ALFRED KASTLER

J. Brossel, Paris

(University of Paris VI)

Alfred Kastler, who died recently in Bandol, southern France, was born in Guebwiller, Alsace, in May 1902.

As a young boy, he went to school in Colmar, and followed a typical cursus of German education (1914-1921). Until the age of 19, he used the German language and spoke no French. In 1921, at the end of the first world war, he became a student at the Ecole Normale Supérieure in Paris and chose to become a physicist. His teachers, there, were H. Abraham and E. Bloch and they exerted a great scientific influence on him until their death during the second world war. Bloch, in particular, introduced Kastler to atomic physics, a field he never left.

Over five years (1926-1931), Kastler taught physics at the high school level in Mulhouse, Colmar and Bordeaux, developing through this experience, a great talent for teaching. All his life, he remained convinced that high quality teaching was essential for young people hearing for the first time of a new domain in science.

In October 1931, Kastler became an assistant to P. Daure at the University of Bordeaux and in 1936 obtained his Doctorat ès sciences (Paris University), becoming soon after professor at the University of Clermont-Ferrand. Two years later (1938), he was appointed at the University of Bordeaux to the chair of Daure who had just retired. In 1941, G. Bruhat called him to the Ecole Normale Supérieure in Paris (to take over the teaching duties of P. Auger who had left for the USA and Canada as a refugee) where he was to stay until he retired in 1968. (A few years before his retirement, he resigned from Paris University to become a Directeur de Recherche at the Centre National de la Recherche Scientifique.)

Between 1938 and 1951, Kastler worked on the Raman effect of mono-crystals and on the emission of the NaD line in the light of the night-sky. His PhD work in 1936 on the polarization of the fluorescence of Hg vapour appears now to have been a very important step in the direction of what was to become "optical pumping".

Kastler knew in great detail Sommerfeld's book *Atombau und Spektrallinien* and he had been extremely interested in the Chapter in which the principle of angular momentum conservation is applied to the interaction between the electromagnetic field and an atomic system. This had led Rubinowicz to explain the selection and polarization rules in the Zeeman effect. Kastler applied the idea to calculate the polarization of the fluorescence following the excitation with polarized light of resonance radiation and stepwise excitation.

At the opening of the 1st EPS General Conference in Florence in 1969 with from left to right: A. Kastler, V.K. Weisskopf, P.M.S. Blackett, G.H. Stafford (present EPS President), L. Jansen (then Secretary of EPS), L. Cohen (Treasurer) and the founding President G. Bernardini.

It is quite clear that in those circumstances, one gets large population differences between the Zeeman $| m >$ sublevels of the excited state, which can be destroyed by many different processes including collisions and a radiofrequency field inducing transitions between the $| m >$ substates. This opened the possibility — this is the so-called "double resonance" method [1]) which was described in 1949 [2]) and demonstrated experimentally at M.I.T. the same year — of extending the methods of radiofrequency spectroscopy to the study of atomic *excited* states. The method does not require a high optical resolution, even though an enormous gain in precision is obtained because one substitutes the natural line width to the Doppler width. A similar situation is obtained when atomic excitation is achieved with a directed beam of low energy electrons (or ions, or neutrals).

Considering then the case of an atom with a paramagnetic ground state (with Zeeman substates $|\mu >$), Kastler described in 1950 the "optical pumping cycle" [3]): submitted to an optical excitation with circularly right polarized light, the atomic system goes from $|\mu >$ to $|m >$ where $m = \mu + 1$. Falling back to the ground state through *spontaneous* emission, it is then transferred from $|m >$ to ground states with magnetic quantum numbers $m-1$, m, $m+1$ (via σ^+, π and σ^- polarizations), i.e. to states $|\mu >$, $|\mu+1 >$ and $|\mu+2 >$: on the average then angular momentum increases, and a macroscopic polarization $< M_z >$ appears in the ground state: there is a continuous transfer of angular momentum from the (σ^+ polarized) pumping beam to the atomic vapour. This polarization (or alignment in the case of a π pumping beam) can be destroyed by collisions, resonant RF fields, etc. Clearly, optical signals can be built on an auxiliary detecting beam to monitor a number of observables (longitudinal as above, or transverse (like $< M_x >$) as has been shown later on).

