



Nobel Voices Video History Project, 2000-2001

Interviewee: Claude Cohen-Tannoudji

Interviewer: Neil Hollander

Date: No Date

Repository: Archives Center, National Museum of American History

HOLLANDER:

Doctor, if you would please introduce yourself and tell us what you do.

COHEN-TANNOUDJI:

Yes. My name is Claude Cohen-Tannoudji. I am a physicist working in Paris. I am professor at the College de France and working at Ecole Normale. My work is dealing with the interaction between atoms and laser light. We use this interaction for controlling atomic motion and for cooling atoms to very low temperature. This is the general field where I am working. I have obtained the Nobel Prize in '97 with my two colleagues, William Phillips and Steven Chu, for the development of methods to cool and trap atoms with laser light.

HOLLANDER:

Doctor, why do we want to do this?

COHEN-TANNOUDJI:

You know, I have been working on light atom interaction for about forty years. My thesis supervisor was Alfred Kastler, and also Jean Vonsan [phonetic]. Alfred Kastler got the Nobel Prize in 1966 for his invention of particle pumping.

I've been always interested and fascinated by the interaction between matter and light. And what I've been interested in mostly is the possibility to use laser light for manipulating atoms for controlling their various degrees of freedom for polarizing them. And the field where I'm working now is using laser light. It changes momentum between atoms and photons for slowing down atoms and for putting them nearly at rest. You see what excites me, the possibility to manipulate matter with light.

HOLLANDER:

Doctor, why or when did you become interested in this? Does it go all the way back to Algeria?

COHEN-TANNOUDJI:

Yes. In fact, I was born in Algeria in 1933, and I did all my secondary school studies in Algeria. You know, at that time Algeria was part of France. It was a French colony. And when I left Algeria in 1953, the Algerian war had not yet started. So I spent my childhood in a very nice environment in a city which, in fact, escaped from the war. Because I can remember I was nine years old when the Americans landed in Algiers, so we were saved, our community was saved from the Nazi persecution at that time, fortunately.

Then I could do my studies in very good conditions. High school in Algiers was excellent level and I was admitted at the [unclear] in 1953 and then I left Algiers for Paris at that time. And then I entered Ecole Normale. Ecole Normale is a very nice institution which is multidisciplinary. We are mixed mathematicians, physicists, chemists, historians, philosophers, linguistics, which is very nice atmosphere. In fact, it is in this place that I follow lecture from the best teachers, you can imagine, in mathematics, physics, chemistry. And then I was attracted by physics and I decided to do physics at that time.

HOLLANDER:

Going back to look back into your past, look back into your childhood, really, perhaps, in Algeria, can you find a moment where suddenly you became interested in science? Why did you become a scientist and not a writer or a poet or something?

COHEN-TANNOUDJI:

You know, in fact, my parents gave me the taste for study, for learning. My father was a self-taught man. He was very concerned with education of his children. He was very interested in biblical and Talmudic text. So he gave me the feeling and the idea that the most important things in life is studying, learning and transmitting to others what one has [unclear]. So I had at home an atmosphere of learning, studying, and I had also the chance to have very good high school teachers, especially in mathematics and physics, and they gave me motivation for continuing in that direction. But, you know, in fact, I also had very good teachers in literature and humanity. In fact, I learn at school Latin and Greek. I have a very classical-type formation. I don't regret it. It's a very interesting combination.

HOLLANDER:

But is there one singular moment or book or person, something that you could say, "I walked into the room not knowing what I was going to do and I walked out and I was going to be a scientist"? Is there some—

COHEN-TANNOUDJI:

No. You know, in fact, in the beginning my parents were considering that I would do medical study, but in fact, at the end of my high school I had a very good mathematics

teacher, so I was very, very much attracted by mathematics, because I liked it, especially geometry.

Then when I entered the Ecole Normale, I followed the lecture of Alfred Kastler, and then he was presenting physics in a point of view with a lot of elegance and funny approach, and I was really attracted by this man and by his way of doing science, and this is what decided me to do physics. So I switched from mathematics to physics when I went to Ecole Normale.

