Profile of a Female Scientist: An Interview with Yasaman Soudagar
By Jennifer Kruschwitz

Yasaman Soudagar

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Meeting brilliant people striving to make long-lasting contributions to the field of optics as well as the science-education community, has been a regular occurrence since my affiliation with the Optical Society of America (OSA). So when OSA asked me to interview and profile a few of the Society's female student members for the MWOSA newsletter, I jumped at the chance.

Yasaman Soudagar grew up in Tehran, Iran. Her story is one of a struggling female student fighting to be considered an equal by her male counterparts to a promising physicist with the endless possibilities. She has witnessed firsthand the oppression and discrimination many women face in their professional lives, on a day-to-day basis. She is now pursuing a Ph.D. at École Polytechnique de Montréal and studying optical implementations of the cluster state model of quantum computation. Her mission to help all women realize that "Women Can", is truly inspiring.

***Kruschwitz**: I am really interested in learning a little about what it was like growing up in Iran. I heard the animated movie Persepolis by Marjan Satrapi accurately portrays the life of young Iranian women. Do you agree? How did you relate to this film?*

Soudagar: Life in Iran was a little bit like going through the history of Europe of the last 100 years in just a couple of decades: war, revolution and a fight for freedom; except that in the case of Iran democracy has not prevailed. Persepolis emphasizes growing up in Iran in the best way one can and the story truly does apply to my generation. As you see in the movie, the Iranian revolution (which was not Islamic and included other parties, such as the Nationalists and Socialists) happened when I was very young.

What I remember the most is my mother's warning each morning: Do not touch any toys you might find on the street as it might be a bomb that will explode in your hands! And the family gatherings which were a battle ground for different ideologies, as each member of the family belonged to a different political party. Naturally, members of the family, teachers and neighbors would disappear every once in a while and reappear after a year or a few years, all broken. You would know that they had been spending time in the dreaded Evin (the prison).

At the very beginning of the revolution, through some twisted fate, not only in Iran and its neighboring Islamic countries, but also in Europe, people started thinking of Ruhollah Musawi Khomeini as a holly person (In fact, Margaret Atwood describes very vividly how such a twist can happen in *The Handmaid's Tale*). Hence, they trusted the leadership of the country in his hands, till a parliament is formed. However, shortly after that, the regime started showing its true face. All leaders and many active members of opposing

parties were arrested and executed. This trend continues today and applies not only to political activists, but to anyone who speaks out against the government. Access to all foreign media was banned and the religious oppression began. Very unfortunately, Iraq, whose government was not considered a dangerous government at that time by the West, attacked Iran just a year after the revolution. This incident halted any revolt of the Iranian people to oppose the regime, as they had to go to war and defend the country. And the Islamic regime, having realized this fact, fueled the war more and more. At that time, the most famous saying of Khomeini was: War is a blessing from God!

On the other hand, the war had its own black veil. Bombs were falling (I still jump when I hear thunder) and the martyrs' bodies were carried to the cemetery, being mourned by the public. War refugees from the bordering cities with Iraq became scattered all over the country. I remember women and children living in the yard of my school for months. All medicine would go to the battle field, causing a major shortage in the country and foods, such as milk, rice, meet and eggs were rationed. The human life was the cheapest commodity and violence was everywhere.

For eight long years, the war was the annihilation of human souls, the destruction of everything. So many people were wounded for life because they lost a part of their body or because they lost someone in the war and then there was the awful post-war economic and social depression, and Khomeini kept repeating that war is a blessing from God. It definitely was for that government, as at the end of eight years, they were firmly established in their place and up to this day they continue to arrest, torture and execute those who threaten their power.

To understand better the horrors of war I suggest reading *Iron in the Soul*, by Jean Paul Sartre and to understand the social and individual post war depressions I recommend one read *The Mandarins* by Simone de Beauvoir.

Kruschwitz: *What an incredible story. I really appreciate you sharing such a personal piece with me.*

I am curious about the education system in Iran. Are young girls encouraged to study math and science? Can you tell me a little about your early education and interests in these subjects?

