

Interview with Cristiane Morais Smith

On the occasion of receiving the EPS Emmy Noether Distinction, we asked Cristiane Morais Smith about her current work, her view on diversity in the physics community and the impact of the distinction.

In 2004, Cristiane de Morais Smith came to Utrecht University in the Netherlands to build a group working on the theory of strongly-correlated systems. On our question why she chose to work in the Netherlands she answered: "Actually, it happened more or less by chance. I wanted to get a job in a place where I did not know anyone because I did not want to be helped. I wanted to get a position all by myself. I saw an announcement of a position in the Netherlands, and given the high status of the country in the scientific scenario, I thought that it would be an ideal place to work."

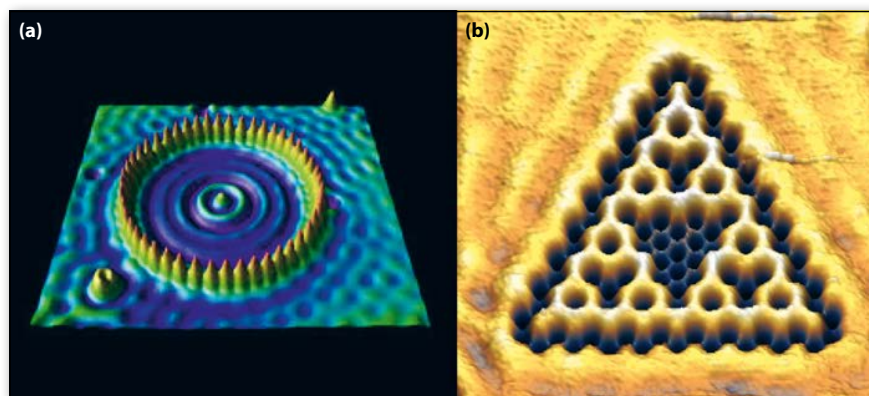
Current research

Recently, in collaboration with experimentalists at Utrecht University, her group has been working on the development of a platform for quantum simulations in electronic systems. "Sixty years ago, Feynman proposed that we could build matter in a bottom-up approach to simulate model Hamiltonians that are supposed to describe complex materials, or even to build metamaterials. Although the field of quantum simulators has been flourishing in ultracold atoms for about 20 years, and in photonics for about 15 years, almost nothing was done involving electrons. We are actively contributing to the field." With this collaboration in Utrecht, the group aims at establishing a new kind of quantum simulator platform, involving electrons. The endeavour is based on the pioneering experiment performed by the group of Don Eigler (Almaden), in which iron (Fe) atoms were manipulated using the tip of a scanning tunneling microscope on the surface state of Cu(111) to build a quantum corral [1] (see Fig. 1a). Later on, the same technique was used by the group of Hari Manoharan (Stanford) to build *molecular graphene* [2]. The manipulation of the atoms on top of Cu are performed on the nanometer scale and

there is a large flexibility with respect to the structure that could be built. "Indeed, we have shown that despite the fact that the underlying lattice is triangular and the COs can only be put on top of a copper atom, one can control the geometry of the lattice and build square or Lieb lattices [3]. In addition, one can control the *dimensionality* of the object formed, going even into fractal dimensions [4] (see Fig. 1b). One can also manipulate the *orbital degrees of freedom*, which can be selected in real space and separated in energy [5]. We have shown that this setup can be used to generate and control topological states, and have realised a *higher-order topological insulator* [6]. My group has been performing the theoretical calculations (muffin tin and tight binding) and most of the conceptual development of the projects, and we are recognised by the community as being among the pioneers of this emerging field. A next step is to *realise interactions* in this single-particle system. Although the CO on copper platform consists of free electrons, one can simulate two-body interactions in 1D by appropriately designing a non-interacting 2D system. This is being currently investigated, theoretically and experimentally. Preliminary results seem to confirm the theoretical predictions."

