

An Interview with

EUGENE P. WIGNER

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Conducted by William Aspray

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Abstract

Wigner talks about his association with John von Neumann during their school years in Hungary. He discusses their graduate studies in Berlin and their appointments to Princeton in 1930. Wigner discusses von Neumann's contributions to the theory of quantum mechanics, Wigner's own work in this area, and von Neumann's interest in the application of theory to the atomic bomb project.

EUGENE P. WIGNER INTERVIEW

DATE: 12 May 1987

INTERVIEWER: William Aspray

LOCATION: Princeton, NJ

ASPRAY: This is an interview on the 12th of May, 1987 with Dr. Eugene Wigner in his office at Princeton University. Could I ask you first to talk about John von Neumann's early school education and whether there was any demonstration of mathematical promise at that age?

WIGNER: Yes, he did have a great promise of that. He went to the Lutheran High School in...

ASPRAY: ... in Budapest. I've been there, by the way, to visit.

WIGNER: Is that so?

ASPRAY: Yes.

WIGNER: Yes. No, it isn't a high school.

ASPRAY: No.

WIGNER: Yes. And that... Our mathematics teacher, Lazll Racz (?) noticed what gifts he had as a mathematician. And he gave him private classes -- a great many -- about three times a week. He refused any compensation for it even though Johnny's parents were quite wealthy. But he felt he did it for himself, and he was a wonderful teacher.

ASPRAY: What did he teach him in these private...?

WIGNER: Mathematics. Well, I think it probably started with mathematical geometry.

ASPRAY: Yes.

WIGNER: And that was very nice; and he learned well and was delighted. He remained very friendly towards his colleagues and even to me who was one year ahead of him in class, but about two and a half years behind him in mathematics.

ASPRAY: I see. This went on at what ages of his life?

WIGNER: It started, I think, when he was thirteen and ended, of course, when he was 18 when he graduated from high school.

ASPRAY: Was he also taking classes at the University while he was still in high school, or studying with the professors?

WIGNER: I don't think so, but I can't be absolutely sure. But he was very much taken care of by this Moratt (?) and other teachers who thought very highly of him and even liked him.

ASPRAY: I take it from the fact that you were at so many places together that you had a long and lasting friendship. So you knew him well in this early period also; is that right?

WIGNER: Not as well as my own classmates. We met sometimes. We took walks together. He liked to walk and explain things and teach me a little mathematics, a little history perhaps. And it was very nice. But these were walks. And I took many more walks with other friends who also were interested in conversations.

ASPRAY: Now, you both ended up in Zurich studying not long after that. Is that right?

WIGNER: I did not study in Zurich.

ASPRAY: Oh, you didn't study in Zurich; he did, though.

WIGNER: He did, yes.

ASPRAY: That's right. So the two of you were apart for some period of time.

WIGNER: Well, yes, we were apart for a period of time. Eventually, he came also to Berlin in Germany. And we studied there. And we often attended the same colloquium, although he rarely came to the physics colloquium.

ASPRAY: I see. So he only came occasionally, whereas you were there on a regular basis; is that right?

WIGNER: I tried to be there on a regular basis.

ASPRAY: He was there as a private docent?

WIGNER: Not in the beginning, of course. I think everybody has to study at least four years. And, of course, I was a little ahead of him, because I am a year older than he was. But we met occasionally. He liked to go to conferences, and celebrations. We met rather frequently.

ASPRAY: In Berlin, who were the scientific influences on him? Who did he take courses with, or talk to, or...?

WIGNER: He took courses with mathematics. And there was a very excellent, famous mathematician there. Do you know his name? He gave good classes and very interesting, and he was interested, and his classes were interesting; and Johnny enjoyed that. He studied at the University. I studied at the Institute of Technology. So we didn't meet that way. But the colloquium to which I went was at the University; and I sneaked away from the Institute of

Technology for those.

ASPRAY: I see. You said that von Neumann did come sometimes to the physics colloquium, though.

WIGNER: Yes, sometimes.

ASPRAY: What were his interests in physics at this time?

WIGNER: Well, you know there was a great deal of difficulty in theoretical physics. The quantum theory was not self consistent. It became self consistent much later. And it's not consistent with the general, or even the special relativity of theory even now. And at that time it was not really consistent with itself.