Soudagar: In Iran, the schools for girls and boys are separate. In girls' schools all teachers were women and in boys' all men. Thus, these subjects were taught to us by women, hence there was no problem of finding a role model for obtaining an education in these fields and becoming a teacher. But to become a real scientist, researcher or an engineer is a totally different matter. Young girls are neither encouraged nor discouraged to study science and math, because at the end of the day, if they are anything other than a medical doctor or a teacher - the two most highly respected professions, as they respond to the most essential needs of the general public - they are not going to be taken seriously. The general cultural belief is that women cannot do anything that requires rationality. What is funny is that there are many women in Iran studying science, math and

engineering. In fact, in some fields they outnumber men. But when you see a woman at a party and realize she is a mathematician, a physicist or an engineer, what you think to yourself is: “OK, she has a good degree and she probably has some job. Nice educated woman!” Instead of thinking: “Another successful woman! Cool!”

I think I received the perfect preparation to become a scientist from my parents, who met each other while studying business management in the University of Tehran. My father was always presenting me with mathematical riddles and questions about the objects that surround us. This planted the seed of curiosity in me and got me interested in science. My mother was always making sure I aced all my subjects, no matter how much I hated them, which gave me the ability to get through the many painstaking hurdles of research.

During my first year of high school, the subject “Science” was divided into its sub-categories: Physics, Chemistry and Biology. I instantly fell in love with Biology as it shed some light on the mysteries of “Life”. With Physics, I felt infinite power in the fact that knowing the initial velocity of an object I could completely determine its trajectory! I was so fascinated by the power of the ”formulae” and the “predictability”, that one night in my dreams I managed to write down the formula of my life, with many variables! Of course, I couldn’t remember what it was when I woke up, but given my knowledge of mathematics at that time, it had to have been a nasty polynomial.

Kruschwitz: *Eventually you had to choose between Biology and Physics. What made you decide to study Physics?*

Soudagar: Yes, we had to choose the branch of our education for the second year of high school. That unfortunately meant I had to choose either Physics or Biology. I chose Physics to prove “WOMEN CAN.” This might sound like a stupid reason to choose a subject, but in a society where women are not allowed to become pilots and judges because they are considered to be too emotional to be able to make highly rational decisions, you are always fighting to prove your equality with men.

Kruschwitz: *Following high school you were accepted into one of the premier physics programs in Iran at the University of Tehran. Were the attitudes and environment at the university more progressive toward female students? Did you feel you still had to prove “Women Can” as you did in high school?*

Soudagar: My time at that university was very unpleasant. All the professors, except for one, were male and while teaching they weren’t supposed to look at the “sisters” side (women’s side) of the class. All opportunities were given to male students, because a male professor couldn’t talk freely to a female student. As always, women were second citizens and weren’t believed to be able to become real physicists.

Kruschwitz: *Can you describe the academic climate and the obstacles women had to overcome on a day-to-day basis? How did you confront these obstacles?*

Soudagar: The university level was the first time in our lives where we would share the class with "brothers." According to the philosophy of the Islamic government, the presence of "sisters" distracts "brothers" from their studies, so to reduce the temptation "sisters" should sit separately. In the more open minded environments, women occupy one side and men the other side of the room. In the more conservative ones, women occupy rows behind men, so men can forget their existence. Going to one of the best universities in the country, in the capital city, I was sure we would go with the more open minded version. That was until I entered the first university session of my life, which was held in the amphitheatre of the Physics building. To my surprise, I saw that men had occupied the entire front row, meaning they expected women to sit behind them. I was furious and was not going to accept this. So I went to the front of the class and loudly asked the "brothers" to move to one side to make room for "sisters," which were, by the way, more than 50% of the population of the class. Many of them moved right away, but a couple of fanatics remained in place and pretended they didn't hear me. I repeated my request, but they decided to intimidate me by completely ignoring me! They were dealing with the wrong "sister" though, as I went to them one by one, repeated my request and stood there until they were all forced to move.

In addition to similar kinds of problems, people like me, who weren't in tune with that government, always had to be very careful about what we said and what we wore, as we were under constant watch by the informants of the regime and any small sign of disagreement with the regime or Islam would have resulted in expulsion from the university and possibly even incarceration. This was a tremendous amount of day-to-day pressure to cope with.

***Kruschwitz**: I noticed in your biography you hold a black belt in the Shotokan and Kyokushin styles of karate and taught karate to other female students. What inspired you to lead these classes?*

Soudagar: The University of Tehran turned out to be very different from what I had in mind. Instead of learning Physics and intellectually enriching my mind, I was being shred to pieces both as a woman and as a human being. Thus, I gradually stopped attending classes and would just write the exams. Instead I initiated the sisters' Karate classes of the University. One of my Karate students won competitions at the national level and another one is the only female Karate instructor in one of the cities of Iran.