HOLLANDER:

So it was Kastler really what—

COHEN-TANNOUDJI:

Is was really the influence of teachers.

HOLLANDER:

But it was Kastler who—

COHEN-TANNOUDJI:

Because, you know, he was explaining experiment in a poetic way, doing very crazy things, very elegant experiment. And this aspect of playing with atoms and with light, this is what decided me to do in this branch of science.

HOLLANDER:

Could you give us an example?

COHEN-TANNOUDJI:

You know, he was trying to polarize atoms and to make some sort of pumping, to take them from one level and like in a pump to put them in another level. And he was trying to give picture of what he was doing, and this is what attracted me.

Also after that, I followed lectures in quantum mechanics, and this also fascinated me, because it's a completely different way of approaching reality. You know, we are used to classical picture, and quantum mechanics is some sort of completely new view of the microscopic world.

Here also I had the chance to have very good teachers and I was really attracted by this discipline, trying to understand what is going on in the microscopic world—how can we establish picture of the mechanics which govern the atomic world. And in fact, trying to understand that, I was really led to deepen this program and then I entered the field more and more.

HOLLANDER:

Can you think of any particular anecdote with Kastler where he explained something in a humoristic or different or crazy way?

COHEN-TANNOUDJI:

You know, I found again in Kastler very similar attitudes of the one I found in my father. Kastler was considering himself always as a student. When I was student at the Ecole Normale, following mathematic lectures at the university I was always fascinated to see Kastler following also the lecture, because he wanted to learn more about mathematics. So I think this is a very important lesson I learned from him. We have always to learn something new.

I think that the research, I found that people who think that we could understand everything are terribly pretentious. We have always to learn something new, and any new discovery raises a lot of new problems which you have to study. And you have always to learn new language, new picture, new [unclear] and you have to do new experiments.

Perhaps this anecdote I'm telling you, I can't give you another one. When he retired at the age of seventy, he came to telling me that "I'm now a [unclear]. We are less and less [unclear] and have time to really start to learn seriously quantum mechanics, and I would be happy to discuss with you a lot of questions that I think is very good lesson for life."

HOLLANDER:

Do you try to teach in the same way that he did?

COHEN-TANNOUDJI:

Yes. Yes, exactly. I am trying to—you know, I am a professor at College de France, which is a very special institution in France. It's a place where anybody can come and follow the lecture. There is no registration. The lectures are free and open to all publics. We don't give any degree. So it's really completely free teaching and courses, and the only rule is that you have to give different topics, different lectures every year. That's extremely difficult, because you feel obliged to the people who have come just for learning something new, you feel obliged to teach them something new, something enticing. And that has been for me essential, because it's by trying to clarify a certain number of questions that I have been led to new ideas, and most of my experimental investigation and technical investigation has been inspired by this effort to teach something new every year. So I think that has been extremely pleasant for me.

HOLLANDER:

Where is this leading you now? Where are you going now with your ideas?

COHEN-TANNOUDJI:

Now, you know, we are trying in our lab to extend the work on cool atoms and to explore new states of matter which are called B₂. We are trying to imagine and to develop new experiment for investigating this problem.

HOLLANDER:

Has the Nobel Prize helped you in any way?

COHEN-TANNOUDJI:

Of course, it has given to my group, because, you know, in research your contribution is important, of course, but the most important part comes from your colleagues and especially from your young students and collaborators. That has been extremely important to receive such recognition, and everybody has been in my group extremely encouraged by this award.

But also it's a source of a lot of problems, a lot of commitment, a lot of travel. And I'm trying to keep, as much as I can, my time free for continuing doing research and teaching.

HOLLANDER:

What kind of problems has it brought you?

