



Fig. 9.1

CHAPTER 9

AHMED ZEWAIL — OUR
PRIDE

Sultana N. Nahar

The Ohio State University (OSU) has been holding the International Symposium on Molecular Spectroscopy for over 60 years and is made popular by scientists all over the world. As I was heading for coffee and donut break at the symposium about nine years ago, I stumbled upon a picture of a smiling face with dark hair on a photo stand, placed on a table right outside the break room. My eyes were fixed with pleasure as below the picture read ‘Ahmed Zewail Prize’ in a large font. “A distinguished Muslim personality promoting science?”, I thought. I wasn’t aware of Zewail’s contributions then. About a year later, I was reading an interesting article in Science magazine, which elaborated on the dream project of bringing a renaissance of science, technology and innovations to the regions of Middle East and Africa through a center, and with wide support from the international scientific community; name of the dreamer surfaced — Ahmed Zewail from California Institute of Technology (Caltech). My respect and curiosity grew deeper. He was the Linus Pauling Chair professor of Chemistry and professor of Physics at Caltech, and recipient of the

Nobel Prize in Chemistry in 1999. I knew immediately — Ahmed Zewail is our pride.

9.1 The Sequences of Events Happening During Chemical Reactions

Zewail opened up the field of study for chemical reactions and is known as the Father of femtochemistry. Human eyes can typically detect a maximum of 60 snaps per second, which is known as the flickers per second or FPS. At FPS higher than 60, it will look like a smear to the eyes as the brain cannot resolve them. Therefore, the sports cameraman increases the frequency of snaps (or FPS) to catch many pictures of a fast event, such as a ball hitting near the boundary line. When the pictures are run at the speed of human FPS, we can see the slow motion movie of the actual event and get the most accurate information for any judgment. Zewail found the way to see the sequences of events happening during chemical reactions. Without these, we cannot get the whole picture of the reaction, and cannot study it precisely in experiments or develop the needed theories.

In the past, scientists could study the initial reactants and products, and thus inferred intermediate states of a chemical reaction. When a chemical reaction proceeds through the transitional states, it passes too fast to be detected. Zewail came up with the idea of ultrafast laser spectroscopy to study them by using the pulses or shots of a femtosecond (10^{-15} s per shot) laser to take the pictures of the transitional states, which would make a movie for the investigation of the process. These femtosecond shots are smaller than the molecular vibration or rotation rates, and hence can freeze the motions in time.

Zewail was able to create ensembles of molecules and synchronize their motion. He would use two laser pulses, one was the pump pulse to initiate the time and trigger the reaction, the other was the probe pulse to take snapshots of the evolution of the chemical reaction. He demonstrated that rotational and vibrational coherence is the key to making femtosecond movies. He showed the connection between the chemical bonds and their dynamics.

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The work brought new and precise insights on the chemical reactions and opened up the field of study to a new high, not only for chemistry but also for physics and biophysics. He remained involved in research in all the mentioned areas. With his own research group, he also developed femtosecond electron diffraction for direct imaging of the evolution and structure of biological molecules or materials changing with time. He was honored with the Nobel Prize and many other prestigious recognitions for his contributions.

9.2 My First Visit to Zewail City of Science and Technology (ZCST)

I went to Egypt for the international conference on Modern Trend in Physics Research in 2008 (MTPR-08), taking my middle school son Alburuj with me.

We were engrossed by the Egyptian Museum in Cairo, the pyramids, the Nile River and Aik Sohna by the Red Sea. By 2013, I was well connected to Egypt and started delivering atomic astrophysics courses with computational workshops under the Memorandum of Agreement (MOA) between OSU and Cairo University. Professor Lotfia El-Nadi, the coordinator of the MOA for Cairo University, suggested me to visit the Zewail City of Science and Technology, where she served as a member on the Board.

