Women's History Month Special Article: Interview with Professor Mahta Moghaddam

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Abstract – March marks Women's History Month, and March 8th is celebrated as International Women's Day. In this Special Article, Sima Noghanian interviews Mahta Mogaddam, renowned scholar in applied and computational electromagnetics.

Index Terms – women in applied computational electromagnetics, women in STEM.

I. INTRODUCTION

Professor Mahta Moghaddam (Fig. 1) is a Distinguished Professor of Electrical and Computer Engineering (ECE) at the University of Southern California (USC) Viterbi School of Engineering. She also holds various positions including the Ming Hsieh Chair in ECE, at the University of Southern California, Co-Director of the Center for Sustainability Solution, Vice Dean for Research, Head of Microwave Systems, Sensors, and Imaging Lab (MiXIL), Director of USC Viterbi Center for Arid climate WAter REsearch (AWARE), and co-Chair of the President's Working Group on Sustainability. Professor Moghaddam is a Fellow of IEEE and is the Past President of the IEEE Antennas and Propagation Society. She was the Editor-in-Chief of IEEE Antennas and Propagation Magazine and a Distinguished Lecturer of the IEEE Geoscience and Remote Sensing Society. She is a member of the National Academy of Engineering.

Dr. Moghaddam has been an active researcher in various fields including microwave sensing of the environment, electromagnetics for medicine, and smart energy-efficient sensor webs. She has pioneered inventive methodologies and algorithms to quantitatively interpret multichannel radar imagery, utilizing analytical inverse scattering techniques applied to intricate and stochastic media. Dr. Moghaddam has spearheaded the advancement of novel radar instruments and measurement technologies for subsurface and sub-canopy characterization. Notably, she has served as a Systems Engineer for Cassini Radar and held the position of Science Chair for the JPL Team X (Advanced Mission Studies Team). She has also been a member of various NASA missions and program science teams, including SMAP, CYGNSS, and ABoVE [1].

Fig. 1. Professor Mahta Moghaddam.

II. QUESTIONS AND ANSWERS (Q & A)

Q1: Could you share a bit about yourself and what drew you to the field of engineering?

A1: I grew up in a culture that values education and science and that is where it all started. My parents had a big influence on me to appreciate math, physics, and science and how these disciplines explain how the universe works.

While my initial curiosity in these fields was sparked by parental influence, my interest deepened significantly over time. The educational system in Iran is rigorous, inundating students with vast amounts of information. This posed a challenge in discerning what was truly essential from what was not. However, in retrospect, this experience was immensely beneficial. Being exposed to fundamental concepts at an early age proved invaluable, laying a strong foundation for my subsequent education. This foundational understanding proved crucial as I progressed in my studies, fueling my interest further. I developed a strong passion for physics and mathematics.

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After graduating from high school in Iran, I arrived in the US and began my undergraduate studies. Initially, I enrolled as a physics major, drawn to its explanatory power in understanding the world. However, I soon switched to electrical engineering, seeing it as closely aligned with physics from a more applied perspective, particularly in the realm of electromagnetics. My interest in electromagnetics was further fueled by the guidance of excellent professors during my undergraduate studies. Engaging in hands-on labs in electromagnetics deepened my appreciation for the subject. And so, my journey towards specializing in electromagnetics began, influenced by both practical considerations and inspirational academic experiences.

I attended the University of Kansas in Lawrence, KS. Thanks to the robust educational foundation in Iran, I completed my undergraduate studies in just 3 1/2 years by taking on a heavy course load. The initial years were straightforward as I had covered much of the material in high school. The later semesters became more challenging but also more intriguing. I managed to graduate early and pursue graduate studies, focusing on electromagnetics.

For my graduate studies, I chose the University of Illinois at Urbana-Champaign, where I had the privilege of being advised by Professor Weng Cho Chew. I applied to several schools and it was not customary to visit the school during the application process. Interestingly, Professor Chew was the only one among my prospective advisors who invited me to visit the campus. Despite a short and disrupted visit due to weather conditions, I was deeply impressed by his genuine care and hospitality. This encounter greatly influenced my decision to join his research group.

