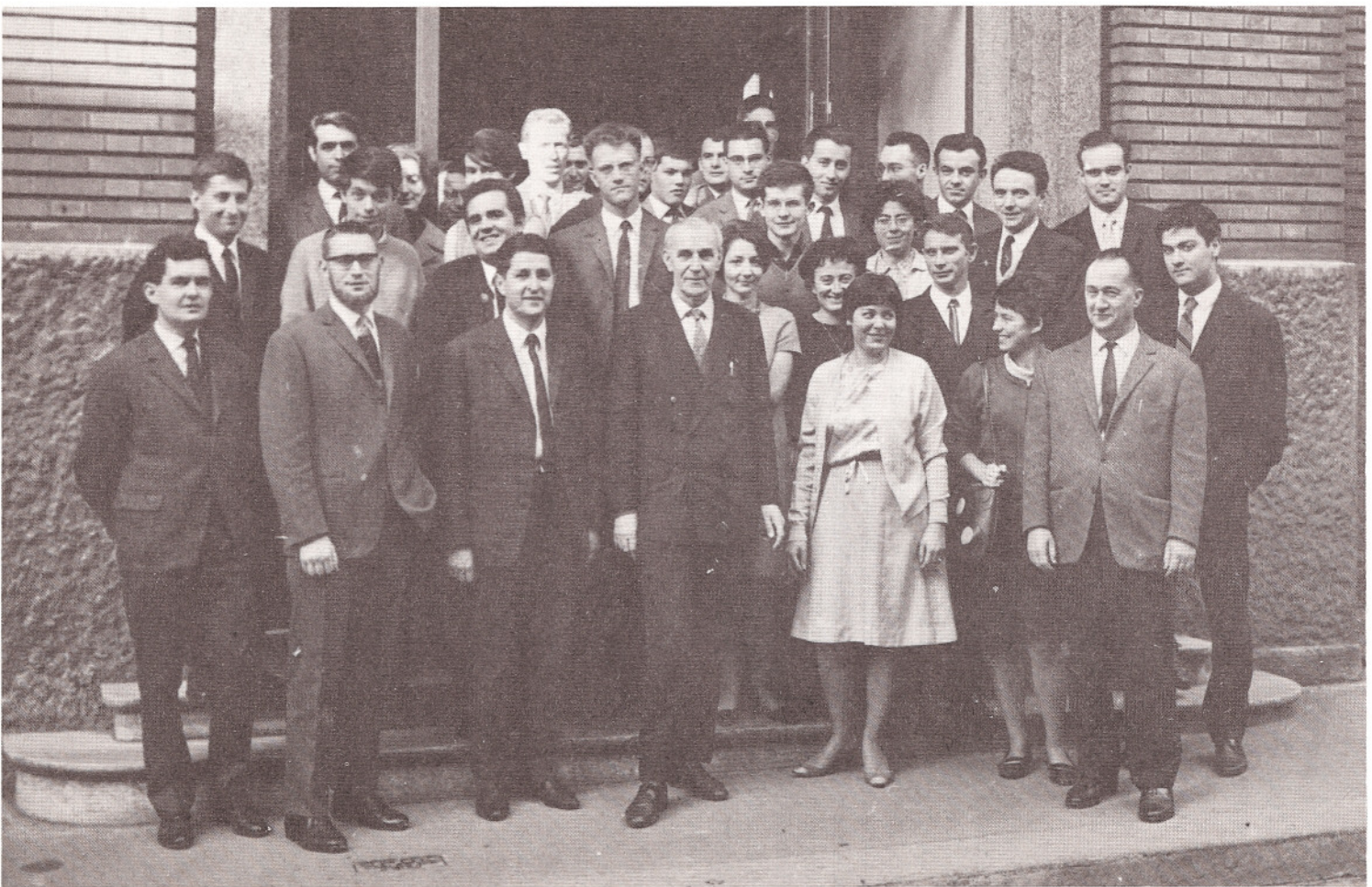
I met A. Kastler for the first time in 1953, when I was admitted at Ecole Normale as a student. I was twenty years old, arriving in Paris from Algeria where I was born, and which was part of France at that time.