***Kruschwitz**: Your family eventually immigrated to Canada and you earned an honors degree in Physics and Applied Mathematics and a Masters in Computational Physics from York University. Tell me a little about some of your most inspirational classes or professors.*

Soudagar: Two courses with two excellent teachers stand out: "Classical Field Theory" by Dr. Jurij W. Darewych at York University and "the Interpretations of Quantum Mechanics" by Prof. John Sipe at the University of Toronto.

The time during my Masters was one of the loneliest times of all. I was sitting in front of a computer in an office all alone, writing codes day after day. On top of that, I couldn't understand what my research was good for! (Later on, I saw an application of it in cancer radiation therapy in an optics workshop our OSA student chapter had organized). So I started wondering if Physics was the right thing for me.

Fortunately at the Annual Canadian Undergraduate Physics Conference, in which I had presented twice during my undergrad years, I heard presentations in a field called Quantum Information Theory, which I found extremely interesting. To learn more about this field I participated in the Quantum Information Summer schools held in Montreal and Waterloo (Canada). I decided maybe I was just in the wrong subfield of Physics, and I should switch fields. Nobody at York University was working in this field, so it was a bit difficult to get a real sense of it and make an informed decision. I talked to my supervisor, Dr. Marko Horbatsch, who is such a supportive person that even though his own field is theoretical high energy and atomic physics, he offered a reading course to me, during which we would study "Quantum Computation and Quantum Information," written by Michael A. Nielsen and Isaac L. Chuang. During this time I also received a lot of precious support from Prof. John Sipe at the University of Toronto.

My experience as a female Physics student in Canada stands in great contrast to that in Iran. When I was in Toronto I was always appreciated as a capable human being. There was never any question of my ability as a physicist because of my gender. In fact in that environment everyone is just a human. There are no divisions whatsoever based on gender, country of birth, culture, ideology, color, etc. Throughout those years I was very lucky to be in contact with such great human beings as John, Marko and many others whose level of thinking was far beyond any pity divisions. These great people have created environments that literally took my mind from the Earth, taught it how to fly high above and look at everything from that position. I am truly honored to have met these people and it was Physics that gave me that chance.

***Kruschwitz**: Since 2005, you have been pursuing a Ph. D. under the supervision of Drs. Jose M. Fernandez and Nicolas Godbout at École Polytechnique de Montréal. What is the focus of your research?*

Soudagar: At the moment I am working on the proof of principle optical implementations of the cluster state model of quantum computing and also a heralded single photon source. Even though the field still constitutes pure physics, it has the promise of revolutionary technology in the fields of computation and telecommunication, which is very satisfactory.

I have the advantage of working in a great team, with excellent supervisors. Nicolas is a very positive person and a true free thinker. So in addition to Optics, I have learned and continue learning a lot from him. Jose is very supportive and always provides helpful academic and non-academic advice.

***Kruschwitz**: How do you see your research and quantum computing in general impacting the field of Optics and future technologies?*

Soudagar: The performance of the proof of principle optical experiments in the field of quantum information processing means taming individual photons. This requires technology that works in the single photon regime. Hence, along the way of arriving at a quantum computer, a lot of new optical technologies will be developed that are useful for other fields of Optics, such as imaging. Some examples are: highly efficient single photon detectors and very efficient coupling of light from a cavity into a waveguide.

When built, a quantum computer will be capable of efficiently simulating a quantum system. Hence, it impacts not only the field of Optics, but all of Physics.

The field of quantum communication has advanced more rapidly than quantum computation. Using quantum cryptography, the transmission of 100% secure data is in the near future.

***Kruschwitz**: You are also the President of the École Polytechnique de Montréal OSA Student Chapter that won the 2007 Student Chapter Excellence award for its many outreach programs, including the "Girls in Science" program, and the development of the "Outreach activity guide for High-school teachers". Would you tell me a bit about these programs?*

Soudagar: In fact our chapter also won this award in 2006, when it was under the leadership of François Busque. We are very committed to introducing the field of Optics to young people, their educators and the general public. To do so, we take advantage of programs that are organized by the province or the university, such as the Girls and Science Day, and the university open houses. During the Girls and Science Day, which is an annual provincial event, hundreds of girls, their educators and parents go to a hosting university. Many female professionals in related fields and from various institutions and companies attend this event to provide an image of female role models, while giving out relevant and realistic information about these fields to the girls and their parents. Our chapter provides hands-on optics workshops for girls and their educators to introduce this field and its relevance to day to day technology. We provide the same outreach during university open houses.