ASPRAY: Yes, I understand... I know about that. Did he know about the problems in quantum mechanics before he came to Berlin, or did he learn about it there?

WIGNER: I think he learned about it there, but I could not swear to it. I knew some of the problems. It was very evident that you don't know how to quantize things. And of course it was changed with a terrible revolution which postulates that the positions and velocities of the particles are not at one time definite. And, altogether, that the old classical mechanics does not apply to very small, light particles.

ASPRAY: Yes.

WIGNER: You know about that.

ASPRAY: Yes, I know about that. Could you describe to me how von Neumann got involved in his work in foundations of quantum mechanics, and what you see as being his contribution?

WIGNER: Well, you know those things are not so very clear. He formulated quantum mechanics when quantum mechanics, not quantum theory, was created, particularly by Schroedinger. It was evident that the old-fashioned scripture, of the state of the system is not varied. And Johnny worked on the question, "What happens if you make observations?" And his theory of observations, although it is not much advertised, and although it is not solely due to him it has a great deal of influence even in present day quantum mechanics instruction. I remember he postulated that every self-adjointed operator can be observed. And that was wonderful, and explained why you can't observe position and velocity, can't produce a state with a definite position and velocity, and so on. I remember that very much later (I think in 1933) I proved that not all self-adjointed operators can be observed. Only very few can be, yes -- and should be. I proved that the others can't be. And you know, I was a little worried about it, because I thought he would object to it. And the strange thing is that my article, which became quite well known later on was not accepted by the first journal to which I submitted. And I told this to Johnny and he said, "Yes, that's a very interesting theorem. Give it to us. We'll publish it in the *Annals of Mathematics*." And that impressed me very much. He realized that his theory had limitations. And he accepted that and was not angry at the proof. No, he was a very reasonable person in that way.

ASPRAY: Yes. What did the other people that were working in the quantum theory at that time, the big names, think of von Neumann's contribution?

WIGNER: Well, you know, I think they realized that this is very interesting mathematically... but I don't think they accepted it fully, and they didn't feel that's very relevant, and so on -- so that it was more disregarded than reasonable. And I think eventually it was slowly realized that it is a very important thing to formulate quantum mechanics definitely from ground up -- from basic principles up, and that we'll do a great deal of help. And in that way it did have eventually a great deal of influence. But originally it was said, "Yes, it's very interesting but I don't want to do it right now," was the general reaction.

ASPRAY: I see. I guess that von Neumann was seen by the physicists, really, as a mathematician rather than as a physicist. Is that correct?

WIGNER: I think so, yes. That was a mathematical theory -- the theory of self adjointed operators have characteristic values and characteristic vectors and so on.

ASPRAY: How would you evaluate von Neumann as a physicist. I mean, we always think of him as a mathematician, but he obviously knew some physics.

WIGNER: Oh, he knew a great deal of physics. I don't think his contributions were to basic physics (except for this one, which turned out to have been very important). I don't know of any other very basic contribution of his. He was not so much interested in small phenomena and special theories. It was very different in his contribution to nuclear weapons. There he contributed very down to earth things.

ASPRAY: Right. Can we hold off and come back to that question a little later in the discussion?

WIGNER: Good. Very good.

ASPRAY: Okay. There's a question I've wondered about for many years. I know that he got a degree in chemical engineering.

WIGNER: I got a degree n chemical...

ASPRAY: He did also. His degree from the Technische Hochschule in Zurich was in chemical engineering.

WIGNER: Yes. You are right.

ASPRAY: Was he ever interested in chemical engineering?

WIGNER: I don't know; I don't think so.

ASPRAY: I see. Do you have any idea why he might have taken a degree in that subject?

WIGNER: Well, it was easier to find a job in chemical engineering than in mathematics. But, of course, he was a very excellent mathematician. So he did find a job -- not one, but several.

ASPRAY: Did you ever see any evidence of his training in chemical engineering in your discussions with him about scientific matters?

WIGNER: Not really. We didn't discuss chemical engineering. Of course, I also was principally interested in theoretical physics. When I got my doctor's degree I returned to Budapest, to Hungary with _____, and worked as a chemical engineer for two years. But he didn't do anything of that sort.