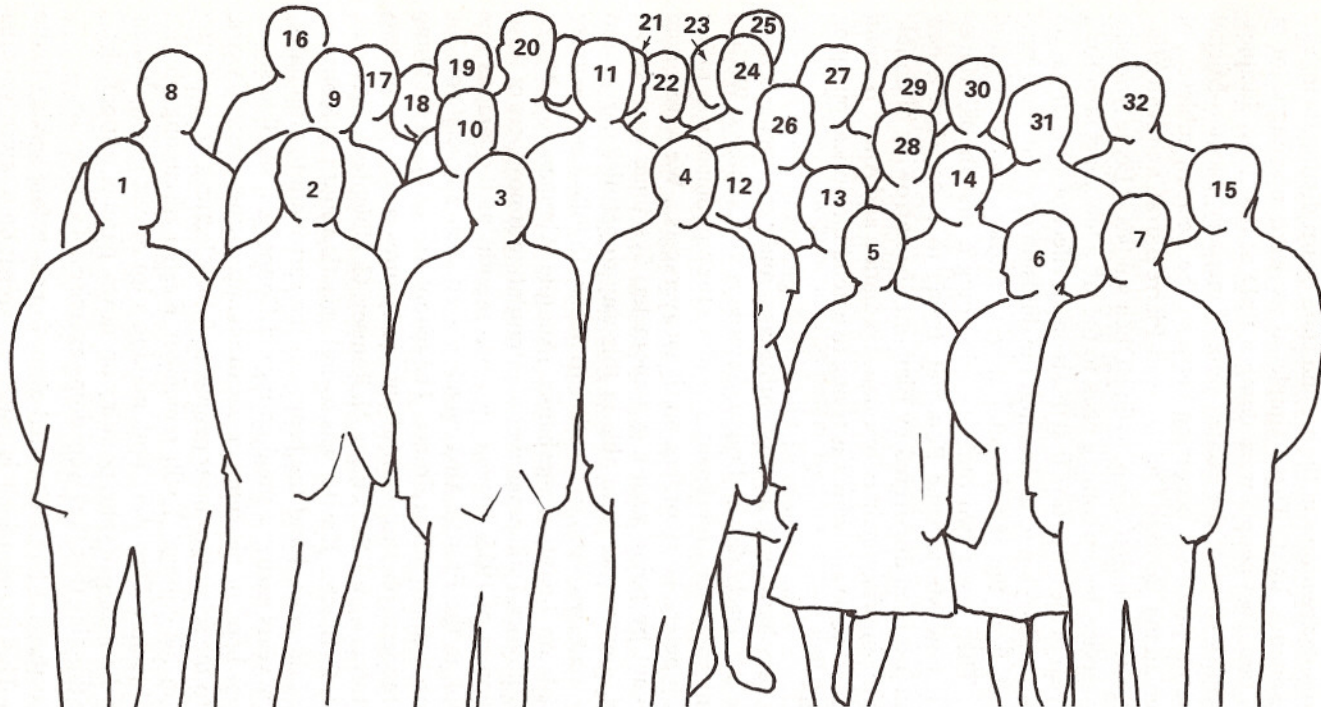
During their first year at Ecole Normale, the students generally follow lectures at the University, which was the « Sorbonne » at that time, and also a few special lectures especially prepared for them and given by people working in the different laboratories belonging to Ecole Normale itself. Kastler was giving an Atomic Physics course. I remember that I was also following lectures by Laurent Schwartz and Henri Cartan on distribution theory and topology. It was a great excitement for me to discover so many new things. I was initially more attracted by mathematics, but Kastler's lectures were really very stimulating. He was describing atoms and photons in simple terms, giving life to these objects and playing with them, showing all kinds of new possibilities which could be explored. His personality was also very attractive. He was very kind and open with the students. Something also which impressed me a lot was to see him quite often, sitting among the students in the Sorbonne, and following lectures on matrix theory. During all his life, he has always considered himself as a student, having something new to learn and very excited by this idea. So, finally, I changed my mind. I decided to do Physics rather than Mathematics and to join Kastler's group.

Kastler himself was a former student of Ecole Normale where he was admitted in 1921. He was born in Alsace in 1902 during the German occupation and, as a young boy, he followed a typical German education. Actually, his native language was German. This explains probably why he was so greatly influenced by the books and the original papers of the great physicists of the German school, such as Sommerfeld, Planck, Einstein, Boltzmann, etc... His lectures on Atomic Physics were inspired by the famous book of Sommerfeld on « Atombau und Spectrallinien ». The fact that he was in contact with two completely different cultures, the German one and the French one, probably explains why his approach to physics was so unconventional, and why his viewpoint were so universal.

