MARZENA SZYMANSKA:
"When I was a student, the quantum field was exciting because it seemed counter-intuitive to me. One would never think about quantum phenomena without learning and researching".

Lydia González Orta: Why choose the quantum field. Who or what can provide inspiration:

Marzena Szymanska: I had graduated with a master's degree in quantum physics, therefore my journey with quantum optics and quantum condensed-matter physics began quite early. During my undergraduate degree, the courses I was most interested in were: quantum optics, quantum mechanics, quantum field theory and all the mathematical foundations behind quantum physics... At that time, the idea of quantum computers was just emerging and there weren't yet so many applications. The quantum field was exciting because it seemed counter-intuitive to me. One would never think about quantum phenomena without learning and researching. I always liked mathematics, and quantum physics is full of complex mathematics. **When I was a student, I perceived all the quantum related modules as an intellectual challenge.** In my university not many students passed quantum mechanics with good grades.

L.G.O.: The reasons to take part in the QuantERA call:

M.S.: Europe is the leading region in my research field. A large number of top groups are located in Europe and QuantERA allows collaborations beyond the UK, where I am based. **The EU enables creation of networks with some of the most significant research teams working together. What's more – QuantERA connects the funding efforts of national funding agencies and the EU.** This is **an important mechanism** since our work is not yet at market product level. QuantERA funds fundamental research and this was perfect for our problem.

L.G.O.: The content of the funded research project for non-specialised audiences: impact on technology and society:

M.S.: There are different pillars within the quantum field and quantum simulation is one of them. Quantum simulation means that when we have a system that people do not understand, such as some complex materials, instead of trying to describe it theoretically, we **create another system - similar but a bit simpler - so it is well-controlled.** For example, real materials contain disorder or some other imperfections. In contrast, quantum simulator of that material can be absolutely perfect. **Studying such simpler system - allows us to better understand the other – more complicated system. This is one aspect of quantum simulation.**

There are different platforms that researchers are currently using for quantum simulation. We propose a platform that is based on polaritons half-light, half-matter particles. One can even build materials out of such polaritons, i.e., in effect out of light. Just to mention an example, one of my consortium partners created a polariton graphene i.e. something that is very similar to the usual graphene, but it is built of photons instead of carbon atoms, and photons have special properties. They have a number of advantages; one of them is that control is much easier, since the system is on a much larger scale. We can now simulate real materials using these photons.

The main topic of the consortium was to bring the polaritons into more quantum regimes. The idea is to make photon interactions strong enough at the single particle level so that they behave more "quantum-mechanically". The challenge was mainly experimental, and the theorists in the team were aimed to support the experiment in achieving the goal by coming up with better designs and exploring different phenomena. The theorists' role was also to develop new methods since theoretical methods are not very well developed for open many-particle, strongly interacting quantum systems.

The ultimate aim of quantum simulators is to help solve practical problems. Applications could range from designing novel materials to helping understanding biological systems, chemical reactions etc... Instead of preforming expensive experiments one could simulate them using photonic platforms. This will have a long-term impact on society. **All QuantERA projects cover research for the future.**

L.G.O.: Coordinator's role: opportunities, challenges and gender issues:

M.S.: Our project involves one of the largest consortia in QuantERA - we have seven partners that represent different countries: the UK, France, Germany, Poland and Israel. We are organised in four experimental groups and three theoretical groups. Coordination is obviously not easy because of the consortium's size.

Thanks to the QuantERA scheme/funding, we were able to meet once every six months, which was very helpful for coordinating experiments, exchanging information and coming up with new ideas. Now, we have quite a number of joint papers, and plans for future collaborations, maybe in the next QuantERA call or some other programme.

L.G.O.: The main challenges for more gender balance in the quantum field: QuantERA first steps, promising measures, the most popular topics in the community's discussions:

M.S.: Work-life balance issues were very important to me: my third child was born during the QuantERA project, which added to the challenges, and required creative ideas. For example, we organised one of the QuantERA meetings in Warsaw which enabled me to come from London with my five-month old son and leave him with my parents during the day. It actually worked quite well, but some things were harder to manage. During the mid-term review in Granada, Spain, my child was only 2 months old so I had to be replaced as a coordinator at the meeting as it was not really possible for me to travel to Spain.

At this point, I have to praise the UK EPSRC as their approach to work-life balance is exceptionally good. It allows budgeting for family travel to longer research visits and conferences. In US, KITP and Aspen Centre for Physics are also very supportive. In my opinion EU lags behind a little. **It would be very helpful if special funds were dedicated for family travel and accommodation to enable scientists to attend conferences and go on research visits.**

As we know, female representation in physics, especially at the professorial level, is very low. Some female professors I know are facing the same problem. Unfortunately, I had to reject many invitations to prestigious conferences or programmes due to pregnancy or early childcare. Eventually, **one loses visibility if one does not participate in relevant events.** This is not good for one's academic career. Paradoxically, with Covid it became easier in a way as all conferences during two years of the Covid pandemic were organised on Zoom, but now life is getting back to normal - and one needs to participate in conferences in person.

Other obstacles for women are maternity leaves. They might take quite a substantial part of the most productive period of life. I think there should be a mechanism in place to help overcome the difficulties. We should work on helping women researchers during this disruption.

On QUANTERA's first steps toward contributing to a more gender-balanced field:

QuantERA II encourages the participation of consortia with a fair representation of female researchers both as PIs and in the research team (2021 call)

2021 call peer review guidelines encouraged all panel members to recognise and challenge "unconscious bias"

The Gender Equality Statement as Annex II of the 2021 call recognised the key role of RFOs while calling on physics institutes and the physics community to:

- Create a gender-sensitive environment and organisational culture
- Create an equality standard regarding the management structure
- Acknowledge that diversity is beneficial for science
- Encourage all women PhDs in physics and in QTs and provide them with the adequate career support
- Acquaint STEM students with role models of women researchers in QTs

There are many ways to help. On an individual level, I should mention one famous male professor whom I know to refuse invitations, where there isn't a minimum percentage of women as speakers. This helps to raise awareness among others. On funding agencies level, it would perhaps help if there were some formal incentives to create more gender balanced teams and consortia. Being part of evaluation committees, my impression is that while gender balance is discussed, it is not really taken into account in the evaluation and does not affect the outcome.

Lydia González Orta is a gender equality practitioner from Spanish Foundation for Science and Technology (FECYT) who supports the QuantERA consortium towards a more gender-balanced quantum field.

Marzena Szymanska is a Professor of Physics at University College London working on non-equilibrium quantum many-particle systems.

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*A series of interviews with female coordinators of QuantERA co-funded projects is a part of Task 5.4 Towards a more gender balanced quantum field, i.e. "Highlighting the presence of female researchers among the Coordinators of the QuantERA-funded projects in QuantERA communication and PR materials".