Professor Chew, renowned for his expertise in theoretical and computational electromagnetics, was an exacting yet excellent mentor. He was a demanding advisor. Under his guidance, I and my peers were pushed to excel, laying a solid foundation for our future endeavors. The experience, akin to ”drinking from a fire hose,” was immensely rewarding, shaping my academic and professional trajectory.

Q2: Did your interest in electromagnetics begin during high school, undergraduate studies, or when you started working with Prof Chew?

A2: I would attribute my foundational understanding of electromagnetics to my high school education, although at that time we didn't explicitly refer to it as electromagnetics; rather, it fell under the umbrella of physics. It was during my undergraduate studies that I encountered electromagnetics courses, which solidified my understanding of the subject and reinforced its connection to physics. Looking back, I'm very happy with my choice to specialize in electromagnetics, although there was a period when I entertained the idea of pursuing photonics or semiconductor technology. However, as I reflect on the importance of waves and fields in modern technology, particularly in wireless sensing and communication systems, I am reaffirmed in my decision to focus on electromagnetics. It remains a pivotal area of study with significant relevance in today's technological landscape.

Q3: You mentioned your transition from Iran to studying in the United States, experiencing a new culture and environment. Despite these challenges, you succeeded. How do you reflect on this experience? Do you feel it made you stronger, or was it exceptionally difficult? Would it have been easier if you weren't an immigrant? What impact did it have?

A3: That's a profound question that I've pondered over the years. While I can't definitively say whether it would have been easier had I not been an immigrant, undoubtedly, being born in the US would have presented fewer hurdles. Nevertheless, I never perceived my journey as overwhelmingly difficult. Sure, there were adjustments, such as being away from my parents, but I was fortunate to have my sister here. She helped me adjust and not feel overwhelmed. I was immensely grateful for the opportunity and approached it with a positive mindset, recognizing the privilege I had been given. I understood that many others around the world face far greater challenges. This perspective drove me to seize the opportunity and make the most of it.

Q4: As a woman in the field of engineering, particularly electromagnetics, you are part of a minority. There are relatively few women in engineering, especially in electrical engineering with a specialization in electromagnetics. Why do you think this is the case? Did you notice this lack of representation when you first entered the field, and what do you think can be done to make it more appealing to women?

A4: It is indeed a complex issue, and I believe there are several factors at play. Firstly, I am not sure if the scarcity of women in electromagnetics is a phenomenon limited to the US or if it is prevalent worldwide. Unfortunately, I don't have the statistics from other regions to make a comparison. It seems in the US to be a cultural bias against women pursuing engineering, which might discourage girls in high school from considering it as a viable career option. This societal pressure can be a significant deterrent.

Secondly, beyond cultural influences, I believe women may inherently seek professions where they perceive a tangible impact from their work. Historically, electromagnetics might not have been seen as a field with immediate societal impact, unlike medicine,

robotics, or biomedical engineering. However, as technology evolves, the significance of electromagnetics in various applications becomes more apparent. From wireless systems to biomedical systems, many imaging, sensing, and therapeutic systems involve electromagnetic fields. This shift in perception could attract more women to the field.

As we continue to highlight the diverse applications and societal impacts of electromagnetics, I believe more women will be drawn to it. Indeed, we are witnessing positive changes in this regard, with increasing numbers of women pursuing careers in electromagnetics.

Q5: Your work spans various fields, particularly biomedical and environmental, showcasing significant impact. Could you elaborate on your contributions in these areas from grad school to the present?

A5: Certainly. During my graduate studies, my research focused on theoretical aspects with practical applications, particularly in subsurface sensing for resource exploration and solving inverse problems with biomedical implications. However, the scope of a PhD is limited, and upon joining JPL (Jet Propulsion Laboratory), which was my first job, I delved into environmental remote sensing. Leveraging my background in inverse problems, I applied quantitative inversion techniques to remote sensing applications. That is how I started applying inverse problems to remote sensing, collaborating with scientists from diverse disciplines like ecology and hydrology. This collaboration was enlightening, as it highlighted how engineering and remote sensing technologies could aid in understanding global climate change and improving predictive models (Fig. 2). That was exciting, motivating, and rewarding.