When I joined Kastler's group in 1955, the group was very small. Jean Brossel, who was one of the first students of Kastler, had come back four years before from M.I.T. after a PhD prepared under Francis Bitter direction. The group was indeed very small,

(*) This paper takes its inspiration from a talk given by the author at the American Physical Society Annual Meeting of the Division of Electron and Atomic Physics on May 31, 1984 in Storrs (Connecticut).





1. Michel Dumont
2. Bernard Cagnac
3. Claude Cohen-Tannoudji
4. Alfred Kastler
5. Françoise Grossetête
6. Nicole Polonsky
7. Jean Brossel
8. Jean-Pierre Faroux

9. Robert Romestain
10. Marc Thomme
11. Francis Hartmann
12. Michèle Leduc
13. Irène Brodschi
14. Bernard Gyors
15. Serge Haroche
16. Georges Camy

17. Solange Dousset
18. Pierre Cassou
19. Anne-Marie Berland
20. Alain Delawoevre
21. Jean-Pierre Descoubes
22. Martial Ducloy
23. Bertrand Legaut
24. René Barbe

25. Alain Omont
26. Jacques Dupont-Roc
27. Franck Laloë
28. Marie-Anne Bouchiat
29. Lionel Pottier
30. Jean-Claude Guillaume
31. Bernard Laisne
32. Bernard Decomps

but the climate for research was exceptional. Two simple and beautiful ideas had been put forward a few years before. The double resonance method, allowing one to optically detect magnetic resonances in excited atomic states, the optical pumping method, allowing one to polarize atoms in the ground state by irradiating them with circularly polarized resonance light. These simple ideas were opening a lot of interesting new possibilities. Two people were doing a PhD at that time, Jacques-Emile Blamont on the Stark effect of the excited state of mercury, Jacques-Michel Winter on RF multiphoton processes occurring between the Zeeman sublevels of optically pumped sodium atoms. Bernard Cagnac, Jean-Pierre Barrat, and Jean Margerie had just left the lab, after their first thesis, to finish their studies at Ecole Normale and to do their military service, before coming back to the lab a few years later for a PhD. I spent myself one year in the lab to do a first thesis on the effect of a buffer gas on optical pumping signals. I was trying to understand the diffusion of polarized atoms in the gas and to deduce from the experimental curves diffusion coefficients and collision cross sections. There were two other people doing a first thesis, Marie-Anne Guiochon, who is now Marie-Anne Bouchiat, trying to understand a new phenomenon, which had just been discovered by Blamont, the narrowing of double resonance curves due to the imprisonment of resonance radiation and André Blandin (who unfortunately died last year) and who was trying to extend the optical pumping method to cesium atoms.

We were all working very hard, with a lot of enthusiasm and excitement. Brossel and Kastler were in the lab nearly day and night, Saturdays and Sundays. We had endless discussions to interpret our experimental results. Our equipment was rather poor at that time. No computers, no recorders, no signal averagers... We were taking the resonance curves point by point, with a galvanometer, five times each curve, averaging by hand. But, anyhow, we were able in this way to get nice curves and exciting results. Once a week, we went all together to Saclay to follow new lectures given by Albert Messiah on quantum mechanics, Anatole Abragam on NMR, Claude Bloch on nuclear physics. I still remember the stimulating atmosphere of these lectures. During the summer of 1955, I spent also two months at the famous Les Houches summer school, in the French Alps, which played such a crucial role for the development of theoretical physics in France. The school was giving at that time an intense training in modern physics, with about six lectures a day during two months. In 1955, the lecturers were J. Schwinger, N. Ramsey, G. Uhlenbeck, W. Pauli, A. Abragam, A. Messiah, C. Bloch... Kastler was so enthusiastic about Les Houches, about the atmosphere of the school and the beauty of the surrounding mountains, that he had bought a few years earlier a small cottage in Coupeau, a small village a few miles away. He spent here all his summer vacations, up to these recent years, and he came regularly to the school, to meet people, to follow lectures, to invite the participants to parties in his cottage. I still remember Kastler discussing physics with C. Gorter in Les Houches. They were both making a lot of gestures with their arms, because they were discussing of spins pointing up, down, parallel, antiparallel... and several people were thinking that they were doing exercises of gymnastics.

