

# Project Meitner. Contributions of the pioneer women of radioactivity

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**Abstract.** Project Meitner is an outreach initiative aiming at raising awareness on the situation of women in Physics. To this purpose, a series of actions have been carried out at the Instituto de Física Corpuscular (IFIC, Spain) with a double purpose: help the pioneer women of radioactivity become known by the broad public, and demystify the current archetypal view of the scientist by presenting the diversity of women who work at our institute. Special attention is paid to stimulate the self-confidence in Physics, Engineering and Computer Science (PECS) subjects to secondary-education female students, as well as to other types of public usually overlooked in outreach activities, such as people with disabilities and elderly people.

## 1. Introduction

The sequence of decisions leading to the future professional life of young people is usually driven by the cultural and societal environment they are immersed in [1]. This environment stimulates the development of stereotypes that unconsciously make them thinking women are more emotional and intuitive –and hence are more skilled in care-related professions–, while men are more intelligent, talented and unemotional –and hence are more prone to succeed in high-status professions as those connected to decision-making or science– [2]. Such stereotypes have similarly been identified in other social groups [3], leading to a loss of self-confidence in their own abilities and skills. These perceptions, in turn, result in imbalanced professional opportunities and achievements and, eventually, lead to the underrepresentation of minorities in many stages of the professional career.

In Spain, the Group of Women in Physics (GEMF) has recently published a report about the presence of female physicists in the Spanish Universities for the period 2015-2020, concluding that only 22% of the teaching and research staff are women. This number drops to 15% in the case of Professorship positions [4]. In the particular case of the Instituto de Física Corpuscular (IFIC), operated by CSIC –the biggest research public body in Spain– and the University of Valencia, the percentage of women represents only 20% of the research staff [5]. The causes for this flagrant gender gap might have multiple origins. One of the most important pointed at by dedicated studies [6] is the dearth of valid female role models showcased in compulsory education. While the two-Nobel prize winner Marie Curie is the only typically appearing in



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textbooks and other school material, young female students might not feel identified with her as they see her achievements too overwhelming.

In this context, we have devised an outreach initiative, Project Meitner, whose main objective is promoting social equality through the biography of an outstanding female nuclear physicist, Lise Meitner. At present, she is well acknowledged by the Nuclear Science community, but hardly known by the broad public. Her scientific work has for long been overlooked by historians of Science, yet it was crucial to unravel the mystery of nuclear fission. Despite receiving 29 nominations to the Nobel prize in Physics and other 19 to the Chemistry one, the Royal Swedish Academy of Sciences refused to acknowledge her as co-discoverer of nuclear fission. Instead, her friend and colleague Otto Hahn was awarded the Nobel prize in Chemistry alone. In this project, hers is presented as a blatant case of partiality of the Nobel Committee that can be extended to many other brilliant women whose contributions faded away along the History of Science.

The story of Lise Meitner, the tiny sixty-year-old Jewish refugee who succeeded to escape from Nazism during the Second World War, is the spinal cord of a more ambitious goal: to reassess the historical credit and the extensive scientific work contributed by the pioneer women of Nuclear Physics, Particle Physics, and Astrophysics: the pioneers of radioactivity [7, 8, 9]. These women formed a structural network of scientists during the first half of the 20<sup>th</sup> century that kept contact and provided mutual support through figures such as Ellen Gleditsch [10]. It is our purpose to recover their lives and contributions, most of them unknown in their own countries, to present a different kind of role model for young female students aiming at a career in Physics. Apart from recovering unknown names such as Sameera Moussa, Harriet Brooks, Branca Edmée Marques, etc., we aim at building a present-day network in our community by showcasing the lives and research interests of the women at IFIC.

## 2. Remembering Miss Meitner

Remembering Miss Meitner is a one-act drama theater play written by the Professor in History of Science and playwright Robert Marc Friedman, recently translated to Spanish and Catalan [11]. The theatrical piece is focused on the historical period corresponding to the discovery of the nuclear fission, when Lise Meitner flew from the Nazi Germany and, as a refugee in Sweden, was compelled to a categorical scientific and economic austerity by her host, Manne Siegbahn. The cast is completed by Otto Hahn, Meitner's closest colleague and best friend for more than thirty years, and awarded alone the Nobel prize for the discovery of nuclear fission. The action, which takes place at present, reveals the most human and personal side of the characters, who look back on the times of the fission discovery and reflect on the controversial Nobel Prize awarded to Hahn from two viewpoints: their own experience and the story narrated by the History of Science.

