

Autobiography

On the banks of the Nile, the Rosetta branch, I lived an enjoyable childhood in the City of Disuq, which is the home of the famous mosque, Sidi Ibrahim. I was born (February 26, 1946) in nearby Damanhur, the "City of Horus", only 60 km from Alexandria. In retrospect, it is remarkable that my childhood origins were flanked by two great places - Rosetta, the city where the famous Stone was discovered, and Alexandria, the home of ancient learning. The dawn of my memory begins with my days, at Disuq's preparatory school. I am the only son in a family of three sisters and two loving parents. My father was liked and respected by the city community - he was helpful, cheerful and very much enjoyed his life. He worked for the government and also had his own business. My mother, a good-natured, contented person, devoted all her life to her children and, in particular, to me. She was central to my "walks of life" with her kindness, total devotion and native intelligence. Although our immediate family is small, the Zewails are well known in Damanhur.

The family's dream was to see me receive a high degree abroad and to return to become a university professor - on the door to my study room, a sign was placed reading, "Dr. Ahmed," even though I was still far from becoming a doctor. My father did live to see that day, but a dear uncle did not. Uncle Rizk was special in my boyhood years and I learned much from him - an appreciation for critical analyses, an enjoyment of music, and of intermingling with the masses and intellectuals alike; he was respected for his wisdom, financially well-to-do, and self-educated. Culturally, my interests were focused - *reading, music, some sports and playing backgammon*. The great singer Um Kulthum (actually named Kawkab Elsharq - a superstar of the East) had a major influence on my appreciation of music. On the first Thursday of each month we listened to Um Kulthum's concert - "waslats" (three songs) - for more than three hours. During all of my study years in Egypt, the music of this unique figure gave me a special happiness, and her voice was often in the background while I was studying mathematics, chemistry... etc. After three decades I still have the same feeling and passion for her music. In America, the only music I have been able to appreciate on this level is classical, and some jazz. Reading was and still is my real joy.

As a boy it was clear that my inclinations were toward the physical sciences. Mathematics, mechanics, and chemistry were among the fields that gave me a special satisfaction. Social sciences were not as attractive because in those days much emphasis was placed on memorization of subjects, names and the like, and for reasons unknown (to me), my mind kept asking "how" and "why". This characteristic has persisted from the beginning of my life. In my teens, I recall feeling a thrill when I solved a difficult problem in mechanics, for instance, considering all of the tricky operational forces of a car going uphill or downhill. Even though chemistry required some memorization, I was intrigued by the "mathematics of chemistry". It provides laboratory phenomena which, as a boy, I wanted to reproduce and understand. In my bedroom I constructed a small apparatus, out of my mother's oil burner (for making Arabic coffee) and a few glass tubes, in order to see how wood is transformed into a burning gas and a liquid substance. I still remember this vividly, not only for the science, but also for the danger of burning down our house! It is not clear why I developed this attraction to science at such an early stage.

After finishing high school, I applied to universities. In Egypt, you send your application to a central Bureau (Maktab El Tansiq), and according to your grades, you are assigned a university,

hopefully on your list of choice. In the sixties, Engineering, Medicine, Pharmacy, and Science were tops. I was admitted to Alexandria University and to the faculty of science. Here, luck played a crucial role because I had little to do with Maktab El Tansiq's decision, which gave me the career I still love most: science. At the time, I did not know the depth of this feeling, and, if accepted to another faculty, I probably would not have insisted on the faculty of science. But this passion for science became evident on the first day I went to the campus in Maharem Bek with my uncle - I had tears in my eyes as I felt the greatness of the university and the sacredness of its atmosphere. My grades throughout the next four years reflected this special passion. In the first year, I took four courses, mathematics, physics, chemistry, and geology, and my grades were either excellent or very good. Similarly, in the second year I scored very highly (excellent) in Chemistry and was chosen for a group of seven students (called "special chemistry"), an elite science group. I graduated with the highest honors - "Distinction with First Class Honor" - with above 90% in all areas of chemistry. With these scores, I was awarded, as a student, a stipend every month of approximately £13, which was close to that of a university graduate who made £17 at the time!

After graduating with the degree of Bachelor of Science, I was appointed to a University position as a demonstrator ("Moeid"), to carry on research toward a Masters and then a Ph.D. degree, and to teach undergraduates at the University of Alexandria. This was a tenured position, guaranteeing a faculty appointment at the University. In teaching, I was successful to the point that, although not yet a professor, I gave "professorial lectures" to help students after the Professor had given his lecture. Through this experience I discovered an affinity and enjoyment of explaining science and natural phenomena in the clearest and simplest way. The students (500 or more) enriched this sense with the appreciation they expressed. At the age of 21, as a Moeid, I believed that behind every universal phenomenon there must be beauty and simplicity in its description. This belief remains true today.