Fig. 2. Professor Moghaddam [2].

In my group, we have also maintained a focus on medical applications, integrating electromagnetics into microwave imaging systems for thermal therapy support (Figs. 3–5). By applying inverse problems to these systems, we developed near-real-time monitoring of ablation therapies. This involves detecting changes in the dielectric constant, which correlates strongly with temperature variations in human tissue due to its high water content. This interdisciplinary approach has the potential to enable much more effective medical treatments, offering precise and effective monitoring during thermal therapies.

Fig. 3. Professor Moghaddam and her research team [3].

Fig. 4. Professor Moghaddam during a fieldwork trip in the boreal forests in Canada.

A6: You serve as a role model for younger students and aspiring professionals, inspiring them to pursue similar paths. How do you perceive yourself in this role? Have you encountered students who express admiration and a desire to emulate your achievements?

A6: Thank you for your kind words. I am truly humbled by the notion of being seen as a role model. It is incredibly heartwarming and serves as validation for the efforts I have put forth thus far. Whenever someone expresses

Fig. 5. Professor Moghaddam with her team on Earth Day.

admiration and mentions being inspired by my journey, it deeply touches me. While I don't consciously perceive myself as a role model, hearing such sentiments is truly gratifying. I suppose it could be attributed to my approach of focusing on solutions rather than dwelling on challenges. Engineers inherently adopt this mindset – when faced with a problem, our instinct is to find a solution.

If my attitude resonates with students and junior colleagues, and if it encourages them to adopt a similar problem-solving approach, then I am more than happy to serve as a conduit for that perspective. It's crucial to recognize both the challenges we can address and those beyond our control. Wasting energy on the latter only detracts from our well-being and productivity. Therefore, emphasizing what we can influence is key. Ultimately, if my experiences can guide others in navigating their own paths with resilience and focus, then I consider that a privilege and a responsibility worth embracing.

Q7: You mentioned transitioning from JPL to university academic positions. What motivated this change, and how do you perceive the pros and cons of working in academia versus a non-academic setting?

A7: It is challenging to delineate between the two experiences. My tenure at JPL was immensely fulfilling. Initially, I joined with the intention of gaining insights into the "industry," thinking it would be a brief stint before returning to academia. Two years became 12 years. I found myself captivated by the stimulating environment and the intriguing problems to tackle. Despite this, my desire to contribute to student training and nurture the next generation persisted, drawing me towards academia.

One significant distinction lies in the scope of problems tackled. At JPL, the focus is often on a set of issues aligned with the organization's mission. While very exciting, it is not as diverse a portfolio as that of academia, where a broader spectrum of topics can be explored with access to more diverse funding sources. This breadth of focus in academia appealed to me, allowing for a more expansive impact.

I cherish my time at JPL, while currently enjoying a blend of both worlds. Collaborations and joint projects with former colleagues enable me to maintain ties with JPL while embracing the academic realm.

Q8: Have you ever been passionate about an idea, applied for funding, and faced rejection? If so, how did you handle it?

A8: Absolutely, it is a common occurrence. I believe most researchers, including myself, face rejection maybe as often as acceptance. There have been instances where I poured my heart into a proposal, convinced it was groundbreaking, only to receive feedback that tore it apart. Initially, such experiences can be disheartening. However, with time, I've learned to view rejection as a learning opportunity.

Each rejection provides valuable feedback, highlighting both the strengths and weaknesses of the proposal. It is crucial to develop a thick skin and embrace rejection as part of the path toward success. Failure, as counterintuitive as it may seem, is an integral step towards success.

Moreover, I have also learned the importance of providing constructive feedback when reviewing others' works. Understanding the impact of harsh criticism, especially on junior colleagues, has made me more mindful of my feedback. It is essential to offer feedback with kindness and empathy, focusing on constructive criticism rather than discouragement.