The play written by Friedman provides a unique opportunity to integrate the relationships between science, technology, society and environment (STSE) by addressing the gender dimension and the discrimination of minorities in Science. The premiere took place in the Sixth International Science Festival (Gothenburg, Sweden) in 2002 and, since then, its track record has been very successful, with performances in theaters, universities, research institutes and secondary education schools of Sweden, Germany, Norway, the US, Italy and, lastly, Spain. The Spanish staging has been managed by the theater company CRIT [12]. The director, Anna Marí, has particularly cared about the contextualization and emotion of the piece by exploiting a new element, a videomapping. The videomapping is a technique based on the use of projectors to show images on surfaces. In the play, the scientific members of the project contribute as digital actresses and actors discussing the importance of the discovery of nuclear fission and introducing the main character, Lise Meitner, projected by videomapping on two screens. By this way, current role models in Nuclear and Particle Physics are presented to the audience. The play is closed with a colloquium in which the cast, the dramatists, the scientific team and the

audience debate together on the ethical and scientific aspects brought up on stage.



**Figure 1.** Photographs illustrating the play performance in Theater Rialto (Spanish premiere), Talia and La Pobla. The colloquia, the session with Sign language translators, the poster in the North Train Station of Valencia and the flyer of 2022 are shown.

### 3. Project actions

The theater play was accompanied by a series of outreach activities aiming at fulfilling the main objectives of the project. Among them, we will highlight two: the Workshop on Science and Gender “Pioneer Women in Nuclear and Particle Physics” and a Science and Arts contest about the pioneer women of radioactivity and related fields.

#### 3.1. Workshop “Pioneer Women in Nuclear and Particle Physics”

The Workshop took place on March 9<sup>th</sup> and 10<sup>th</sup>, 2021, at the University of Valencia. The main activities included talks, seminars, colloquia, monologues, interviews and round tables; and were directed to both the general public and secondary school teachers. The latter could attend the Workshop as part of a training course through the Centre for Training, Innovation and Resources of professorship of the Valencian Community, abbreviated to CEFIRE in Spanish. The main objective of the course was to make known the names of the women who contributed significantly to the incipient field of radioactivity at the beginning of the 20<sup>th</sup> century, but were superseded by those of their male colleagues. Women who were victims of the Matilda effect [13], such as Berta Karlik, Stefanie Horovitz, Piedad de la Cierva or Chien Siung Wu, who challenged the social conventions and paved the way for the new generations.

Following our goal of joining the two cultures –science and humanities –, the program foresaw interventions from scientific and outreach experts, secondary school teachers, sociologists, historians of Science, and women of letters. The keynote speakers were Robert Marc Friedman, the author of the play, and the famous Spanish writer and journalist Rosa Montero, National Prize for Spanish Literature 2017 and author of “The ridiculous idea of never see you again”, a book about grief and mourning, feminism, and Marie Curie. The former gave a masterly lecture about the politics behind the never-awarded Nobel prize to Lise Meitner. The latter was interviewed by the Professor in Nuclear Physics Berta Rubio, who exchanged her job with Montero and played the role of a journalist.

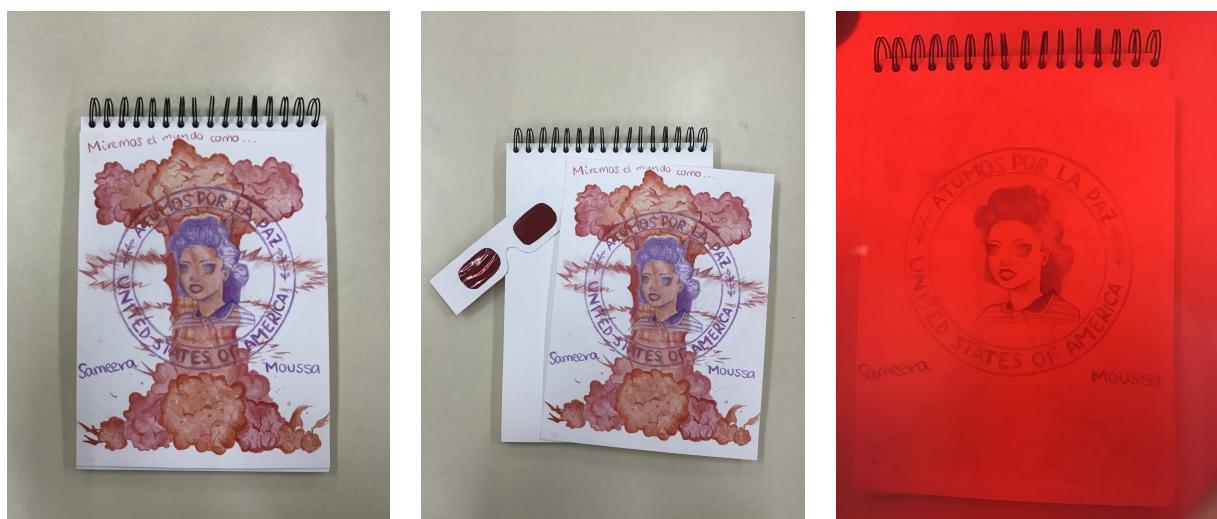
### 3.2. Science and Arts contest about the pioneer women of radioactivity

