

Story The telegram

Irene was alone at home as her husband Frederic had to give a lecture early in the morning. Their two children were taken for a walk by the nanny, and Irene was sitting at her desk trying to finish a research paper. Recently, the political situation had developed quickly, and in some respects unpredictably. The Nazi party had taken power in Germany, and Irene and Frederic had been amongst those French intellectuals who co-founded an anti-fascist movement in Paris. Despite her political engagements, they had also been very active in their scientific research. This was the reason why Irene had to stay at her desk working on the paper instead of going into the laboratory where she would usually be at this time of the day. Out of the blue, the doorbell rang, and while she was still wondering who could be visiting so early in the day, the bell rang again. It must be urgent, and a bad feeling overcame Irene as she rushed to the door. When she opened it, there stood a man in a uniform who said: "I have a telegram for Frederic and Irene Joliot-Curie – it is from the Swedish Academy of Science." Irene held her breath, and at the same time, several thoughts flashed through her mind, thoughts that started with those stories her mother had told her.

Marie Curie was certainly the best known female scientist of her time, and having her as a mother sometimes felt like a burden. But Irene was always keen on science, maybe partly because she loved all those stories her mother told her while she was still a child: stories about her research which she carried out together with Irene's father who had died when she was only eight years old. And of course, there were those moments which Irene had loved best, when her mother told her about their success in the laboratory finding a new and unexpected truth about Nature. Even though sometimes their findings in the end turned out to be erroneous. And of course there were also stories about the moments when they had received their recognition – most notably the story when Marie and Pierre had gone to Sweden to receive the Nobel Prize, the highest scientific award. She especially liked the fact that Marie was the first female to receive this honor. Incredibly, she was not only the first female to receive a Nobel Prize, but also the first person ever to receive a second Nobel Prize.

But then these days of childhood were over, and so were the peaceful times. War broke out when Irene was only 17 years old, and she started working with her mother in military hospitals where they operated the X-ray machines, an innovation to surgery that saved a lot of lives of wounded soldiers. At the same time Irene started to study at the university, physics, of course. After completing her studies she became one of the research assistants at her mother's institute. There, in 1924, she met the handsome and very bright young technical assistant Frederic Joliot. She fell in love with him

and, even though he was at that time just a technician who was aiming to study physics, and Irene had almost completed her PhD and was superior to him, they married.

Life was easy at that time, even though Irene sometimes had the feeling that some of her co-workers saw in her more the daughter of Marie Curie than a researcher by her own right. Especially since, she was also working in the same field of radioactive research. However, she and Frederic gained more and more approval in the laboratory as they were very successfully applying new techniques. Actually, at one point they had been close to making a major breakthrough themselves. In some of their experiments with cloud chambers she and Frederic had observed particles which apparently had strange properties – they were positively charged and thus, they should have been protons. But some measurements seemed to indicate that they had about the mass of an electron – this was weird, if not impossible. So what could they do about these experimental findings?

Q1: Propose how Irene and Frederic may have proceeded with respect to their unusual observation.

Q2: Should a researcher set her or his initial experiment aside in order to examine a seemingly strange phenomenon? Explain your suggestion.

At that time, Irene and Frederic had been busy doing other experiments, experiments in

which different materials were exposed to α -radiation. They discussed whether they should investigate this strange phenomenon further. Irene argued: "Let us set this result aside, it is probably just an artifact of the apparatus – you know how error sensitive the mass determination can be." Frederic agreed: "Yes, and our experiments with the α -particles are going well – particularly the exposure of materials containing Hydrogen show really interesting results – it seems that we have produced another mechanism of emitting free protons." It was only nine months later when Frederic entered the laboratory with a journal in his hand and said excitedly: "Irene, the new Physical Review has arrived and there is an article by a certain Mr. Anderson. He claims to have found traces of a positive electron which he calls a positron." Irene took the article, quickly glanced through it, looked carefully at the pictures from the cloud chamber that were printed in the article, and said: "This is very similar to our findings, maybe it was not an artifact after all. We probably should redo these experiments as soon as possible." They looked at each other and smiled, on the one hand a bit disappointed as they were well aware that it was too late to claim priority for the discovery of positrons, but on the other hand they were pleased to know that their experiments were contributing to the development of scientific knowledge.

Q3: Why is Anderson considered to be the researcher who gave the first experimental evidence of the positron?

Q4: Is this fair? Explain your opinion.

As it turned out, their experimental results actually served as additional empirical evidence for the existence of the positron; however, this was just supporting Anderson's work. But in some sense, things were even more disappointing. Irene and Frederic had to learn that the experiments which they had continued instead of turning towards the analysis of the strangely behaving particle, had led to similar results. In these experiments, they had traced the particles that were emitted from materials containing Hydrogen when exposed to α -radiation. Initially they had considered these particles to be protons, but then a paper by the English researcher Chadwick appeared in

which those particles were characterized as being something new, namely particles without a charge and about the mass of a proton. Once Chadwick had identified these as neutrons, all Irene and Frederic could do was once again to confirm his experimental findings.

However, there was something else that puzzled them, something that seemingly had not been noticed by other researchers: Irene wondered, "If Chadwick's findings are correct, and our data seems to confirm his so-called neutron, then how does it work?" Frederic looked up from his instrument and said in a somewhat frustrated voice: "I really don't know, Irene. When a proton is emitted from the Aluminum, it is obvious. We get a Silicon atom. But what kind of atom can be formed when a neutron is emitted? And what is worse, we also have these positrons that are emitted as well – I have no idea how to explain that." "Well, if we have a neutron and a positron, that would bring us back to silicon. However, it would be very unusual to have triggered emission of the two particles simultaneously. Let us carry out the experiment once again."

Irene and Frederic set up the apparatus and started to observe once again. However, the results remained unchanged, and Frederic finally removed the α -particle source. Irene was still looking at the set-up and suddenly became excited: "Frederic look, there is still a trace of a positron." Frederic looked up and said: "No this can't be, you probably have just misinterpreted something." But Irene was sure: "There was still a trace of a positron. Look, there just was another one." "Impossible" mumbled Frederic, but he came back and took a look himself. He waited. "Nothing", he said, "I don't see anything unusual." But Irene insisted: "This is something we have to check once again."

Q5: What is so exciting about the observation Irene had made?

Q6: Should Irene and Frederic repeat the experiment? What if they don't observe traces of positrons after removing the α -source?

Frederic brought back the α -source, they irradiated the aluminum foil once again for some time, removed the source and observed the traces. "There!" Frederic and Irene said, or nearly shouted, almost simultaneously. "That

was a positron, for sure it was” said Irene – and Frederic, nodding with his head, said: “You are absolutely right, but how can this be? When we irradiate materials with α -particles, the result is a transmutation of a new element. But this is an instantaneous process. So how can it be that we have this radiation even though there was no α -source anymore? Only ...” He silenced, and they looked both at each other. “Only ...!” said Irene. A casual bystander might have heard some sort of triumphant undertone in this word.

Q7: What kind of idea to interpret this result could Irene and Frederic have considered?

Irene was still standing in the door, and the man from the telegraphic office looked at her in an expecting manner, holding the telegram in his hand. Finally, Irene was back into the present, smiled at the man and said: “Do you want me to open that telegram?” The man looked somewhat puzzled and responded: “No, Mad-

ame, I just need your signature here.” Irene hesitated, and with her heart beating quickly, she signed and finally received the telegram.

Should she open it, or should she wait until Frederic was with her?

In 1935, Irene and Frederic Joliot-Curie were awarded the Nobel Prize in chemistry in recognition of their synthesis of new radioactive elements.

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