SOME PERSONAL REMINISCENCES

by

Laura Fermi

Of the work that went on at the Metallurgical Laboratory in Chicago during the war I knew nothing at the time. The last piece of scientific excitement that had reached my ear had to do with the discovery of fission: it was early in 1939, and we, the Fermis, had been only a few weeks in New York, where we had come to live, having fled Fascist Italy. The news of fission, which spread rapidly in the wake of a trip of Bohr's to the United States, excited me as well as Fermi, for it appeared to be closing once for all an upsetting episode, the outcome of which had been uncertain for a long time. Almost four years before, in the spring of 1934, Fermi and his collaborators in Rome had bombarded uranium with neutrons and obtained several radioactive products, at least one of which they could not identify. If it were the result of beta emission, they thought, it might be an element, not existing in nature, of atomic number 93. They attempted chemical analysis, but although this too pointed toward element 93, they were aware that they did not have sufficient experience in handling the very small amounts of radioactive substances produced to be able to trust their results entirely.

The director of the Physics Laboratory, Professor O. M. Corbino, in a formal address before the king, stated that although Fermi was right in wanting to pursue further investigations before announcing the discovery, in his (Corbino's) opinion the production of element 93 was already ascertained. The Fascist press announced the discovery without reservations, and newspapers in other countries divulged the news. The small outburst of incredulity among foreign scientists that ensued so upset Fermi that I never saw him as much troubled either before or later. In the following years the Roman experiments were repeated by several scientists; Otto Hahn and Lise Meitner at first confirmed Fermi's findings, but then doubts arose again. With the discovery of fission by Hahn and Strassmann, the elusive activity was identified with that of an isotope of barium, and a death certificate seemed to be issued for element 93; so far as I know, no one at that moment foresaw that 93 would be resurrected in a matter of months, this time for good, as the intermediate stage between uranium and plutonium, and would be called neptunium.

Shortly after learning of fission, I also learned from Fermi that it had occurred to him that in the fission process neutrons might be released, and that this hypothesis, which he had discussed with Bohr at a theoretical meeting, had stirred up much interest. He then proceeded to explain to me the principle of the chain reaction. But at some time in the weeks

Laura and Enrico Fermi (Photo University of Chicago and Argonne National Laboratory)

that followed the famous lid of secrecy fell on atomic work, a secrecy that the physicists themselves, Fermi included, had initiated with a heavy heart and against their traditions, once they realized the military implications of atomic energy. I was cut off from any information on Fermi's work, and so I did not come to know that, in order to attempt to achieve a chain reaction in practice, he and Szilard had conceived the idea of building a pile. It is true that once, in my presence, someone mentioned having seen a wall of coal in the physics building, but I did not attach too much importance to the fact, and Fermi said that I should forget about it. Nothing else leaked out afterwards.

I did not mind secrecy, as it was observed at Columbia University. Fermi never indulged much in talking shop at home, except on the rare instances when he had become excited over his work, as when he had interpreted the increased efficiency of neutrons that had gone through light substances in inducing radioactivity, and had thus made his theoretical contribution to the discovery of slow neutrons. He would have had much greater reasons for excitement had he

been able to predict that slow neutrons would be his main interest for at least fifteen years and would become the means to achieve the controlled release of nuclear energy. More than directly from Fermi I had picked up bits of atomic physics during the Sunday walks that we used to take with other physicists in the Roman countryside. Sooner or later the men would start talking of counters and sources, the strange behaviour of neutrons, or the heads and tails of their radioactive products, as in their lingo they called the rapidly decreasing and the longer lasting activities. I missed the walks more than physics.

In the spring of 1942 Fermi moved to Chicago where all work on the chain reaction was being gathered under the leadership of Arthur Compton. Life became easier for him: for several months he had been shuttling between New York and Chicago but, being an enemy alien, had been compelled to secure special permits for his trips, although he travelled to serve Uncle Sam and the war effort. In Chicago secrecy was more organized, much more tangible than at Columbia University. There were guards at all laboratories of the Metallurgical Project, some men had bodyguards, wives were lectured on the grave dangers of loose talk, certain rules had to be followed, and an amazingly large number of persons came together for the same purpose and accepted this secrecy as their lot.

