

**MILENA D'ANGELO:**

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

Milena D'Angelo: During the last year of my studies, I saw the information about a summer school on the foundations of quantum mechanics, organised by a professor of my university. I decided to attend the course and it turned out to be a great decision. A mixture of science and philosophy – that was my first impression about the fundamental principles of quantum mechanics. I felt very inspired. Therefore, I decided to stay longer in this field, and I worked

for my master's thesis on quantum teleportation. It was the very beginning of my experience with quantum technologies, although they were not even called this way back then.

What I like a lot about this field, what inspired me the most is the mixture of foundational aspects and rising technologies. It was true when I became fond of quantum technologies and it is even more true nowadays.

The story came full circle – this year I am the one organising a summer school on quantum technologies and I hope to inspire students of the next generation.

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

M.D.: As my research career develops, the number of my responsibilities grows as well, including participation in calls.

I participated in the first QuantERA Call, in 2017, and the first Quantum Flagship Call, in 2018; these were my very first experiences within European projects. I did not succeed then, but I have learned many things that have certainly contributed towards the funding of our project in 2019.

At that time in my career I felt ready for participating in European calls. QuantERA offered a great opportunity to start.

QuantERA really seemed to be tailored for my needs as one of its topics – quantum imaging, fit very well with what I was working on at that time. Applying in the QuantERA call turned out to be the right choice.

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

M.D.: Imagine that you take a picture of a person, and it often happens you decide to have the background out of focus because it gives more visibility to a face. Generally, if later on you decide that you were interested in something that was behind, that information is gone, it is lost. You have no option; you have no possibility to refocus that image.

The same situation happens when the subject of the picture moves and the result is not satisfying. Unfortunately, there is no way of recovering that information – the image of the object. Therefore, **we are working on a new type of imaging device – the so-called plenoptic cameras. This equipment would allow the focus of pictures that have already been taken to be changed.** The same principle enables three-dimensional imaging only with one shot.

Thanks to such technology, we would have enough information to change the focus and to reconstruct the three-dimensional image by employing its multi-perspective capability. Plenoptic imaging already exists on the market, but it has several limitations. One of these is a lack of resolution, as well as a strong compromise between resolution and depth of field. To gain those interesting features it is inevitable to abandon image resolution.

By using the quantum correlations of light, we have developed a novel technique that helps us to do plenoptic imaging and thus re-focusing and 3D imaging without loss of resolution. Even more – thanks to this technology it is possible to decide how many planes the camera can focus on and define depth of focus in the picture. This is one of the main goals of our research: we are developing demonstrators and prototypes of these novel quantum plenoptic devices. The big challenge in this field is speed, because when you do correlation measurement, you don't acquire just one picture, you need to acquire a lot of them. Measuring correlations is a statistical process,

which is one of the reasons why quantum technologies and quantum applications are still not competitive with available techniques. We are addressing the problem of speeding up acquisition and elaboration time with European partners who are dedicated to developing ultrafast sensors, advanced electronics and novel statistical algorithms.

Nowadays, imaging is everywhere: microscopy, biomedical application, cell phone cameras, imaging from satellites, industrial inspections... **I really think that the new generation of imaging devices will be quantum plenoptic cameras.** I would like to make a change concerning the speed issue, but this is also the most challenging part. Therefore, this is what we are working on.

Thanks to the QuantERA project, which gave me some visibility within my institution, I also started a project with biologists from my university dedicated to microscopy. Another project was funded by the Ministry of Economic Development in Italy with the aim of building a prototype of a quantum plenoptic microscope.

L.G.O.: The role of coordinator: opportunities, challenges and gender issues

M.D.: I'm used to the situation when I am the only female researcher at the table. It happens quite often so at some point I stopped noticing it anymore. Therefore, when we decided that I was going to be a project coordinator, it didn't cause any inconvenient feelings based on the gender background. I can really say that generally I don't feel this difference between being a male and female researcher in the international context.

