



Nobel Voices Video History Project, 2000-2001

Interviewee: Walter Kohn
Interviewer: Neil Hollander
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HOLLANDER:

Could you state your name and briefly identify yourself and get started.

KOHN:

Yes, I'm Walter Kohn, and I'm an emeritus and research professor of physics at the University of California in Santa Barbara. I'm also, I should really add to this right away, I now have a double identity as a physicist and as a chemist, because after being a physicist for half a century, roughly, give or take a few years, the Nobel Foundation very kindly surprised me by giving me a Nobel Prize in chemistry.

HOLLANDER:

Did that confuse you a little bit?

KOHN:

Doesn't really confuse you. Makes my self-identity more complicated and more interesting.

HOLLANDER:

Are you continuing along the lines of chemistry now?

KOHN:

Well, you know, actually, I have been working in areas that clearly are physics, but I have mostly worked in areas that are sort of not so far from chemistry. So I'm working on things that some chemists would say are chemistry and some physicists would say are physics.

HOLLANDER:

Well, I'm going to take you back now quite a few years. We'd like to get an idea. I know you had a very sort of stressful beginning of life. Can you say something about

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how you eventually got going into science as a very young person, or when you started thinking about science?

KOHN:

Yes, okay. Well, actually, I didn't get into science as a very young person. I didn't seriously get into science, I would say, until I was about sixteen or seventeen. So that's maybe a little bit unusual, but there was nothing in my family background that would have suggested science. My father was an art publisher with a particular kind of specialty, but we don't need to go into that.

I was a pretty good student, but my mother sent me to a non-science high school, Latin and Greek, that type. My favorite subject was Latin. My least favorite subject was mathematics. So I have a somewhat unlikely beginning for somebody who ends up as a theoretical physicist and theoretical chemist.

HOLLANDER:

Where were you at this time?

KOHN:

I began my life and my schooling in Vienna, Austria, and I had a really happy childhood, even though the times were difficult. I was born in 1923, and there was, of course, the United States had the big depression starting in the late twenties. In Austria, which had been on the losing side of the First World War, the depression really started a little earlier and then went right through the so-called Anschluss, the occasion when Hitler marched into Austria.

So there were these economic difficulties, but I was a kind of happy personality. My family was moderately well off, and my father had to struggle quite a bit, but he managed.

HOLLANDER:

How did the transition happen that you were trained and started out in literature and that sort of thing? What is it that turned you on to science? Was it a person, was it a book, was it a place?

KOHN:

I would say it was two persons. So my family and I myself were Jewish, and so, of course, once the Anschluss took place in March 1939, the Anschluss being the unification of Germany and Austria, then everybody was subject to a lot of very explicit and shocking discriminations. So, for example, and it was, of course, not the worse thing that

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happened, I was thrown out of my school right away.

Then there was some reorganization, and some of the better students, and I, by some formula, was counted among the better students, had an opportunity to continue studying in high school, but we were all put into a completely segregated Jewish high school. It had only Jewish or half-Jewish, non-Aryan, one should say. One of my best friends, for example, was a Protestant, but he had some grandmother, Jewish grandmother, so he also was in that that school.

And the same for the teachers. The teachers were all teachers that could not or had been fired from their regular jobs because of the German race laws. And so I was temporarily put in one school, and then when the school year was over, I spent a whole year in another Jewish school like that, and there encountered two fantastic teachers.

It's a little interesting that ten years later or fifteen years later, I reading a book, and I discovered that one of those teachers, in fact, had been an assistant of Einstein's. So you know, he was well qualified, and, further, he was a wonderful person. It was really a kind of combination of my admiration for this man as a person and his deep knowledge of physics, and that started me off.

I do want to mention the other guy. First of all, I need to mention the name of this man, [Emil] Nohel, like Nobel almost. Replace the "B" with an "H," Nohel. And the other guy was a wonderful mathematics teacher, and his name was [Victor] Sabbath, like the Sabbath.

HOLLANDER:

Can you briefly describe their character?