ASPRAY: Do I recall correctly that you both came to Princeton at the same time?

WIGNER: Yes. We got invitations to Princeton at the same time. And it was, in fact, very amusing that the salary which they offered to me was so high that I thought, 'that's evidently a misprint,' But when I saw him I told him about it and he said he got the same cable, and he had the same salary. And it evidently was not a mistake.

ASPRAY: How did this happen? How did you both get invited at the same time? Do you know the circumstances?

WIGNER: Yes. The University here was advised by a very famous physicist in Holland -- who lived in Holland -- named Ehrenfest. And he had advised them to invite two people who knew each other, who are friends so they don't feel so strange in a new country and a new environment among a new language. So invite at least two of them simultaneously. He also advised them to invite Johnny von Neumann and me together. And that's what I did.

ASPRAY: Was there any question but that you would accept coming to Princeton?

WIGNER: Well, not really, because it was such a wonderful invitation. And it was for one term, you know.

ASPRAY: Just for one semester -- one term.

WIGNER: One semester, yes.

ASPRAY: I see. This was in 1930?

WIGNER: Yes, 1930, February it started. But I started to learn English in 1929 in October when I received the cable.

ASPRAY: I see.

WIGNER: He knew English better than I did at that time.

ASPRAY: What were your duties, if any, here at Princeton?

WIGNER: Well, we went to the colloquium. We gave talks in seminars and that kind of thing. We had contacts with people. And that was it essentially. They offered us a position for a longer period. I don't remember exactly what his position was. I had for five years half a year appointment in Princeton. So that I spent half a year in Berlin where I had another job, a job very much less exciting and very much less generously paid. But then I had five months in Princeton and five months in Germany, and two months I could spend with my parents in Hungary.

ASPRAY: I see. If I remember correctly, von Neumann was spending his whole academic year in Princeton by this time.

WIGNER: I did not remember it that way, but you may be right.

ASPRAY: How did you remember it. I would very much like to hear.

WIGNER: I think he also spent some time in Germany.

ASPRAY: I see -- splitting the year between Germany and Princeton.

WIGNER: It's not unreasonable when you are a stranger in a new country.

ASPRAY: And you had teaching duties at the University here?

WIGNER: Yes, yes; and he also was teaching, but I don't remember what. I taught quantum theory, of course.

ASPRAY: Yes. Do you recall who he was talking to, who were his closest scientific associates. Oswald Veblen was one and several others. He became very popular. I became very unpopular.

ASPRAY: I understand that he was also reasonably closely associated with H.P. Robertson.

WIGNER: Well, not so very closely. I don't know much about it. Robertson wanted the job, which I got finally, and he was very angry when eventually I was offered that job. And he left Princeton.

ASPRAY: I see. This is the Jones chair.

WIGNER: The Jones professorship.

ASPRAY: What can you tell me about how von Neumann's scientific interests changed after he came to Princeton?

WIGNER: I don't know whether he changed, really. He already had a theory of not bounded operators, self adjointed but not bounded operators. And that was very important. And he contributed thereby to quantum mechanics very much, because quantum mechanics was mainly based on non bounded operators. And it's still based on that. And he contributed to that quite significantly. He wrote a very ? ? can do. And his whole theory of measurement which he proposed, became very well known and very basic to quantum theory -- very basic. As I mentioned, it turned out that not every operator is measurable, but he thought originally that every self adjointed operator is measurable. And we didn't yet know how to do it, and of course, we still don't know. But that was it.

ASPRAY: The reason that I asked that question about changing interests is that while he was still primarily in Europe, he had been working in the area of mathematical foundations, logic, set theory; and there was no evidence of any research in that area after he came to the United States that I know of.

WIGNER: I don't know either, and I am not as familiar with his work on the basic foundation of mathematics as I could be.

ASPRAY: I asked Alonzo Church about this and he said that they never talked about these things because von Neumann had lost interest in the subject.

WIGNER: Is that true? That's very interesting. I did not know that. I never was really involved in basic problems of mathematics.

ASPRAY: After he'd been at the Institute for a few years, he turned his attention a great deal more to questions in applied mathematics.

WIGNER: Yes. And particularly to the nuclear explosions. And he contributed to that very much.

ASPRAY: I was wondering if you remembered his having interests in partial differential equations or in theory of shock waves, or anything like that early on?