Fermi was extremely good at keeping secrets, and I never got out of him anything that had to do with the project, not even the least guarded secret that there were no metallurgists at the Metallurgical Laboratory. In time, as we became settled and I came into contact with more people, I became his informer on outside gossip. "They say that at the Met Lab you are developing a treatment for cancer", I once reported, and his only answer was: "Is this what they say?". And another time: "People who live near the West Stands say that their buildings shake now and then, and that it is a machine you physicists have built that makes them shake." "Is it?" Fermi would ask. I do not remember feeling any irritation at the evasive answers. They were part of a game in which I tried, without much conviction, to get information and was invariably the loser. Once, however, I became incensed.

On a snowy evening in early December 1942 we had a party at our home and, since we had been discouraged from mixing with the regular faculty for security reasons, all our guests were workers at the Met Lab and their wives. As they came in and shook the snow off their clothes the scientists among them congratulated Fermi without saying what for. Throughout the evening they behaved as if they shared with him the secret of some achievement, but they refused to give me any explanation. Fermi appeared pleased, but was as tight-lipped as ever. I felt that the men's refusal to have me join their fun, in my own home, was very inconsiderate. I became insistent and in the end was told that Fermi had sunk a Japanese admiral with his ship. To this day I do not know by what calculations my informer equated the chain reaction with such a naval feat; and I was not to learn of the first atomic pile until shortly after the end of the war, when Fermi brought home a mimeographed copy of the yet unpublished Smyth Report.

The picture I have now in my mind of the pile experiment is composite, and it would be difficult for me to sort out what I learned from Fermi and what from his associates. Fermi talked more often of not too important details than of the role he had played in the construction of the pile. He liked to recall, for instance, the secret enjoyment that they had experienced at the expense of the Goodyear Tire and Rubber Co., when they had placed an order for a balloon cubic in shape. The balloon was intended to envelop the pile and permit the evacuation of air from it, but this fact was a secret not to be revealed to the company which built it under the illusion that the Army was going to fly a square balloon. Despite the joke, the balloon was an indication of the constant alertness in the almost four years of work on the pile, the effort to anticipate difficulties and be prepared for them. Even after they had ascertained that a pile using natural uranium was feasible and had roughly estimated its dimensions, the physicists knew that its final size would depend on the purity of the materials. A block of uranium or of graphite of less than the desired purity would mean a larger pile, but there was a material limitation: the height of the ceiling of the court where the pile was built. To counter this difficulty Fermi insisted on making provisions for removing from the pile, if needed, the air with its neutron-absorbing nitrogen. Hence the balloon. The effect of the air on the pile had already been studied by Fermi and his group at Columbia University.

Of the final test on 2 December I had several descriptions, since the witnesses were not reluctant to reminisce on it. They all agreed on one point: Fermi had been very calm as he directed the experiment, calmer probably than anyone else among those present. At times I thought that in his friends' comments there was a touch of criticism for this imperturbability at such a moment, as if some degree of anxiety would have been more appropriate than his assuredness. It was almost certainly oversensitiveness on my part, but I could not fail to be reminded of a remark that in the fall of 1942 a physicist, a pessimist by nature, on a visit to the project, had made to me. After exhorting me not to worry about my fate he had said, "If Enrico blows up, you will blow up too". All this made me take up with Fermi the question of the inherent danger in the pile experiment, carried out as it was in the heart of a big city. I must have expected a black and white answer, for his reply seemed very sophisticated to me, and begging the question. As the pile was built, he said, he and his

group had taken careful measurements of all the quantities involved, and they understood the behaviour of the pile thoroughly. They did not expect surprises from it and felt sure that, once it was allowed to go critical, it would perform smoothly and safely. Yet, in dealing with something entirely new, as the release of nuclear energy, they could not disregard the possibility that an unforeseen phenomenon might disturb the experiment. Whatever risk they had taken lay in this unforeseeable element.

In order to minimize the risk, they took all the precautions they could think of. Large amounts of cadmium were at hand to "put out" the pile if it were to get out of control; automatic safety rods were set - at too low a point, as it became evident when they slammed home with a loud clap which Fermi interpreted as the signal to go and eat lunch. The experiment was performed slowly and cautiously, step by step, while Fermi checked repeatedly whether the pile behaved according to calculations. And so the simple operation of removing all controls and starting the pile took all morning and a good part of the afternoon.