COHEN-TANNOUDJI:

You know, I am asked sometimes to write people, to give my advice on problem on which I'm not expert at all, so I refuse. You know, many people, especially in the press, believe that because you are Nobel Prize winner you are expert in everything. That's not true, of course. I have to resist to avoid taking position and giving advice on topics which I'm not expert, which I don't master. That's one of the main problems.

I receive a lot of mail, a lot of crazy people asking me, "Yes, I found a genial idea and would like to submit it to you," and things like that. And it's difficult to manage this time table for doing everything.

HOLLANDER:

Doctor, you're working a bit then with science and society in general. You've broadened your field into dealing with society in general.

COHEN-TANNOUDJI:

Yes. What I think should be done by scientists is scientists should make an effort to explain in simple terms what they are doing and what the importance of science for society. I think that is an important duty we have to explain clearly and in a way in which it can be understood by as many people as possible what we are doing and why it can be useful.

Also I think that, unfortunately, many people, especially in the large public, consider that science is bringing a lot of [unclear], pollution, and they become anti-scientist, and that's a bad evolution. I think we have to be careful to correct it and to show that science can bring a lot of improvement in our life, not only for medical life, but also for the environment and for everything. I think we should give examples of benefits which can be obtained from science, and we should explain why it's important to support basic science without asking the scientists to show specific problem. Because, you know, generally the government wants to give programs for guiding research, and I think that is a mistake. Important thing is to have good basic research with people of high quality, and then generally when you have a good science in a country, then afterward you find new application, which were unexpected at the beginning and which can be a bit fruitful for everybody.

HOLLANDER:

Do you think people really fully understand this?

COHEN-TANNOUDJI:

Unfortunately not, especially the politician. The politicians want to have— you know, they want to support some specific plan, you know, to get benefit during their term. But science is a long-term enterprise, and to build a group of good people, creative people, takes twenty years. And you cannot answer a question in four years. You have to make good science to teach good scientists to make a good team, and then afterwards you get the benefits of that formation.

I can give you a few examples. For example, when I was a young student, it was a time where the laser was discovered. This was the beginning of 1960. At that time most people were considering that lasers were a crazy idea of scientists in the laboratory, that they would never get out of the laboratory. But you know what happens now, the laser invaded our lives. They are used for eye surgery, for CD players, for communication, for any kind of application. They were completely unexpected at that time. I can assure you that most of the people, even the scientists, were considering that that will have no application.

Another example, transistors. It came from a lot of studies in the propagation of electron [unclear] conductors. It was a [unclear] at that time a very specific now field of study, which was completely useless. And now you know that without transistor we have no

computer, no solid state device, and it completely transformed. It would be impossible to really, as we live now, without this discovery.

Another example is the magnetic resonance imaging, [unclear] was a very important discipline of basic science and it was very fundamental physics. And now with the development of computers, the development of our ability to treat better [unclear] allows you to make an image of the body. In any hospital now you would like to have a magnetic resonance imaging device. It's certainly important for medicine.

So we could give many, many examples of that kind. I think we should explain to the public and to the politicians that the basic research of today will be the high tech of the generation in ten or twenty years from now. I think that's important.

HOLLANDER:

I can't help but ask you, what inventions or discoveries of today do you think will be the basis?

COHEN-TANNOUDJI:

This is a question we have. But the question we don't know—you know, science is progressing. We know the fields which are moving fast, where new ideas are coming. For example, the cold atoms, the laser cooling and trapping, which I mentioned before, is a field where a lot of new phenomenon are studied and new physical effects are discovered. So I think the field is ripe for having new really breakthrough [unclear] for application. Of course, that already a few application which can be considered, like atomic clocks. Our field with cold atoms is important for building new atomic clock which are about a hundred times more precise than all previous ones. So that's an example of application. Perhaps there will be some other application [unclear]like mentioned the name of atom laser, a device which for use beam of atomic [unclear] waves which are similar to what lasers are for light waves. That, perhaps, could have fascinating application. But really the real application, we don't know yet. Perhaps it will be not, but perhaps it will be very important. That's a game. You know, if there was a [unclear] application, we will do it, of course.