KOHN:

Yes, I will be happy to describe their character, but maybe the first thing I should tell you is quite recently, six, seven years ago, in my little town in Santa Barbara, somebody asked me to write a little bit of contribution to the Fourth of July issue of the local newspaper, 500 words.

So I wrote about a few of my teachers, my quite unusual teachers. I wrote about Nohel, the physics teachers. It was published, and some people read it. Most people did not read it. About six weeks later, I get a letter from Israel, and I look at the sender, and it says Nohel. Impossible, really, it's impossible. I open it up, and it's from his son. This little contribution of mine, just a few hundred words, somehow made its way to Haifa, where he lived. So I've seen him many times now.

The father, I'm very sad to say, suffered the fate of so many. He was first taken to a moderately livable concentration camp, and then he was a widower. His sister was with

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him, and then his sister was taken to Auschwitz, and he insisted on going with her.

HOLLANDER:

The other inspiration for you, the other man, Sabbath?

KOHN:

Yes, the other man, yes, Sabbath was also a fantastic guy. The thing I remember about him is, while he was teaching us—and that was excellent and really inspiring. While he was doing that, he told us about a book he was reading. It was a new book, a scientific book written by a great French physicist, Debroi [phonetic], and it was called *Light and Matter*. So after every weekend, you know, he'd give us a book report about what he had read, and again, I was so, you know—not only was it very exciting what he told us, but I was also inspired by this man who under, you know, terrible circumstances, he also was murdered eventually. Nevertheless, he still had this enthusiasm that he felt he had to communicate to us.

HOLLANDER:

These people were your inspirations to go into science?

KOHN:

They were certainly my inspiration, my primary inspiration. No, I had many other inspiring people after that, but I mean, without them I probably would never have made that first turn in the direction of science.

HOLLANDER:

This was in Vienna?

KOHN:

It was in Vienna.

HOLLANDER:

Then you made your way to the States.

KOHN:

Well, that, again, a little complicated. My parents were able to send my sister and myself to England. My father had a very distant business relationship.

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[Taping interruption]

KOHN:

Well, of course, the circumstances under which we attended these special schools were extraordinary circumstances. For example, on one occasion, we started the regular school day, and we were told, well, unfortunately, our teacher of Latin had disappeared since the previous day. Of course, he was arrested and taken away. Well, there wasn't a different or substitute teacher available, and so that same Professor Nohel, whose field was physics, said, "Well, we don't have anybody to teach you Latin, so I'm going to do it. I haven't had any Latin for the last twenty years, but with a dictionary, I think I can do it." So, if I remember correctly, we read Virgil together, and in some way, you know, under such stressful conditions, in a way, you appreciate more what you learn, because you say to yourself, "Well, the whole thing may stop tomorrow, may be the end of it."

HOLLANDER:

You were talking about leaving via England, when we left off.

KOHN:

Yes, right. I was, of course, unbelievably lucky. It's a little bit a misnomer, because luck sort of sounds like just total happenstance. In some way it was, because I left on what I think was the last train of its kind from Vienna. These trains later were generically called the children's trains. There were some wonderful people in England, members of the government, very prominently Quakers, very prominently members of the Jewish community in England, who made a concerted effort to get out of Germany and Austria as many as possible young people whose future was obviously very threatened. It's not exactly clear how many they got out, but it was many tens of thousands. So I was on, as far as I know, the last train of its kind out of Vienna, because three weeks later the war started, broke out.

Then I mentioned earlier that my father had a business contact in England, and they turned out to be absolutely wonderful people. They took both my sister and myself into their home, and I felt that I, you know, was treated, particularly by the lady, like a member of her family.

My own intention at that point, in spite of my interest in science, was I felt I'd better do something where I could become really independent. I wanted to become a farmer. So it was arranged for me to go and work on a training farm where, presumably after some period, I would come out of there and be—not exactly an agricultural college. It was a training farm. But nevertheless, I learned, so I pulled carrots and looked after the piglets and I did all those things.