Proud

Morais Smith is proud of the collaborative work of her group on several subjects and with several experimental and theoretical groups in Utrecht, Sweden, Brazil, and Germany. "But a work that I consider really original is our formulation of a thermodynamic description of topological phase transitions. This work was done completely in my group, by some very bright PhD students, and I am very proud of it because nobody thought that this could be possible. Topological systems have metallic states at the boundary, and this seems to be in contradiction with the thermodynamic limit, in which one studies infinite systems. Nevertheless, we found a way to circumvent that..." As a theoretical physicist she enjoys working with experimentalists. "I have a deep respect for experimental work, since it brings the connection to the real world. I collaborate extensively with experimentalists, and learn a lot from them, as probably became clear from the answers above. Experiments are for me a motivation to do a new theory, but I also want to go beyond and predict something else, that could stimulate my colleagues to perform further experiments. One of the highlights in



▲ FIG. 1: (a) A quantum corral is realized by depositing Fe adatoms (yellow-red dots) in a ring on the surface of Cu(111) [1]. The corresponding electronic waves (blue) are then visible in the confined geometry. (b) Local density of electronic states in a Sierpinski triangle, generated by patterning CO molecules (black dots) on the surface of Cu(111) [4].

connection with theoretical predictions is a work we did in 2004. It is a mean-field calculation of the electron-solid phases in a quantum Hall system, and I did not expect it to work very precisely in experiments. However, 6 months after we published the theoretical results, the group of Dan Tsui measured exactly what we had predicted, and even the numbers worked out well. I was enchanted.”

Role model

Moraís Smith makes an effort of being a good role model and accepts many invitations for conferences. At many occasions she is the only woman giving an invited talk. “Every time when I think that it is too much, and I could stay calm at home, I think: but if I do not go, maybe there are no female speakers. And I feel an urge to accept the invitation. Fortunately, things are improving during the last years, and now there are more female colleagues who are invited. But the numbers are still low.” Participating in committees or boards she keeps a keen eye on the participation of women in physics. “As a member of the International Advisory Council of the T. D. Lee Institute in Shanghai Jiao Tong University, I recently suggested that they could create a prestigious Fellowship with the name of Madame Wu, to honour this brilliant physicist who deserved a Nobel Prize but unfortunately did not get it, and stimulate further Chinese women to follow her example. I was delighted when I learned that the Director, Prof. Frank Wilczek decided to accept the suggestion and implement it.” She stresses the importance of being a role model not only for physicists but for women in general and in particular for women in minority groups. “One day I had a wonderful experience in my office at the University of Utrecht. We had a very intelligent cleaning lady who came originally from Morocco. She entered my office and told me that she had decided to pursue her studies at the University, and that she wanted to let me know that I was her source of inspiration. Her husband was not very happy about it, since she also had a child, but she was determined to do so. I was enchanted! I think that when someone like me sits in a professor chair, it implicitly tells everyone that they can also. And this is very positive.”



▲ FIG. 2: Cristiane Moraís Smith (with red scarf) amidst (part of) her research group.

Diversity and Inclusion

Currently, her group comprises many Dutch students, but still a student from Russia and some from Brazil. She had more than 100 students in total, including Bachelor theses, Master theses, PhD students and postdocs, and from very different countries, like Malaysia, Italy, Germany, Spain, France, Switzerland, Norway, Ukraine, Serbia, Brazil, and Argentina. “But the majority is from the Netherlands, since I work there. I also have several female students, at all levels (Salma Ismaili for the Bachelor theses, Silke Schonecker for the Master, and Jette van den Broeke and Mariya Lizunova for the PhD). Unfortunately, many of them were not there the day when the professional photographer could take the group photo [see the picture] It is really a pity!” As a Brazilian, she makes an effort to attract PhD students and Postdocs from Brazil. She hopes to be a hub in Europe for Brazilian physicists or scientists from South America in general. “I kept a strong scientific link with Brazil and have already formed 3 Brazilian professors, and I hope to form more. At the moment, there is a professor and 2 PhD students visiting my group with Brazilian fellowships. Two more are going to arrive in 2020. I was awarded a Special Visiting Professor position in the framework of the Science Without Borders Program between 2013-2016 for a collaboration with the group of Eduardo Marino in Rio de Janeiro. Recently, we were awarded a NUFFIC/CAPES proposal for a collaboration

between Brazil and the Netherlands, from 2018-2021. I am very glad to get support for this very prolific collaboration and I am glad to establish these links.”

Emmy Noether Distinction

Cristiane Moraís Smith has received prestigious grants and prizes, but even so considers the Emmy Noether Distinction very important as recognition of her work “....and it really warms the heart!!! Especially because Emmy Noether has always impressed me so much. every time when I lectured about her life, I had tears in my eyes. She was an incredible woman.”

We asked whether she knew that she was nominated for the Emmy Noether Distinction. Her answer is encouraging for others who consider nominating their outstanding female colleagues: “Yes, I knew it. My colleagues had informed me and I was delighted to learn that they were making time in their busy lives to do that.”

■ Els de Wolf, EPN Editor

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