Being the main part of a project coordination group requires a lot of effort, but it is very inspiring and instructive for me. I really enjoy having the whole picture of the situation and discussing with people what could be the best, how to fit pieces together. At the core of the conducted project was the technology I had already been developing, so in a way it was kind of natural that I could be the coordinator. At the same time, all of the partners were contributing in an amazing way.

Of course it required a lot of effort but the first time, in 2017, I had little

experience and was much more stressed than later in 2019. I have learned a lot of things from the first experience, with thanks also to some older colleagues who were very keen to support me and give me suggestions. **There was a very collaborative atmosphere that really helped me to grow.** So, coordination of the project was smoother in 2019.

Regarding gender issues, **work-life balance is a huge problem, but not because of QuantERA.** It's a huge problem in our job, I think, and there isn't any good solution, yet. I got married and I had my first child when I was over 40 years old. I have a husband that does the same job so there is an understanding towards my deadlines. We support each other a lot, but the point is I definitely work too much. In the work-life "unbalance" it is generally the family that suffers more than work.

As for the team, we always try to have meetings in suitable hours. **I work till 7/8:00 o'clock but our meetings in Q3D never finish after 5:00 o'clock.** So it's pretty natural for me to have meetings in this way. I tend to keep weekends free

unless I participate in a conference, and such work organisation is somehow natural for me.

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

M.D.: I think that institutions need support to do this change. **Honestly, I believe that it's not enough to say that women are encouraged to be involved in project proposals. It's a good idea to write it, of course, but it certainly doesn't make a difference.** I think that things will change only when concrete actions are taken. I am not an enthusiast of "giving priority to women", but I think that within a transition period it's really necessary because it's the only way to arrive at a balance. Currently men dominate in science, and there is no balance. This makes the overall system poor, and the view restricted. If you are not sensitive to the topic, phrases such as "women are encouraged", do not change your way of thinking or doing.

It's a nice phrase to hear for someone who is sensitive to the topic, but it does not change the minds of people who simply do not see this as an issue.

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

I regard that as a transition for this situation to really change; unfortunately, we need to have clearer, more explicit actions. Not words, but actions to achieve a balance. In my opinion, we are stuck in an over-complicated bureaucratic system and we are asked to take care of too many things. It should be more clearly divided whether I am a scientist or a management person, whether I'm an expert on gender balance, ethics, public engagement, exploitation... I really think that QuantERA should find experts within the field who can help us to address all these issues because our time, as scientists, is limited. Of course, all these things are important, but at the end of the day they are left to you as a coordinator and no one gives you the tools to work with.

I think that European Union should really support institutions with concrete actions and dedicated work groups, because having gender balance experts at each institution is not that apparent yet. Maybe the first step would be to hire people in that field.

It is just the same problem with technology transfer: there are big universities where technology transfer offices are just great and other places where this is not the case. This support is nowadays essential for scientists, and to be honest – I do not feel I have it.

L.G.O.: Are you facing specific challenges for being a woman in the field?

M.D.: We have faced challenges historically, certainly less nowadays, but we still have to work towards equal rights and opportunities. Sexual harassment exists, and it happens from time to time. It is very disappointing but unfortunately it happens everywhere.

I also feel that there are people who are really upset by the fact that a woman can achieve success – “You are younger, you are a woman and your success is just not an option”. This is why I said we need “actions” because people need to feel that the success of woman matters to others, while often it is seen as a problem, as something that is undesirable.



Yet, I must say – sometimes there are also people who really care about your growth and they encourage you despite the difficulties because they know that there are not enough women in the field.

L.G.O.: On the usefulness of these visibility actions targeting women researchers:

M.D.: I think it was a good idea. Maybe we can open it also to people who are just involved in the projects.

I think it's a general problem, not only related to coordinators, but I guess it was a good idea to get the feeling about the topic.

I was open and transparent because I feel it's important. I really hope that my daughter will live in a different world, although compared to the previous generation, I cannot complain. There are situations in which I don't realise I am a woman. When I do, it is tough.

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