On the research side, I finished the requirements for a Masters in Science in about eight months. The tool was spectroscopy, and I was excited about developing an understanding of how and why the spectra of certain molecules change with solvents. This is an old subject, but to me it involved a new level of understanding that was quite modern in our department. My research advisors were three: The head of the inorganic section, Professor Tahany Salem and Professors Rafaat Issa and Samir El Ezaby, with whom I worked most closely; they suggested the research problem to me, and this research resulted in several publications. I was ready to think about my Ph.D. research (called "research point") after one year of being a Moeid. Professors El Ezaby (a graduate of Utah) and Yehia El Tantawy (a graduate of Penn) encouraged me to go abroad to complete my Ph.D. work. All the odds were against my going to America. First, I did not have the connections abroad. Second, the 1967 war had just ended and American stocks in Egypt were at their lowest value, so study missions were only sent to the USSR or Eastern European countries. I had to obtain a scholarship directly from an American University. After corresponding with a dozen universities, the University of Pennsylvania and a few others offered me scholarships, providing the tuition and paying a monthly stipend (some \$300). There were still further obstacles against travel to America ("Safer to America"). It took enormous energy to pass the regulatory and bureaucratic barriers.

Arriving in the States, I had the feeling of being thrown into an ocean. The ocean was full of knowledge, culture, and opportunities, and the choice was clear: I could either learn to swim or sink. The culture was foreign, the language was difficult, but my hopes were high. I did not speak or write

English fluently, and I did not know much about western culture in general, or American culture in particular. I remember a "cultural incident" that opened my eyes to the new traditions I was experiencing right after settling in Philadelphia. In Egypt, as boys, we used to kid each other by saying "I'll kill you", and good friends often said such phrases jokingly. I became friends with a sympathetic American graduate student, and, at one point, jokingly said "I'll kill you". I immediately noticed his reserve and coolness, perhaps worrying that a fellow from the Middle East might actually do it!

My presence - as the Egyptian at Penn - was starting to be felt by the professors and students as my scores were high, and I also began a successful course of research. I owe much to my research advisor, Professor Robin Hochstrasser, who was, and still is, a committed scientist and educator. The diverse research problems I worked on, and the collaborations with many able scientists, were both enjoyable and profitable. My publication list was increasing, but just as importantly, I was learning new things literally every day - in chemistry, in physics and in other fields. The atmosphere at the Laboratory for Research on the Structure of Matter (LRSM) was most stimulating and I was enthusiastic about researching in areas that crossed the disciplines of physics and chemistry (sometimes too enthusiastic!). My courses were enjoyable too; I still recall the series 501, 502, 503 and the physics courses I took with the Nobel Laureate, Bob Schrieffer. I was working almost "day and night," and doing several projects at the same time: The Stark effect of simple molecules; the Zeeman effect of solids like NO_2^- and benzene; the optical detection of magnetic resonance (ODMR); double resonance techniques, etc. Now, thinking about it, I cannot imagine doing all of this again, but of course then I was "young and innocent".

The research for my Ph.D. and the requirements for a degree were essentially completed by 1973, when another war erupted in the Middle East. I had strong feelings about returning to Egypt to be a University Professor, even though at the beginning of my years in America my memories of the frustrating bureaucracy encountered at the time of my departure were still vivid. With time, things change, and I recollected all the wonderful years of my childhood and the opportunities Egypt had provided to me. Returning was important to me, but I also knew that Egypt would not be able to provide the scientific atmosphere I had enjoyed in the U.S. A few more years in America would give me and my family two opportunities: First, I could think about another area of research in a different place (while learning to be professorial!). Second, my salary would be higher than that of a graduate student, and we could then buy a big American car that would be so impressive for the new Professor at Alexandria University! I applied for five positions, three in the U.S., one in Germany and one in Holland, and all of them with world-renowned professors. I received five offers and decided on Berkeley.