HOLLANDER:

What about something like super conductivity?

COHEN-TANNOUDJI:

That's the same thing for super conductivity. A few years ago there was discovery of the high TC, high temperature super conductor, and now it's clear that this will have application, but it's still in the development stage, and we have to wait a little more, I think, before getting a very useful device. But that's not my field, so I cannot really tell

exactly what will be going on.

HOLLANDER:

Doctor, apart from your studies as a physicist, are there other areas of interest? Do you still read literature?

COHEN-TANNOUDJI:

Yes, I like, of course, I like music. I don't play music myself, but I like to listen to music. I like to read, but also I have not very much time now for reading books. Unfortunately, I don't know enough sports.

HOLLANDER:

What was the last book you read?

COHEN-TANNOUDJI:

What?

HOLLANDER:

The last book you read.

COHEN-TANNOUDJI:

I like very much a story book of history on the French Revolution, on the last world war, and things like that.

HOLLANDER:

You read that for pleasure?

COHEN-TANNOUDJI:

Yes, that is pleasure.

HOLLANDER:

What kind of music do you like?

COHEN-TANNOUDJI:

Classical music. Schubert, Mozart. I'm not expert at all in modern music. I feel

completely non-expert for appreciating it.

HOLLANDER:

Going back for just a second to the Nobel Prize. Now, you, of course, have the power to make nominations yourself. Do you think the prize is given out justly to the right people?

COHEN-TANNOUDJI:

I think, you know, it's a very difficult enterprise, because your field of expertise is given and you don't know what is going on in all branches of physics. But I think that the Nobel Committee is doing a very serious job. I think many, many people in the world for different specialties. And I think, of course, you always find colleagues who could have obtained it, but it's difficult to do otherwise. It's only a limited number of prizes can be given.

I think, also, that science is a common enterprise. It's the result of combined effort from everywhere. And when a field is awarded by the Nobel Prize, it impacts the whole community which is awarded, because we have a lot of colleagues in United States, in Russia, in France, in England, there are many who have contributed to the [unclear] and who have been only three to be awarded. So I think we could have not done the work we have done without the contribution of this whole community. So it's difficult for me to judge now, to judge the work of the committee, but I think they are doing a very careful job and a very serious job.

HOLLANDER:

Did you expect to win a Nobel Prize?

COHEN-TANNOUDJI:

No. I knew that they were considering several fields which were developing, including laser cooling and trapping. But, frankly, it's very secret and I didn't know anything about it before receiving the phone call from [unclear].

HOLLANDER:

I'm sure you've been asked many times, but where were you and what happened when you—

COHEN-TANNOUDJI:

I was at home working, preparing one of my research [unclear], because when I want to prepare a lecture, quietly I stay at home one or two mornings for having no disturbance. About 12:30 I received a call from the phone, telling me that the Nobel Prize was

awarded to me and to Steven Chu and Bill Phillips. So it was a big emotion, of course.

HOLLANDER:

Then what did you do?

COHEN-TANNOUDJI:

Well, it was half past twelve. I tried to call my boy and my daughter, and they were probably at restaurant or the cafeteria. They are both biologists doing research, too. So I couldn't join them. So I tried to call one of two colleagues. And then I escaped, because the journalists came already at home, and I escaped to the lab. I did have time to change. I came with a sweater. And so I went immediately to the lab. And then all the afternoon I was at my interview by phone call. In fact, the Swedish ambassador came to the lab, and bringing a big flower bouquet, and I was very touched by this attention.

HOLLANDER:

The attention has not ceased, I imagine.

COHEN-TANNOUDJI:

What?

HOLLANDER:

The attention has not stopped?

COHEN-TANNOUDJI:

Yes.

HOLLANDER:

Are there any other questions I should have asked that I didn't?