Well, then, in England, I, unfortunately, on that farm, I contracted what turned out to be

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meningitis, so I was very ill. Many of the drugs that we now have didn't exist, but sulfa drugs had just been invented. So I pulled through. It was touch and go. After that, I was very weak. Of course, as a young person, you don't really understand how that is. You're no longer ill, but just weak. In any case, going back to the farm was out of the question.

Then I was put into a very fine government school, studied there for a few months. Then again, fate struck. Well, the last time fate struck, it was very kind to me. I got the Nobel Prize. But that time it was very unkind to me. Two gentlemen from Scotland Yard appeared and said, "Well, you are a German national, and all German nationals, people who are in Britain with German passports, and if they are male and if they are a certain age," and at that point I had just turned seventeen, and so I was eligible—"are to be interned."

So I found myself interned, first in Britain for a couple months, and then in Canada. I was sent over to Canada as an internee, back into a camp, and that's another whole story. I don't know if you want to hear more about it or what.

HOLLANDER:

Well, if we have time. Let's move forward to the other time fate struck. Can you say something, then, about the Nobel Prize, receiving it, and how that changed you?

KOHN:

Okay, yes. All right, I will try to do that. So I'll work from the actual lightning stroke. So that was a phone call, and my colleagues in one form or another, my colleagues who are here all got such a phone call. In my case, because of the time difference, it arrived at five o'clock in the morning.

My wife picked up the phone. Her jaw literally dropped. [Laughs] She didn't say a thing. She just handed me the phone. Then I got the news from, I believe, a member of the staff of the Swedish Academy of Sciences, that I had been awarded, together with John Pople, the Nobel Prize in chemistry. So I said a few incoherent and not terribly original words. Then they said, "But wait a moment, there's somebody else who wants to talk to you," and that turned out to be Professor Rose, a Swedish theoretical chemist with whom I was slightly acquainted. He got on the phone and said, "Walter, I just want you not to misunderstand. You didn't get the Nobel Prize in physics. You got it in chemistry."

I said, "Okay, I understand that." [Laughs]

Then he said, "What do you think of it?"

I said, "Well, that, to me, makes it a lot more fun." I mean it's hard enough for a

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physicist to get the Nobel Prize in physics, but to get it in chemistry is even a little more unusual.

In any case, I do want to say that I think this sounds a little bit self-serving, and please don't take it as such, don't refer to me, but that a chemistry Nobel committee would say, "Here's a guy from another discipline, but what he did was very, very useful for us chemists. So, even though he is not a card-carrying chemist, even though he may not know much about bases and acids and so on, he did something important, and so we chemists are going to take this physicist and say we give him the Nobel Prize in chemistry." And that says something, I think, very positive about the scientific community, not to be so bound by conventions or by saying, "Oh, well, this is our turf, and we have to reward our own and not somebody from outside." But I felt very, very grateful and fortunate that I happened to be the recipient of that professional openness.

HOLLANDER:

Aside from that, can you say something about the significance of the Nobel Prize as a prize?

KOHN:

Yes. Okay, I will say something which I would have said to you a few years ago before I won the Nobel Prize. I think the Nobel Foundation has really been of tremendous value to all of science, because for two reasons. Number one, they've been extremely conscientious in the selections they've made. Of course, there are some cases that are particularly splendid, but if you talk to people you'll find very few, if any, cases where there is a feeling no such-and-such a person should never have been given the Nobel Prize. So they establish certain high standards, and that is a very good thing.

Secondly, they are truly totally international, and I think that's very important. I think the internationalism of science is not only essential for science itself, but it contributes more broadly to good relationships between well-meaning people.

Lastly, for myself, it is, of course, in the first place, an honor which in my case I will say I consider not that I don't understand that my work has been useful—I do—but on the other hand, you know, there are so many other people who could equally well have been chosen, so there is a certain amount of luck involved, and one needs to maintain some adequate degree of humility to understand that.

Lastly, it gives one, of course, responsibilities, because one is asked to do many things, but also opportunities. So I found my life quite a bit more hectic since that time, and also more rewarding.

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It may be hard to believe, but I am now fourteen years old, and I would like you to try to explain your Nobel-winning concept to me. I'm fourteen.