Early in 1974 we went to Berkeley, excited by the new opportunities. Culturally, moving from Philadelphia to Berkeley was almost as much of a shock as the transition from Alexandria to Philadelphia - Berkeley was a new world! I saw Telegraph Avenue for the first time, and this was sufficient to indicate the difference. I also met many graduate students whose language and behavior I had never seen before, neither in Alexandria, nor in Philadelphia. I interacted well with essentially everybody, and in some cases I guided some graduate students. But I also learned from members of the group. The obstacles did not seem as high as they had when I came to the University of Pennsylvania because culturally and scientifically I was better equipped. Berkeley was a great place for science - the BIG science. In the laboratory, my aim was to utilize the expertise I had gained from my Ph.D. work on

the spectroscopy of pairs of molecules, called dimers, and to measure their coherence with the new tools available at Berkeley. Professor Charles Harris was traveling to Holland for an extensive stay, but when he returned to Berkeley we enjoyed discussing science at late hours! His ideas were broad and numerous, and in some cases went beyond the scientific language I was familiar with. Nevertheless, my general direction was established. I immediately saw the importance of the concept of coherence. I decided to tackle the problem, and, in a rather short time, acquired a rigorous theoretical foundation which was new to me. I believe that this transition proved vital in subsequent years of my research.

I wrote two papers with Charles, one theoretical and the other experimental. They were published in *Physical Review*. These papers were followed by other work, and I extended the concept of coherence to multidimensional systems, publishing my first independently authored paper while at Berkeley. In collaboration with other graduate students, I also published papers on energy transfer in solids. I enjoyed my interactions with the students and professors, and at Berkeley's popular and well-attended physical chemistry seminars. Charles decided to offer me the IBM Fellowship that was only given to a few in the department. He strongly felt that I should get a job at one of the top universities in America, or at least have the experience of going to the interviews; I am grateful for his belief in me. I only applied to a few places and thought I had no chance at these top universities. During the process, I contacted Egypt, and I also considered the American University in Beirut (AUB). Although I visited some places, nothing was finalized, and I was preparing myself for the return. Meanwhile, I was busy and excited about the new research I was doing. Charles decided to build a picosecond laser, and two of us in the group were involved in this hard and "non-profitable" direction of research (!); I learned a great deal about the principles of lasers and their physics.

During this period, many of the top universities announced new positions, and Charles asked me to apply. I decided to send applications to nearly a dozen places and, at the end, after interviews and enjoyable visits, I was offered an Assistant Professorship at many, including Harvard, Caltech, Chicago, Rice, and Northwestern. My interview at Caltech had gone well, despite the experience of an exhausting two days, visiting each half hour with a different faculty member in chemistry and chemical engineering. The visit was exciting, surprising and memorable. The talks went well and I even received some undeserved praise for style. At one point, I was speaking about what is known as the FVH, picture of coherence, where F stands for Feynman, the famous Caltech physicist and Nobel Laureate. I went to the board to write the name and all of a sudden I was stuck on the spelling. Half way through, I turned to the audience and said, "you know how to spell Feynman". A big laugh erupted, and the audience thought I was joking - I wasn't! After receiving several offers, the time had come to make up my mind, but I had not yet heard from Caltech. I called the Head of the Search Committee, now a colleague of mine, and he was lukewarm, encouraging me to accept other offers. However, shortly after this, I was contacted by Caltech with a very attractive offer, asking me to visit with my family. We received the red carpet treatment, and that visit did cost Caltech! I never regretted the decision of accepting the Caltech offer.

My science family came from all over the world, and members were of varied backgrounds, cultures, and abilities. The diversity in this "small world" I worked in daily provided the most stimulating environment, with many challenges and much optimism. Over the years, my research group has had close to 150 graduate students, postdoctoral fellows, and visiting associates. Many of them are now in leading academic, industrial and governmental positions. Working with such minds in a village

of science has been the most rewarding experience - Caltech was the right place for me.

My biological children were all "made in America". I have two daughters, Maha, a Ph.D. student at the University of Texas, Austin, and Amani, a junior at Berkeley, both of whom I am very proud. I met Dema, my wife, by a surprising chance, a fairy tale. In 1988 it was announced that I was a winner of the King Faisal International Prize. In March of 1989, I went to receive the award from Saudi Arabia, and there I met Dema; her father was receiving the same prize in literature. We met in March, got engaged in July and married in September, all of the same year, 1989. Dema has her M.D. from Damascus University, and completed a Master's degree in Public Health at UCLA. We have two young sons, Nabeel and Hani, and both bring joy and excitement to our life. Dema is a wonderful mother, and is my friend and confidante.