COHEN-TANNOUDJI:

No, I think you asked the important question, how to support science and how to make science popular for a large audience, especially for young people. I think I am a little anxious by the fact that in many countries, many developed countries, the number of students in science is decreasing, and I think that shows the importance of explaining to young people the importance of science and the fact that science is not—and reasons, not a source of problem, that it's a source of improvement and source of progress for mankind.

Also, one of the big concern I think we should have in mind, is that I'm afraid that the gap between developed countries and developing countries increasing, has been increasing, the technology going very fast. It's progressing fast in the United States, Europe, Japan. And there are a lot of developing countries which have difficult time to develop similarly excellent centers. What I find depressing is that when they have good students, good researchers, very often they leave their country and go to United States. That's a brain drain.

I think it's a question which should be answered. How can we help developing country to build a good education system, a good university system to keep their elite and to develop their country and their science? Because I think it would be dangerous to have an enormous gap between some countries which can master very advanced technology, which can speak a new language, Internet, and so on, and highly advanced communication technology, and on the other hand, to have people which are dying with the problem of disease, AIDS, and things like what happened, unfortunately, in Africa. So I think that's a question we should have in mind seriously.

HOLLANDER:

In other words, you're saying you're a bit pessimistic about the future?

COHEN-TANNOUDJI:

I am. I am afraid that globalization as was the politic of getting benefits, making money, does not help humanity to grow in a harmonious way. You know, we had a roundtable here on the energy problem, and I think that probably the huge factor between the energy consumption in the United States or in France or in Germany and the energy consumption in Africa or in India, and so that's a problem we should try to answer.

I'm afraid that the main motives of the evolution of our society is profit, money. It's not really how to improve the mankind condition. And I think scientists have a responsibility in that. They should explain that science should benefit to everybody, not only to a few privileged nations.

HOLLANDER:

But how could we change this [unclear] society, as you call it, from one of—

COHEN-TANNOUDJI:

By education, I think. I don't see something else than education. You know, there's a tendency, when I was young, the high school teacher, the schoolteacher in the primary school, was considered as an important person in the village or in the city. It has a high prestige. And the prestige of this function has decreased considerably, and that, I think, is

bad. I think we should try to [unclear] and to give to the education and to the teaching, to the teachers at all levels, not only at the university level, but also at the primary school. This is important, because it is at the primary school and the secondary school that vocations are appearing. That should give importance to that respect of [unclear]. I think that the government should give priority to education and to help also developing country to develop education.

One of my colleagues, Nicoli Bromagen [phonetic], was saying that one of the main problem of mankind would be to control the birth rate and to [unclear] the total population to reach [unclear] values. But how can you make an efficient birth control without educating the people, and the woman in particular? I think that's a big effort to be done.

HOLLANDER:

One last question.

COHEN-TANNOUDJI:

Yes.

HOLLANDER:

What are you doing in this respect?

COHEN-TANNOUDJI:

Oh, a very modest thing, but you know I am—

[Tape interruption.]

HOLLANDER:

What are you doing in this respect?

COHEN-TANNOUDJI:

You know, in my field of expertise and possibility, I'm trying to participate to international collaboration with developing countries, like Brazil, like India, like M__, to go there to give lectures, to welcome researchers in my lab and to participate to summer school, to write books for education, for teaching. And of course, I don't try to keep the people in France. I think it's important they come back to their country. I think the worst thing is the brain drain.

I'm terribly depressed when I see India, which, for example, needs a lot of engineers,

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science experts, and many thousands of Indians are leaving their country to go to the United States. And I'm sure they will not come back, because when they have lived several years in the United States, they will not come back.

The same tragedy occurs now with Russia. All the intelligence here of Russia, whether it be high school, very bright schools in physics, all of them have left, because they can no longer live in Russia. They have no longer possibility to work. When a big nation like Russia has no intellectuals, no scientists, no engineers, no teachers, that can be extremely dangerous, because [unclear], a lot of weapons. I think we should keep that in mind.

HOLLANDER:

Thank you very much.

COHEN-TANNOUDJI:

Thank you.

[End of interview]