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## Hum Kohn Hai

### The Inspiring Story of Walter Kohn, The Nice Guy Who Won a Nobel

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July 19, 2009, is a date I will remember. It was the first day of a summer school on density functional theory that I was organizing at the University of California, Santa Barbara. I was seated at a table at the opening reception, together with my graduate students Kanchan Ulman and Sananda Biswas, who were participants in the school. As we were marveling at the slightly unreal perfection of Southern California – gorgeous weather, smiling beautiful people who seemed to have walked straight off the sets of *Baywatch*, super-sized food that somehow looked too good to eat – an elderly man wearing a beret came up to our table and asked, a little shyly, if he could join us. “Hello,” he said, in a voice that bore traces of a Germanic accent. “My name is Walter Kohn. What is *your* name?”

Of course, as practitioners of density functional theory, all three of us had recognized Walter Kohn, the Nobel-Prize-winning founder of our field, as soon as we had a glimpse of him. He really had no need to introduce himself to us! Nevertheless, we were charmed by the fact that he chose to do so, and continued to be charmed over the course of the ensuing conversation that ranged from the etymology of Indian surnames (he seemed convinced that Kanchan must have had a Swedish or German ancestor that everyone had forgotten about!) to gossip about scientists and scientific institutions in India.

As Kohn chatted with us, my thoughts flashed back to an article I had read in *The New York Times* twenty years ago, when I was myself a graduate student. The article’s title had stuck in my mind, as it stated bluntly: “Nice guys don’t win Nobel Prizes”. In the intervening two decades, I had been lucky enough to have several opportunities to gauge the validity of this statement through personal interactions. I won’t say what conclusions I drew from these encounters; however, I can state that it was only after this meeting with Kohn that I felt completely reassured that yes, nice guys DO win Nobels!

Walter Kohn’s life story serves as an inspiring example of how one cannot just survive through adverse circumstances, but somehow make the best of them – and emerge with one’s niceness and humaneness, as well as sense of hope for the future of mankind, intact.

Walter Kohn was born in Vienna on March 9, 1923, into a Jewish family. As a young boy, Walter was more interested in learning Latin and Greek than science, though he accepted (“with resignation and without the least enthusiasm”) that he was destined to eventually take over the family business of producing high-quality artistic postcards. However, Walter’s life was to change drastically when the Nazis came to power in neighboring Germany. A few days after



Walter's 15th birthday, there occurred the 'Anschluss', whereby Germany annexed Austria; one immediate consequence for Walter was that he was expelled from his school, because of the Nazis' anti-Semitic policies. Indeed, all Jews were now at risk of losing not just their educational prospects, but their lives. At that time, Jewish organizations were organizing the 'Kindertransport' (German for 'children's transport'), a now-renowned rescue effort whereby about 10,000 predominantly Jewish children were sent by train and ship from mainland Europe to Great Britain, in order to protect them from Nazi atrocities. As a part of a Kindertransport, Walter, who was then a young teenager, was separated from his parents and taken to England; his older sister Minna had already been placed with a family there. Walter and Minna never saw their parents Salomon and Gittel Kohn again – their parents were sent by the Nazis to the notorious Theresienstadt and Auschwitz concentration camps, where they were exterminated.

Unfortunately, Walter's travails did not end there. A year later, Great Britain entered the Second World War against Germany. As a young man of Austrian origin, Walter was considered an 'enemy alien' and was imprisoned in a camp on the Isle of Man. The guards of this prison camp were not kind to the inmates, and Walter's experiences at this time were not happy ones. Things improved when he was later moved to an internment camp in Canada. Many intellectuals of German origin were imprisoned there, and in conversations and lessons with them, the young Walter began to get increasingly interested in science. They helped him study for his high school diploma, which he obtained while imprisoned in the camp. During a much later visit to India, Kohn described, how throughout his career, he had benefited from interactions with mathematicians, starting from his time in the Canadian prison camp. He especially mentioned the exiled Austrian mathematician Fritz Rothberger, who had taught him set theory, and the German-born mathematician Richard Brauer, with whom he was to later interact at the University of Toronto.

Though Kohn's interests had now shifted to science, he was unsure whether he wanted to focus on physics, mathematics or engineering. However, various mentors helped him realize that his true interest lay in physics. After a stint in the army and obtaining an undergraduate degree from the University of Toronto (which he completed in one-and-a-half years instead of the usual four years), Kohn went to Harvard University in the USA for a PhD in physics. Here is how Kohn described his feelings on entering Harvard: "I felt very insecure and set as my goal survival for at least one year." This should hopefully reassure young students that feeling intimidated and outclassed need not necessarily preclude later success in science. Kohn says that he initially told his professors that he had no interest in solid state physics (something that many young students tell me at the start of their graduate studies), but he seems to have become fascinated by it almost against his will, much to the benefit of the field. One funny story about Kohn and solid state physics I will quote verbatim from the autobiography he wrote at the time



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of winning the Nobel Prize: “As an ‘expert’ in solid state physics, I offered a few lectures on that subject. Wolfgang Pauli . . . when he learned of my meager knowledge of solids, mostly metallic sodium, asked me, true to form, if I was a professor of physics or of sodium.”