After finishing my first thesis, I had still a final exam to pass before leaving Ecole Normale as a student. This exam, which is called « Agrégation », gives you the possibility of teaching in high schools. The preparation to this exam consists in theoretical and experimental courses, and also in some pedagogical training. You give a lecture which is attended by the other students and by a professor, and after the lecture, there is a general discussion to criticize the lecture and to see how it could be

improved. Kastler was participating to this pedagogical training. Actually, he started himself his professional career as a high school teacher and during all his life, he was always very much concerned with educational and pedagogical problems, with the elaboration of new attractive programs in Physics. Hundreds of high school teachers in France have followed Kastler's lectures. I will never forget myself these lectures and I am very much indebted to him for teaching me how to prepare a lecture, how to present the motivations and the conclusions, how to write on a blackboard.

After the « Agrégation », I left Ecole Normale and I did my military obligations, which were very long at time (about two years and a half) because of the Algeria war. And I came back in the lab in the beginning of 1960 to do a PhD. The political situation was difficult in the country. Most people were tired by the war, but part of the army could not accept the idea of stopping the war. As always in these periods of tensions, violence was growing. And « liberal people » such as Kastler, who was protesting openly against torture and violence, became a target for extremists. Actually, his flat was partly destroyed by a bomb put at his doorstep and he was threatened with death. His courage and self control were impressive and I remember that it was very difficult to convince him to let people from the lab escort him every day, when he walked in the street to the lab or back to his home.

The lab had become a little bigger by that time. Cagnac was finishing his thesis on the optical pumping of the odd isotopes of mercury. I was trying with Jean-Pierre Barrat to derive a master equation for the optical pumping cycle and to understand the physics of the off-diagonal elements of the density matrix (the so-called atomic « coherences »). Our calculations predicted the existence of « light shifts » for the various Zeeman sublevels, a curious phenomenon which we didn't expect. I decided to try to see the effect. Cagnac left me his experimental set up during Christmas vacations. I remember that I got the first experimental evidence during the night of Christmas 1960. I was very excited and Kastler and Brossel were very happy. Kastler called the effect the « Lamp shift », since it is produced by the light coming from a discharge lamp (Now, it is called the a.c. Stark shift). Kastler was always fascinated by the interaction processes between atoms and photons and he liked very much the idea that absorption and dispersion of light on the one hand, broadening and shift of atomic energy levels on the other hand, were two sides of the same physical phenomenon. He was always putting on my desk small notes suggesting improvements, new ideas of experiments, of calculations. It was very pleasant to discuss with him because he had, in some sense, a poetic view of physics, and his approach was full of fantasy and surprise. During the seminars also, he frequently asked simple and sharp questions, I would say the important question, going into the heart of the physical problem and bypassing any complicated algebra.

I finished my PhD at the end of 1962. And I started to supervise the work of younger people. At that time also, a very important reform was taking place in our University system, the so-called « Troisième Cycle », or third cycle, which consists of a graduate level teaching, with a flexible program. Brossel asked me to teach a Quantum Mechanics course. He was teaching himself Atomic Physics, Kastler and J. Yvon Statistical Physics, P. Aigrain and P. G. de Gennes Solid State Physics. We had the best students of Ecole Normale attending the lectures and it is in this way that I built a small group with a new student joining it every year to do a third cycle thesis or a PhD. I consider that I have been exceptionally lucky in my scientific life, first to have as teachers physicists as Kastler and Brossel, then to have as first students people like Nicole Polonsky, Serge Haroche, Franck Laloë, Jacques Dupont-Roc, ...

and so many others. Meanwhile, I had been appointed at the University of Paris, and I was teaching also a Quantum Mechanics course at a lower (second cycle) level. It is from this teaching experience, done in collaboration with Franck Lalœ and Bernard Diu, that our quantum mechanics book originated.

Kastler's Nobel prize in 1966 was a big event for the lab, with a lot of reporters coming in and taking pictures and asking for interviews. It is difficult to realize how distressed Kastler was by the fact that Brossel didn't share the prize with him. He couldn't accept the idea that Brossel, who was so intimately connected with all important ideas and realizations of our group, did not share with him such a distinction. During all his life he remained upset by this.