KOHN:

Okay. Okay, it's a challenge I obviously cannot meet, but I'll try to meet it. In any case, I don't know if you've heard that saying, and I think there's great truth in that, ascribed to Einstein, like many wise sayings, that any truly important progress in science, if a scientist truly understands it, the test is whether they can explain it to a ten-year-old. So you guys are fourteen and sixteen, so you're making it relatively easy for me. [Laughs]

Okay, what it is about? It deals solely—the technical expression for the area in which I've contributed is electronic structure of matter. All of matter, the bench I'm sitting on, the hand that's part of me, everything, the camera, is made of just two kinds of constituents, nuclei and electrons.

So, let's start with an atom. The simplest atom is the hydrogen atom. It has a very heavy center, which in the case of a hydrogen atom is a proton. Then it has a much lighter electron that is moving around the vicinity of this proton. If you take, now, a more complicated situation—the hydrogen atom is very simple and has been really almost fully understood since, well, it must be about over eighty years now. But the subsequent challenge was when you have a solid, even a tiny piece of solid, it has zillions of these electrons and nuclei. The nuclei are not so much of a problem, because they are heavy and they move so slowly that you can in good approximation just pretend they're stationary, they're sitting. But the electrons are swirling around through one another. You have these zillion of electrons interacting with each other, moving through each other. How are you going to make sense of this?

Well, I contributed something to that challenge, how to make sense of it, and the great contribution that has opened the way for almost all the work in this area, including my work, was made by somebody by the name of Freudinger, who, it so happens, went to the same high school in Austria as I did. So he established the so-called Freudinger Equation, and another great scientist said shortly afterwards that, "Well, in principle, that takes care of all of chemistry." Well, he also said, "Unfortunately, we can't do the calculation." So it's yes, in principle, if we could do the calculations, it would.

Well, I developed a kind of a new viewpoint, unexpected in a way, where I, in kind of a draconian change, instead of thinking about the zillions of particles, I just think of a cloud of the electrons. I've shown that it sounds incredible, but in a certain subtle sense it's true, a total understanding of just the distribution, the average distribution of electrons, is sufficient to offer you an insight into all of chemistry. So it was a reformulation coming at it, you know, at right angles. It is extracted out of the Freudinger Equation, but radically reformulated.

So the impact has been that whereas prior to our work theoretical analysis were limited to

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rather small systems, so we didn't have all the zillions of particles, we have no problem with zillions of particles, because we only look at the average distribution, so now with our approach, which is called density functional theories, everything is the density distribution of this electron cloud, with that method people are now calculating routinely systems that contain hundreds or even thousands of atoms. So it's opened up large new areas of chemistry.

HOLLANDER:

One more question. Last and final question. Can you just say something about the practical impacts of this that an ordinary citizen might know?

KOHN:

Yes. Well, you know, in ordinary life, we don't really encounter small systems consisting of just a few electrons. You normally encounter big systems containing zillions and zillions of electrons. So the impact is very broad. But specifically, for example, this approach is now extensively used by the pharmaceutical industry to design new drugs. It turns out you can now very often calculate the effect of, let's say, some modification drug and calculate it by this procedure much more quickly than you can study it in the lab. It's being used in medicine. It's being used extensively in material science. So if you're interested in electrical properties, optical properties, mechanical properties or materials, this is now the method of choice.

HOLLANDER:

One final question. Doctor, you've been in some very difficult situations in your life, quite obviously, life and death. And now you've studied the elements of life, the atom composition. I know it's a very nebulous sort of question, but what has it taught you about life?

KOHN:

Well, it's taught me that life is something very precious, and those of us who not only have been given the gift of life to begin with, being born into this world, but then have been given opportunities to pursue worthwhile goals, need to appreciate this, and among many other responsibilities, obligations, and so on that we have, I think we have the responsibility and obligation to see to it that other young people who are equipped to take advantage of opportunities are, in fact, given those opportunities.

HOLLANDER:

Thank you very much. Appreciate your time.

[End of interview]

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