Young scientists will also be interested to hear that when, at the end of his time at Harvard, Kohn applied for several permanent academic jobs in Canada and the USA, he received no offers at all. He therefore went as a postdoc to Copenhagen, which of course attracted a stream of illustrious visitors at the time because of the presence there of Neils Bohr and his satellites.

After this, Kohn returned to the USA, where he held faculty positions first at Carnegie Tech and later at the University of California at San Diego, but he also spent a lot of time at Bell Labs, which was then (and continued to be for several decades) probably the world’s leading centre for research in both experimental and theoretical solid state physics.

Already in his time at Harvard, Kohn had applied variational principles (see the article in this issue – ‘A Tryst with Density’) to attack and solve various problems. This approach and train of thought was to culminate gloriously in the work he did in 1963 and 1964, when he was spending a sabbatical year at the Ecole Normale Superieure (ENS) in Paris. It was during this time that it occurred to Kohn that ‘density is enough’, *i.e.*, in order to determine the ground-state properties of a many-electron system, it suffices to know just its ground-state density. Importantly, one does not necessarily have to know the many-electron wavefunction. Kohn was able to prove this with his celebrated four-line proof; even to Kohn himself, this proof seemed so simple that at first, he did not trust it! He therefore consulted another visitor to ENS, the American physicist Pierre Hohenberg, who confirmed the finding. They then went on to prove their second theorem: that there exists a universal functional of the density that becomes a minimum at the correct ground-state density. Together, these two theorems constitute the famous 1964 Hohenberg–Kohn paper, and form the foundation for the field of density functional theory.

The next year, with his postdoc Lu Jeu Sham, Kohn went on to formulate the celebrated Kohn–Sham system of auxiliary one-electron equations whose solution yields a ground state density and energy that are equivalent to that obtained by solving the many-electron Schrödinger equation. They also suggested a practical method for solving these equations. This approach to tackling many-body problems completely revolutionized the field, and changed not just how solid state physics was carried out, but had (and continues to have) a significant impact on fields such as quantum chemistry, drug design, mineralogy, and metallurgy.

Walter Kohn continued to carry out research at the forefront of solid state physics. However, as he grew older, and his influence on the larger scientific community as well as spheres of government increased, Kohn also began to concern himself more deeply with the future of Earth and its people, and to campaign actively for causes that he felt would promote a better tomorrow.



Together with a fellow Chemistry Nobel laureate, Alan Heeger, he produced a documentary film called *The Power of the Sun*, which was intended to alert governments, funding agencies as well as the common people to the global energy crisis, and to spur them on to invest in solar power. Kohn believed that only solar power held the answer to Earth's energy needs. He was especially proud of the fact that the film's narration was provided by the British comedian John Cleese (famous for *Fawlty Towers* and *Monty Python's Flying Circus*). Well into his eighties, Kohn continued to travel the world showing his movie to audiences of students, scientists, and policy-makers. He would come to each showing carrying a stack of DVDs of the movie, which he would hand out to anyone who would promise to organize a screening of the movie to an audience of at least ten more viewers. He was also concerned about the implications of unchecked population growth on the future of humanity, and allied himself with efforts to address this problem.

Late in his career, Kohn moved to the University of California at Santa Barbara, where he was instrumental in setting up its famed Institute for Theoretical Physics (ITP, now known as the Kavli Institute). Well into his seventies and eighties, he could be spotted around the UCSB campus, sometimes whizzing by on roller-blades! The conversation he'd had with us about my student Kanchan Ulman's surname took on an especially poignant colouring when I later learnt that in memory of Jewish victims of the Holocaust, Kohn had helped organize a music concert by the Austrian composer Viktor Ullmann, who was killed in the gas chambers at the Auschwitz–Birkenau concentration camp; Ullmann had been imprisoned at Theresienstadt at the same time as Kohn's parents.

The building of the ITP at UCSB is named Kohn Hall after Walter Kohn. Two years ago, the Quantum Espresso Foundation (Quantum Espresso is one of the most popular density functional theory computer packages) and the Abdus Salam International Centre for Theoretical Physics in Trieste, Italy, decided to institute the 'Walter Kohn Prize' for quantum mechanical materials modeling. This prize is intended to be awarded biennially to young scientists from developing countries. Kohn was very pleased to learn that such a prize was being set up; sadly, he passed away before the first Kohn prize was awarded in 2017 to Yanming Ma. Walter Kohn breathed his last on April 19, 2016.

Kohn once said "Physics isn't what I do, it is what I am." It is therefore somewhat ironic that, in 1998, he received the Nobel Prize not in physics, but in chemistry. Of course, in the popular imagination, a Nobel Prize represents the culmination of a scientist's career, and there is no doubt that Kohn's Nobel Prize was richly deserved. However, he was already a legend before receiving the Nobel, and will remain a legend for years to come.



## Suggested Reading

- [1] W Kohn, *Walter Kohn: Biographical*, [http://www.nobelprize.org/nobel\\_prizes/chemistry/laureates/1998/kohn-bio.html](http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1998/kohn-bio.html)
- [2] A Zangwill, *The Education of Walter Kohn and the Creation of Density Functional Theory*, arXiv:1403.5164 [physics.hist-ph]
- [3] D J Scalapino and R Sugar, *Walter Kohn: 1923–2016*, *PNAS*, 113, 8883, 2016.
- [4] N Angier, *Nice Guys Don't Win Nobel Prizes*, *New York Times*, November 6, 1988.

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