The prize of course highlighted him in the general public, but he remained exactly the same as before, very simple, very open, and as usual full of courage. I remember that, in 1968, during the so-called student revolution, at a time where some of his colleagues at the University were proposing to give a passing grade on exams to everybody, whatever they did, Kastler didn't hesitate to enter alone in an amphitheatre full of excited people, just to state quietly that he considered exams as necessary and as providing the most democratic way to select people according to their personal work.

I would like to give you another example of Kastler's personality. He felt that people were too old when they were elected at the French Academy of Sciences. He was elected himself at the age of 62, two years only before his Nobel prize. So, he decided in 1973 to present a paper devoted to this problem in an open meeting of the Academy. In this paper, which has been published in the « Comptes-Rendus », he presented two curves, the first one giving the evolution, during the last 300 years, of the mean age of the Academicians at the time of their death, the second one, the evolution during the same period of the mean age of the Academicians at the time of their election. He showed that the second curve has a higher slope than the first one, so that, if nothing was done, the two curves would cross, which means that the future Academicians would be, on the average, elected after their death ! As you can imagine, this paper created a big sensation. It actually triggered an important reform of the Academy which took place a few years later. The new rule is now that at least half of the people entering the Academy should be below 55.

Kastler retired in 1972, but he considered actually his retirement as a new starting point for new activities. I remember that he was telling me : « I will have now less administrative duties and more free time for learning in detail quantum mechanics, and I would be very happy to discuss with you a few questions ». He was actually fascinated by the problems of physical interpretation, by the discussions between Bohr and Einstein about the completeness of the quantum mechanical description. He followed very closely the experimental tests of Bell's inequalities. He was also very excited by the wave particle duality, by the diffraction experiments of neutral atoms or molecules on crystal surfaces, by interference experiments with feeble light. And he was always proposing new experimental schemes, new improvements. He was also very much interested by the History of Sciences and he wrote several superb papers on Einstein and the concept of photon, on the way Planck derived the blackbody law...

Kastler was also deeply concerned with international cooperation. He was active in the European Physical Society and was the first chairman of the European Group of Atomic Spectroscopy, which is now the Atomic Physics Division of E.P.S. His European vocation was based on his double culture, German and French. In 1971, he published a book of poems with this title, « Europe, my native land — German

songs of a European Frenchman », where he expressed the distress he felt during the last world war and the hopes he held for a peaceful and friendly Europe. He also considered it to be an extremely important task to help developing countries. After his retirement, he went every year for several weeks to the International Center for Theoretical Physics in Trieste and organized sessions on Atoms, Molecules and Lasers for physicists coming from several developing countries. He invited me to give a series of lectures in 1973. He was very happy to be in this Center. He attended all the lectures, spent hours and hours in his office to welcome the participants, to talk with them and to help them to find an orientation. I remember a long walk we took together on the hill above the school and where he explained to me what science and education should, in his opinion, bring to mankind.

Another problem to which he devoted all his energy was the defence of human rights. He was constantly fighting against injustice, oppression, persecution, torture, writing articles in newspapers, chairing public meetings or marching in demonstrations. He created several committees to help refuseniks in Soviet Union, scientists in Argentina. Every scientific refugee arriving in Paris visited Kastler. He tried to find jobs for them, to help them financially, to comfort them. He abominated all forms of racism. The holocaust of the last war had left a deep impression upon him. One of the last recollections I have from him is what he told me last October when I visited him at the hospital where he was nursed. He started to tell me how Henri Abraham, who had been one of his teachers at Ecole Normale and a former director of the Physics Laboratory, was deported by the Nazis during the war to a concentration camp from which he never came back. He was obsessed by this idea and I was very impressed to see how intense was still his emotion more than forty years after these tragic events.

One of his last fights was for Peace. He was depressed by the arm's race, and terrified by the idea of a nuclear war. Even when he started to fall ill, he exerted himself by circulating petitions to halt the arms' race, xeroxing them himself and personally handing them to people.

I think we have lost a poet in physics and also a man similar to those who are called in the Bible « justs ». Even if he is no longer here, I am sure that he will remain a model and a guide for us, not only in Physics, but also for conducting our lives.