Professor Lotfia El-Nadi herself is an exemplary female scientist, who was the founder of several important organisations and conferences; namely the National Institute of Laser Enhanced Sciences (NILES), the Topical Society of Laser Sciences (TSLs), the Modern Trends in Physics Research (MTPR), and Ultra-Fast Laser Technology and Applications (UFLTA). She has also introduced a few new areas of research in physics in Cairo University. I came to know a lot more about Ahmed Zewail from her.

Zewail was an Egyptian by birth from Alexandria and went on to study at the University of Alexandria, then to the University of Pennsylvania in the USA for his PhD. Zewail felt strongly the need

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to enrich science and innovations in Egypt, the Middle East and Africa as a whole. Egypt had contributed wonders to human civilization long ago. Even now, it is the leading country for those from Africa and the Middle East seeking to get a degree. In 2013, Zewail wrote, “A part of the world that pioneered science and mathematics during Europe’s dark ages is now lost in a dark age of illiteracy and knowledge deficiency.” Zewail laid the cornerstone of what would become the dream institute in the city of 6 October. Supported by the then President Anwar Sadat, Zewail started to recruit dedicated scientists from all over the world. His idea of building the dream institute became a national project and was named the Zewail City of Science and Technology (ZCST).



Fig. 9.2 Entrance of the Zewail City of Science and Technology in 2013.

I was very much interested in visiting the Zewail City and the prospect of meeting Ahmed Zewail himself.

In 2013 when I first visited Zewail City, the institute was already in operation, although not fully, with Zewail as the Chair. I was greeted by the beautiful blue glass façade of the Administration building, and inside were modern labs with new equipment.



Fig. 9.3 The author (sixth from right) with Vice Chair Prof. Salah Obayya, Prof. El-Nadi and members of ZCST after seminar in 2016.

Most of the scientists were of Egyptian origin, who have successfully established themselves abroad. Faculty members whom I met came from the US, Canada, the UK, Italy, Germany, etc., who all have quit their jobs in their respective countries to respond to Ahmed Zewail's invitation to join the ZCST. There was even one nanotechnology specialist, who came from US and joined the ZCST with a huge grant from the US.

In the following week, I gave a seminar on my project on solar opacity and abundances. I noticed there were a few astronomers in the seminar. I donated some astronomy textbooks that were being used in US universities to the introductory courses on astronomy at the ZCST. Unfortunately, during my visit, I was not able to meet Zewail as he was traveling back and forth between Caltech and the City. His travel schedule could not be made known for security reasons.

However, I had the pleasure of seeing his grand effort, the dedication and enthusiasm going around on inside of the Zewail City. I wrote about my experience in a news article published by the American Physical Society (APS). The Zewail City of Science and Technology now has three sectors: the university, research institutes, and a technology park. The research institute sector has a number of centers: Aging and Associated Diseases, Excellence for Stem Cells Research and Regenerative Medicine, Genomics, Nanotechnology, Nanoelectronics and Devices, Materials Science, Imaging and Microscopy, X-Ray Determination of the Structure of Matter, Fundamental Physics, Photonics and Smart Materials, Economics and Development, Learning Technologies, etc.

9.3 Missed Meeting Zewail at ZCST Again

In 2015, I visited the ZCST again, this time to give a seminar on X-ray spectroscopy for effective cancer treatment. I missed meeting Zewail again, but instead met the person-in-charge, Vice Chair Prof. Salah Obayya, who oversees the daily business at ZCST. He was appointed by Zewail. Prof Salah Obayya is a very dedicated physicist, who left his position in England to join the ZCST. He had made considerable contributions in photo-electronics and was the author of two elaborate textbooks. Zewail City had already incorporated its university component then.

