

Michel Carayol, the Genuine Father of the French H-Bomb

Michel Carayol was born in 1934 and died in 2003. His father was an industrialist and his mother a teacher. He entered Ecole Polytechnique in 1954, graduated in 1956, and joined the Armement. In 1962, he was part of the DEFA assigned to CEA-DAM at Limeil. In 1967, Carayol was part of the advanced studies branch.

Carayol was involved in the small group established to discuss ways to design a configuration in which the Li6D would be initially compressed using the energy from a first, separated fission stage. Very soon Carayol tried a simulation of a new type of thermonuclear stage using a spherical geometry, the most efficient design for an inward crush. This system included a substantial quantity of Li6D . The originality of the scheme was its thick external layer, made out of a metal of intermediate atomic number, moderately transparent and moderately opaque vis-à-vis the photonic rays coming from the fission stage when the chain reaction was ending.

To start the calculation, he hypothesised that this external layer would be at high temperature, probably several millions or tens of millions of degrees Kelvin, without any explicit specification of how this would be reached. This simulation

confirmed the possibility of a very strong Li6D compression before the heating and produced a very good thermonuclear yield. The reliability of this encouraging result depended directly upon the validity of the physics included in the codes and of the data used. Two previous French tests (Rigel on September 24, 1966, and Sirius on October 4, 1966) had been disappointing from the perspective of thermonuclear studies, but they had validated the simulation codes and the physical data.

Carayol did not talk much, and he did not tell us at that moment exactly what he had in mind, nor did he see any need to write a report on this successful numerical experiment. He presented his results to several people, including Jean Ouvry, Edouard Moreau and myself.^a By doing this simulation, Carayol had shifted the focus of the problem. The question was now how to find a way to convey enough energy to the coated sphere, such that it would heat up the external layer in a short time and, if possible, in a uniform fashion.

Bernard Lemaire writes:

The studies and assessments made for this test [the Antarès test, on June 27, 1967, based on Dagens' design, had been disappointing, but the preparatory studies and calculations referred to in this quote had been made in March 1967] had led us to think of final architectures including two different

stages. Moreover, these studies had led to the fundamental idea that had been lacking. Some engineers of the Applied Mathematics Department, and particularly J. Crozier, noticed some unexpected effects in the results of the calculations that they mentioned to Luc Dagens, Michel Carayol, and Bernard Lemaire. The explanation was found straight away. It showed the role of radiation as a vector of the energy. These unexpected effects were soon exploited by Michel Carayol and Gilbert Besson. Carayol then devised an architecture of the thermonuclear device well adapted to the conditioning of the [Li6D], along the lines proposed on this point by Pierre Billaud.^b

Soon after, in April 1967, Carayol wrote a brief report describing his proposal for a cylindrico-spherical case in dense metal, containing a fission device on one side and a thermonuclear sphere on the other. The report showed that the photons radiated by the primary—still very hot—in the X-ray frequency range, swept into the chamber rapidly enough to surround completely the thermonuclear sphere before the metal case would be vaporized. Carayol had discovered independently a scheme equivalent to the concept developed by Ulam and Teller in the 50s.

^a Certain that Carayol would not write anything, I wrote a summary of this presentation for the record in one of my internal DAM reports.

^b Bernard Lemaire, *La naissance du thermonucléaire*, p. 6. This DAM report dated November 29, 1993 was unclassified and was supposed to be published in the DAM's monthly bulletin, but the

publication was vetoed by Robert Dautray, the high commissioner at the time, and it has only been distributed to a very limited number of people.