In addition, as much as time allows us, we hold our workshops in various grade schools for both students and science teachers.

Outreach to teachers is very important, as it allows us to transfer our knowledge to many more students through the educators. We developed the "Outreach Activity Guide for High-school Teachers," which has been distributed by the provincial board of education to some French high-schools.

We are also collaborating with the Insectarium of Montreal to transfer the Liquid Crystal Kit, developed by Dr. Stephen Jacobs' team at the University of Rochester to them. Interestingly enough, this process has started a great communication between our chapter and their community.

***Kruschwitz**: The École Polytechnique de Montréal OSA Student Chapter is constantly enhancing existing programming and developing new outreach activities. Are there any events or new programs on the horizon?*

Soudagar: We developed a new educational kit on UV light florescence and how it is used in make-up for the Girls and Science Day. It was a very successful and fun kit.

At the graduate level, in addition to inviting many speakers for scientific presentations, we have started to focus our attention to the skills that are not a part of a regular university curriculum, but are vital to any successful researcher. Examples of these subjects include: business etiquette, business networking, information management, time management, project management and leadership skills. We held a two-day entrepreneurship workshop in collaboration with the Ottawa-Carlton OSA and Montreal SPIE student chapters and received very positive feedback from our participants about the quality of the speakers and also the organization of the workshop. We are planning to continue inviting speakers from the Business School and the Entrepreneurship centre to cover the named subjects.

***Kruschwitz**: What are your post-doc plans? How do you hope to leverage your PhD in experimental optics to enhance your career?*

Soudagar: I should graduate by May 2009 and although I will definitely do a post-doc, the details of my plans will very much depend on my receiving a post-doc scholarship. There are a number of very good research groups in the US and Europe that work on cluster state quantum computing. In choosing a group, in addition to the type of research, I will take into account the culture of the group.

In terms of the career path, as I love both research in my present field and teaching, I hope to end up in a place where I can do both. As a plan B, I hope to obtain a job in the R&D sector of an optics company and satisfy my thirst for educating others by teaching part-time in a college and doing outreach programs in collaboration with OSA.

While my education is providing me with the great technical skills I need to build a great career, my involvement with OSA is truly enhancing the capabilities that are complimentary to my scientific knowledge. I am not only building a great professional network, but also enhancing various skills through leading my chapter and organizing events in different scales, which require a large amount of management, leadership and communication with people from all backgrounds: from kindergarten kids to teachers to chief technology officers and venture capitalists.

***Kruschwitz**: Thank you for sharing your story with me. Your experiences growing up in Iran and the great strides you have made since are truly inspirational. In closing, do you have any words of encouragement for other young women facing oppression and discrimination around the world?*

Soudagar: Yes, I would like to say a few things:

* Believe in yourselves! You CAN be a scientist and succeed just as any male scientist can!

* Try to do graduate studies in countries where women have equal fundamental human rights as men. This way you will be able to truly realize what it means to be treated equally and enrich yourself as a human being. Although you might think to yourselves that you are equal, you will not know what that really means unless you are put in the right situation, where the environment expects the same level of performance from you as it expects from men. This will help you realize that you ARE TRULY EQUAL to your fellow male colleagues in all aspects, and NOT inferior to them.

* Read the laws of your country (e.g. the laws of marriage/divorce and inheritance) and learn about your rights or lack of them! To learn more about the lack of your rights, you can read the same laws from a more progressed (in terms of domestic human rights) country and compare. If you can possibly do anything to improve on these laws to make them more equal for yourself or other women, do so!

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Jennifer is a Sr. Optical Coating Engineer and President of her coating design firm, *JK Consulting*. She received her Bachelors and Masters Degree in Optics from the University of Rochester in 1989 and 1995 respectively. She has been working in the field of optical interference coatings since 1988. Jennifer has been an active member of OSA since 1990, serving in a variety of volunteer and governance capacities.