However, in 2013, a legal tussle over the ZCST land almost derailed Ahmed Zewail's dream. The Supreme Administrative Court ruled in favor of Nile University, affirming the institution's ownership rights to the lands and buildings. The name, Zewail City of Science and Technology, was no longer on the beautiful blue façade of the Administration building. It was a big blow after years of extensive and thoughtful efforts in working towards the renaissance of science and technology in Egypt. The Egyptian Government came forward by giving ZCST a new and larger piece of land in 6 October City and promised to speed up construction of the institute under the army's supervision. During that period, ZCST had to run its operation at the buildings at

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the back of its previous premise until it was able to move to its new buildings after construction was completed. Zewail was already familiar with administration and global politics on education. He had served as Science and Technology advisor to the US President Barrack Obama and was his appointed US Science Envoy to the Middle East.

9.4 Zewail Honored by the Symbolic Plaque of Aligarh Muslim University of India March 2016

OSU was a sponsor and partner of the IV International Conference on Nanoscience and Nanotechnology (Aligarh Nano-IV) in 2014, organized by Aligarh Muslim University (AMU) in India. I was the convener from OSU. The chief convener, Professor Alim Naqvi, the founder of the Nanotechnology Center at AMU, asked whether we could bring someone prominent in the field as a highlight of the conference. I remembered talking to an Egyptian academic, who suggested Prof. Ahmed Zewail. Based on that suggestion, I invited Prof. Zewail to Aligarh Nano-IV conference. Zewail could not attend, but he sent a welcoming message to the conference participants that I read it at the inauguration ceremony. His message was the highlight of the conference. I invited him again in 2016 for Aligarh Nano-V, organized jointly with the STEM Education and Research of OSU, and held at AMU in India. He was not able to attend, but sent the following message:

“... advances in nanoscience and nanotechnology are increasingly impacting our lives and society. I am pleased that Aligarh Muslim University is now playing a significant role in India with its inventions in nanomaterials and nanoscience. I am also pleased that Ohio State University is involved in the STEM program for teaching and research in Indian universities ...”

The press found it interesting and highlighted it in the media.

A large plaque with Stretchy Hall as the background, a symbol of AMU, was given to him in honor after I read his message in the inauguration session. I felt proud to accept it on behalf of Zewail.



Fig. 9.4 Left: The message of Prof. Ahmed Zewail was highlighted at the Aligarh Nano-IV international conference on nanotechnology in India in 2014. Right: He was honored by the symbolic plaque of Aligarh Muslim University of India at the aforesaid conference, which was held jointly with the International Conference on STEM Education and Research of OSU-AMU in March 2016. Sultana Nahar, see here, accepting the plaque on behalf of Zewail.

In early August of 2016, Prof. Naqvi and a faculty friend at Basra University sent me a sad message separately to inform me on the passing of Prof. Ahmed Zewail. A few months after his passing, I visited ZCST and felt a huge vacuum left after his passing and made worse by the downfall of the Egyptian economy at that time. However, when I gave a seminar on the spectroscopy of exoplanets to enthusiastic group of scientists and students, at that moment, I felt his spirit was still there.

9.5 Visiting Zewail's Final Resting Place

Laboratories were continuing with their experiments and students were engaged in discussions and activities the way Zewail would like them to be. Vice Chair Salah Obayya was steering ZCST in the right direction. They had found a leader who could maintain ZCST's economic flow by bringing in grants for the research, education and innovation. On the way back, Professor El-Nadi and I stopped by the tomb of Prof. Ahmed Zewail. He chose to be buried in Egypt and built a tomb for himself

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Fig. 9.5 Ahmed Zewail's tomb.

not far from ZCST. It is roofless, but even with walls surrounding the structure, it can easily be seen through the iron fence. There is an open squared pavement space outside the wall where people can offer their prayer. Both Prof. El-Nadi and I offered our prayers before leaving. This place will remain a landmark for others to come to pay respect and offer prayers for his soul. Zewail was courageous in soldiering on towards achieving his goals. Even after he was diagnosed with cancer, he continued his work at Caltech and at the same time as Chair of the ZCST. To honor his effort, there is a plan to build a university near his birth place. His legacy will continue to inspire and contribute towards the benefit of humanity.