The contest is of national scope and its Spanish name is Express-Arte ConCiencia. This is a word game using the Spanish words arts, science, awareness and expressivity. It is aimed at secondary school students to help introducing the pioneer women of radioactivity and related fields in the Science lessons. The contest combines Science and Arts with a gender perspective.

The students must perform, with support from a supervisor, an original artistic work in video, text or image about one or more pioneer women. The format is almost free, they can present a poem or a short story, a newsletter, make choreographies, paintings, comics, music, monologues, Youtube videos or any other artistic work, as long as it is submitted in digital format and can be shared in our social networking sites. There are two voting phases. The first is based on a popular vote in Twitter, Instagram, and Facebook (also Youtube in the case of videos). The 20 most voted works of each category continue to the next round. In the second phase, a jury of experts in arts, scientific outreach, communication, and humanities select the winning work of each category, each awarded with 500€ for the students' educational centre. In addition, the jury selects the 18 best artistic works for a digital exhibition. Up till now, two editions of the contest, 2021 and 2022, have been carried out. The two are available in our webpage [15]. As an illustration, the winning works in the category *image* are shown in Figs. 2 and 3.



**Figure 2.** Best image of the 2021 edition of the contest Express-Arte ConCiencia. A composition of the pioneer Leona Woods with the Chicago Pile-I team illustrates how this brilliant woman became overlooked among her male colleagues.



**Figure 3.** Best image of the 2022 edition of the contest Express-Arte ConCiencia. The story of the pioneer Sameera Moussa [14] is narrated in three stages.

#### 4. Communication strategy and TIC resources

Our image brand was designed by the Berlin-based illustrator Elena Resko. Some illustrations can be seen in Fig. 4. The communication strategy has included the development of a website [15] with the basic information of the project: the biography of Lise Meitner, our main objectives, information about the theater play, the author, the company CRIT, the cast and other complementary content, as e.g., the videomapping and the play teaser. We also provide information on the workshop and the contest. The workshop program, together with short biographies about the speakers, are available. The web, in addition, has a registration system for the workshop. As well, information about the contest conditions, the voting system, the jury and the final resolution is provided. Two dedicated pages are available for the digital exhibitions of 2021 and 2022.

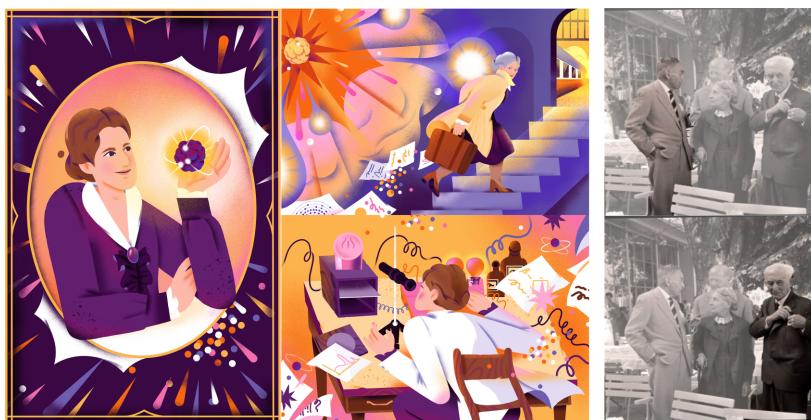
Apart from the information about the project actions, we created original digital material about Nuclear and Particle Physics to be used by teachers in their Science lessons. With the aim to provide new kinds of female role models, we invited the famous Valencian Youtuber Elena Denia to make a video about the origins of the elements in the universe. Elena Denia is known for including interviews in her videos. In this case, she interviewed Prof. Olga Mena, member of the project and expert in dark matter and early nucleosynthesis. Short videos about pioneer women are also available in our website. They were recorded by us and spontaneous, altruistic collaborators in a “social networking site-like” style, and are accompanied by links to extended biographies for their free use as a didactic resource. Finally, other types of resources, such as infographics, games, escape rooms, and flipped classes, are also available in the website.