The journey from Egypt to America has been full of surprises. As a Moeid, I was unaware of the Nobel Prize in the way I now see its impact in the West. We used to gather around the TV or read in the newspaper about the recognition of famous Egyptian scientists and writers by the President, and these moments gave me and my friends a real thrill - maybe one day we would be in this position ourselves for achievements in science or literature. Some decades later, when President Mubarak bestowed on me the Order of Merit, first class, and the Grand Collar of the Nile ("Kiladate El Niel"), the highest State honor, it brought these emotional boyhood days back to my memory. I never expected that my portrait, next to the pyramids, would be on a postage stamp or that the school I went to as a boy and the road to Rosetta would be named after me. Certainly, as a youngster in love with science, I had no dreams about the honor of the Nobel Prize.

Since my arrival at Caltech in 1976, our contributions have been recognized by countries around the world. Among the awards and honors are:

Special Honors

King Faisal International Prize in Science (1989).

First Linus Pauling Chair, Caltech (1990).

Wolf Prize in Chemistry (1993).

Order of Merit, first class (Sciences & Arts), from President Mubarak (1995).

Robert A. Welch Award in Chemistry (1997).

Benjamin Franklin Medal, Franklin Institute, USA (1998).

Egypt Postage Stamps, with Portrait (1998); the Fourth Pyramid (1999).

Nobel Prize in Chemistry (1999).

Grand Collar of the Nile, Highest State Honor, conferred by President Mubarak (1999).

Prizes and Awards

Alfred P. Sloan Foundation Fellow (1978-1982).

Camille and Henry Dreyfus Teacher-Scholar Award (1979-1985).

Alexander von Humboldt Award for Senior United States Scientists (1983).

National Science Foundation Award for especially creative research (1984; 1988; 1993).

Buck-Whitney Medal, American Chemical Society (1985).

John Simon Guggenheim Memorial Foundation Fellow (1987).

Harrison Howe Award, American Chemical Society (1989).

Carl Zeiss International Award, Germany (1992).

Earle K. Plyler Prize, American Physical Society (1993).

Medal of the Royal Netherlands Academy of Arts and Sciences, Holland (1993).

Bonner Chemiepreis, Germany (1994).

Herbert P. Broida Prize, American Physical Society (1995).

Leonardo Da Vinci Award of Excellence, France (1995).

Collège de France Medal, France (1995).

Peter Debye Award, American Chemical Society (1996).

National Academy of Sciences Award, Chemical Sciences, USA (1996).

J.G. Kirkwood Medal, Yale University (1996).

Peking University Medal, PU President, Beijing, China (1996).

Pittsburgh Spectroscopy Award (1997).

First E.B. Wilson Award, American Chemical Society (1997).

Linus Pauling Medal Award (1997).

Richard C. Tolman Medal Award (1998).

William H. Nichols Medal Award (1998).

Paul Karrer Gold Medal, University of Zürich, Switzerland (1998).

E.O. Lawrence Award, U.S. Government (1998).

Merski Award, University of Nebraska (1999).

Röntgen Prize, (100th Anniversary of the Discovery of X-rays), Germany (1999).

Academies and Societies

American Physical Society, Fellow (elected 1982).

National Academy of Sciences, USA (elected 1989).

Third World Academy of Sciences, Italy (elected 1989).

Sigma Xi Society, USA (elected 1992).

American Academy of Arts and Sciences (elected 1993).

Académie Européenne des Sciences, des Arts et des Lettres, France (elected 1994).

American Philosophical Society (elected 1998).

Pontifical Academy of Sciences (elected 1999).

American Academy of Achievement (elected 1999).

Royal Danish Academy of Sciences and Letters (elected 2000)

Honorary Degrees

Oxford University, UK (1991): M.A., h.c.

American University, Cairo, Egypt (1993): D.Sc., h.c.

Katholieke Universiteit, Leuven, Belgium (1997): D.Sc., h.c.

University of Pennsylvania, USA (1997): D.Sc., h.c.

Université de Lausanne, Switzerland (1997): D.Sc., h.c.

Swinburne University, Australia (1999): D.U., h.c.

Arab Academy for Science & Technology, Egypt (1999): H.D.A.Sc.

Alexandria University, Egypt (1999): H.D.Sc.

University of New Brunswick, Canada (2000): Doctoris in Scientia, D.Sc., h.c.

Università di Roma "La Sapienza", Italy (2000): D.Sc., h.c.

Université de Liège, Belgium (2000): Doctor *honoris causa*, D., h.c.

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For more updated biographical information, see: Zewail, Ahmed, *Voyage through Time. Walks of Life to the Nobel Prize*. American University in Cairo Press, Cairo, 2002.

An up-to-date CV is available from http://zewail.caltech.edu/biography/Zewail_CV.pdf