Optical pumping, in the broad sense, has brought about a complete renewal of atomic physics and has been developed successfully over the last 30 years. The 1966 Nobel Prize in Physics was awarded to Kastler on this account and the gold medal of the Centre National de la Recherche Scientifique in 1966.

These methods of optical pumping were developed at the Ecole Normale Supérieure in Paris and in many places the world over. They proved to be a very powerful tool to study the interaction between the e.m. field (multiple quanta transitions and associated non-linearities, light shifts, etc.) and many relaxation problems.

Optical pumping magnetometers and atomic clocks have been developed: the Laboratoire de l'Horloge Atomique was set up in Paris by the Centre National de la Recherche Scientifique to investigate, at Kastler's request, how important this line of research might be.

Kastler succeeded in creating a very favourable climate for basic research. He was very open minded, his knowledge of physics was very broad and deep. He put forward a great number of clever ideas. In the community of French physicists, he stood as a person of great originality and, many times, as unconventional. In a large measure, this was due to the fact that he had a deep and complete knowledge of French and German cultures.

He was deeply committed to international cooperation in the scientific and political fields: his interest in the International Centre for Theoretical Physics in Trieste and his participation in the many activities of the EPS are two examples of this involvement. He was among the very first to enrol as an Individual Ordinary Member and was a member of the organizing committee of the 1st General Conference, in Florence, chairing the sessions on quantum electronics and optics. Later, he was a delegate for the Individual Ordinary Members on the Council, and the first chairman of EGAS which was to become the Atomic Spectroscopy Division and then a Section of the Atomic Physics Division of EPS. His continuous fight for peace, against any kind of oppression and for human rights is well known and was an essential aspect of his personality.

REFERENCES

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John Adams (second from left) in perhaps his finest hour as the SPS starts up.

An Engineer Amongst Physicists

Europhysics News records with regret the death in March, at the age of 63, of another founder member of EPS — Sir John Adams. Three times a Director-General of CERN and Director of the "300 GeV" proton synchrotron project (SPS), member of Council and the Scientific Policy Committee, as well as numerous international consultative committees, he had a major impact on European physics. Yet his instincts were (in English terminology) essentially those of an engineer, and he had no time for the single-minded unworldliness that he saw in some of his "purer" colleagues.

He came to the accelerator field from radar development and worked on the Harwell 180 MeV synchro-cyclotron where his exceptional design talents were quickly marked by J.D. Cockcroft who subsequently encouraged him to be one of the first to join the new organisation, CERN. There he concentrated on the design of the 25 GeV proton synchrotron (PS), taking over in 1954 the Department which built the machine. His first appointment as Director-General, 1960-61, came when he was already preparing his return to England, but during that short period he established the committee structure that was to regulate so effectively the exploitation of the highly successful PS and CERN's subsequent machines. In European physics this was a new departure, the start of big centralised science on a continental scale for which CERN still acts as the pole-star.

Whilst in England, Adams established the thermonuclear fusion laboratory at Culham and after the euphoric period of the early 60s supervised its subsequent contraction as his own unyielding logic as government advisor on science policy was applied to his former creation. Although a subtle advocate of the projects he believed in — a master of the understatement and throw-away line — he was not comfortable in the corridors of politics, lacking the patience to support those he considered inconsistent or the total commitment that can sometimes be required.

His recall to CERN to unscramble the problems of the SPS and then to build the machine in the wake of R.R. Wilson's scintillating performance at the Enrico Fermi Laboratory in the USA, allowed him to display both his organisational and design talents to the full. His style was distinct: having kept his options open to the last possible moment, he would then present an imperturbable firmness. He drove his staff hard but he had the knack of treating them as people and retaining the common touch and a sense of humour. Not everyone agreed with his way of doing things, but none would gainsay his astonishing grasp of all aspects of accelerator design and his genius for elegant solutions to engineering problems. He was knighted in 1981.

In recent years, with the SPS performing in a class of its own, Sir John was much occupied with consultancy work related to the scientific and technical programmes of the European Communities. Europe is the poorer for the summary curtailment of his services in this capacity.

E.N. Shaw