Twitter, Instagram and Facebook profiles were created to publicize the project actions. They were also used to develop an ambitious outreach program in social media networks, including a weekly presentation of a pioneer –with her biography, videos, and information about her–, a weekly presentation of a local scientist, and the game #WhoIsWho, aiming at highlighting the importance of the male support for the career development of the pioneers. In #WhoIsWho, a picture of a male scientist with other people was shared, and our followers were invited to guess who was the emphasized figure (see Fig. 4). Along the day, we provided clues to identify him and the pioneer he had given support to. All the actions on our social networking sites were supported by the broader profiles of IFIC and the CSIC House of Science in Valencia.

#### 5. Impact, results and future perspectives

The media coverage of the project was excellent. In February 2021, we launched the communication campaign with a press conference in which the main representatives of CSIC –Rosa Menéndez, president of the public body–, and University of Valencia –Maria Vicenta Mestre, rector– were present. The project activities have been echoed in local and national media, including newspapers, radio interviews, round tables, video recordings and outreach fairs. In addition, the theater play received an excellent review from the specialized press.

In numbers, thus far Remembering Miss Meitner has been played around 30 times, including the Spanish premiere in the central Theater Rialto of Valencia, followed by performances in Teatre Talia (Valencia) and the Cantabria Festival Palace (Santander), among others. It has been directed to a wide range of publics, including the general audience, the secondary education community, university students, etc. A session was specially dedicated to groups usually overlooked in outreach events, as the Sign language community and elderly people (see Fig. 1). Furthermore, Victoria Salvador, the actress who interpreted the character of Lise Meitner in 2021, received the Best Actress award of the Academy of Theatrical Arts of Valencia for her role in the play. The workshop and the contest also had an excellent reception by the targeted publics: more than 180 registrations for the former, and two editions with about 130 artistic works received for the later. In 2023, we plan to follow up with the 2<sup>nd</sup> Workshop on Science and Gender, a new edition of the contest, and more theater performances. New actions



**Figure 4.** (Left) Illustrations of Project Meitner. Elena Resko received the “Pro-highly commended” mention in Science Category in the World Illustration Awards 2021 of the Association of Illustrators (AOI) of the United Kingdom. (Right) Images highlighting the scientists Otto Hahn and Max Born in the game for our social media networks #WhoIsWho.

to integrate young women and other minorities in Science have been devised, as specific training courses for teenagers from deprived areas of Valencia and the mentoring program #MagnIFIca for undergraduate female students.

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### References

- [1] Hill C and Corbett C 2010 Why So Few? Women in Science, Technology, Engineering, and Mathematics <http://www.aaau.org/>
- [2] Eagly A H and Wood W 1999 *American Psychologist* **54** 408–423
- [3] Steele C M and Aronson J 1995 *Journal of Personality and Social Psychology* **69** 797–811
- [4] Martínez P G *et al.* 2022 Las físicas en cifras: Universidad. Estudio realizado por el Grupo Especializado de ‘Mujeres en Física’ RSEF
- [5] IFIC, Equality and Diversity C 2020 Analysis of the gender distribution at IFIC, December 2020 <https://webific.ific.uv.es/web/jigd/estadisticas/genero/2020-12>
- [6] López-Navajas A 2014 *Revista de Educación* **363** 282–308
- [7] Rayner-Canham M F and Rayner-Canham G W 1997 *A devotion to their science. Pioneer women of radioactivity* (Montreal & Kingston, London, Buffalo: McGill-Queen’s University Press) ISBN 9780941901154
- [8] Rentetzi M 2009 *Trafficking material and gendered experimental practices. Radium research in early 20th century Vienna* (Montreal & Kingston, London, Buffalo: Columbia University Press) ISBN 9780231135580
- [9] Pigeard-Micault N 2013 *Les femmes du laboratoire de Marie Curie* (Glyphe) ISBN 9782358151115
- [10] Lykknes A 2019 *Chemistry International* **41** 26–27
- [11] Friedman R M 2021 *Proyecto Meitner. Una historia de ciencia y traición* (Algar Editorial & Bromera) ISBN 9788491425311 & 9788413582153
- [12] URL <https://teatrecrit.com>
- [13] Rossiter M W 1993 *Social Studies of Science* **23** 325–341
- [14] Khalil R, Karim A A and Moustafa A A 2021 *Female Pioneers from Ancient Egypt and the Middle East* (Singapore: Springer) pp 47–60
- [15] URL <https://recordandoalise.es/>