Q9: Can you share a memorable moment from your career, one that stands out either positively or negatively?

A9: I will share two contrasting moments. Early in my career at JPL, I had what I thought was a groundbreaking idea for an internal funding call. Excitedly, I presented it to my section manager with bright eyes; he looked at it and said: "No, it is never going to work, we will not present it." It was disappointing and left me feeling discouraged. He was right, but he did not take any time to explain to me why it could not work. Despite the initial setback, I persevered, reevaluated my concept, and eventually refined it into a successful proposal. This experience taught me the importance of resilience and not allowing rejection to stifle creativity. I also learned not to reject ideas without clarity, causing discouragement in the young engineers.

On a more positive note, decades later, I was deeply honored to receive the Distinguished Alumni Award from the University of Kansas, my undergraduate alma mater (Fig. 6). The unexpected recognition filled me with joy and gratitude, reminding me of the lasting impact of

my education and the connections forged over the years. I couldn't believe that the university still remembered me after decades!

However, the most rewarding moments in my career are witnessing the success of my students. Whether it is seeing them graduate, publish a paper, or defend their thesis, their achievements bring me immense pride and motivation. While I play a role in their journey, their accomplishments belong to them, serving as a reminder of the importance of mentorship and nurturing the next generation of scholars.

Fig. 6. Professor Moghaddam received the Distinguished Service Alumni Award from the University of Kansas [4].

Q10: What advice do you have for students and young professionals interested in working in this field?

A10: My advice encompasses both career and personal aspects. Firstly, if you have a passion or strong interest in the field, persevere and pursue it wholeheartedly. Immerse yourself in the problem you are tackling, knowing that obstacles are inevitable but surmountable.

Equally important, prioritize being a thoughtful, kind, and considerate individual. In the grand scheme of life, your character and how you impact others matter far more than specific professional achievements. When you are 90 or 100 years old, people will remember you for the person you were and the overall positive impact you left on your colleagues, mentees, and the technical field, not the number of papers, patents, and amount of research funding you generated. Whether you are a researcher, a professor, or a manager, your career title won't define your legacy. It is the kindness, helpfulness, and positive impact you leave behind that truly resonate.

Q11: What inspires you the most?

A11: For me, it is the human factor, which includes the true societal impact of our technical work. I find immense inspiration in considering the people involved: my partners, collaborators, and the team executing the work (Fig. 7). I am driven by questions about the human outcomes, the training opportunities we can provide, and the collective impact we can make. Year after year, this aspect has only grown in importance to me.

Fig. 7. Professor Moghaddam celebrating with her students and their families on their graduation day.

Q12: What do you envision for your future? What challenges do you aim to tackle, particularly in the field of computationally applied electromagnetics?

A12: Over the three decades since earning my Ph.D., there has been a persistent challenge in connecting remote sensing and electromagnetic inverse problems. The sheer size of the remote sensing problem, spanning hundreds of thousands or millions of wavelengths, poses a significant computational challenge. Despite advances in computational electromagnetics, we haven't been able to fully address this issue. My goal is to bridge this gap and find a solution that doesn't compromise the underlying physics of the problem. Currently, we're exploring artificial intelligence and machine learning approaches to complement theoretical electromagnetics. However, I still see this as an unsolved problem that needs attention. We need to find a way to reconcile this mismatch without sacrificing the accuracy and integrity of the physics involved. It's about finding a balance between statistical representations and capturing the intricate details of individual scatterers to truly understand the complexity of remote sensing. Apart from addressing the gap between remote sensing and computational domains, I also believe it's crucial to bridge the gender gap in electromagnetics. There's no fundamental reason why there should be significantly fewer women in this field, and I hope to see more gender parity as we continue to demonstrate the impact of our work. Additionally, attracting more individuals to electromagnetics, regardless of gender, is another important challenge. We need to focus on improving our educational approaches, starting from high school and undergraduate levels. Unfortunately, many academic departments are reducing the

emphasis on electromagnetics education, but we must find ways to address the shortfall. This mission is on us.

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