WIGNER: I think he had some interest in shock waves. But that, also, I don't remember very well. And I really don't know.

ASPRAY: Let me make one other remark that might stimulate a comment. Garrett Birkhoff had told me that he thought it was the connection with Oswald Veblen that led von Neumann to become interested in shock waves, because in 1937 Aberdeen started up its scientific consultation program again and Veblen was the senior scientist for that, and immediately got von Neumann to become a scientific consultant. And it was there that he was brought in and asked questions about shock waves. Does that remind you of anything?

WIGNER: It should, but it does not. I must admit I knew that he was interested in shock waves, and that he knew much more about it than the speakers, than the present speaker. But I did not realize it, you know. Our scientific interests were quite different.

ASPRAY: Yes, I understand that.

WIGNER: And as a result, I knew... And since scientific interests bind somebody to his subjects, I was not so much interested in his contributions, although to the basic foundations of quantum mechanics, I was, of course, very much interested.

ASPRAY: Yes. We heard at this conference in Arizona on "The Computer and the Brain" about some of the Hungarians discovering some correspondence of the 1930s in which von Neumann and a number of other Hungarian scientists, some still in Hungary, some in the United States, had written to one another about questions about the brain and computing devices. Do you know anything about this?

WIGNER: No, not really. I knew that it existed, but I could not tell you who was his principal colleague in Hungary.

ASPRAY: Did you have conversations with him at all about questions of the brain and the computer, either then, or later on?

WIGNER: I think, then, principally, and I told him that I don't think that presently physics explains the existence of light, and so on. And I think I persuaded him, but he felt it was important, just the same, to formulate everything in a strict mathematical language.

ASPRAY: Okay. So this would have been in the 1930s.

WIGNER: Yes, the late 1930s.

ASPRAY: Let me ask one more question about the Hungarian connection before I turn to the atomic material, which I told you I'd come back to. There are so many distinguished Hungarian born and trained scientists like yourself and von Neumann. Can you speculate about why that is?

WIGNER: Well, you know, we became interested in that. Politics was not very attractive for us until we became interested in science. And the high schools were very good -- very good. Our high school, as I mentioned, was really a miracle. And I often wish we had some high schools like that here in Princeton.

ASPRAY: Let me turn then to what is my next to last question. Would you tell me a little bit about his contributions to the bomb work and to the atomic energy work?

WIGNER: Well, you know, he was asked by the people in Los Alamos to visit there. And he became interested in it. And he also talked to me about it, even though, of course, I should not have known much about it. And I knew a good deal about it, because Americans are not good at keeping secrets. He had a very important idea, and a very

important contribution to make the explosion vigorous and very effective. And that is being used all the time in nuclear weapons when nuclear weapons are tested. Let me tell you one more thing -- that I always was full of admiration for Johnny, that I liked him very much, and I was sorry that, on the whole, his life was not entirely happy. His marriages were not really as successful as they should have been.

ASPRAY: That's too bad.

WIGNER: Yes.

ASPRAY: We were trying to figure out whether he had been back to Hungary after World War II.

TAPE 1/SIDE 2

WIGNER: You know, I don't remember having heard that he was back, but he may have been back without my knowing it. You see, I also went back, not right away, because I was afraid that the Hungarians wanted to find out the secret of the atomic bomb from me, and they would not leave me alone. And so I don't know whether he went back. But eventually I went back because they knew the secrets of the atomic bomb.

ASPRAY: Did you remain fairly close to him later in his life?

WIGNER: Fairly close only, because, you see, he went away. He lived for a long time in Washington. But in Princeton we saw each other quite frequently. He had nice parties, many people there, and I enjoyed that. And he was a very nice person.

ASPRAY: Yes. You did some work in the area of automata theory and self-replication... There was that one book that...

WIGNER: Yes.

ASPRAY: Was that related at all to what von Neumann was doing?

WIGNER: I don't know, but perhaps the whole idea to work on it, to think about it, perhaps that was inspired by Johnny. I don't know for sure. And I don't want to maintain it. But it seems to me natural, you know, what directs your thinking in science is not very clear.

ASPRAY: Sure, but you were familiar with his work in this area.

WIGNER: Yes.

ASPRAY: Is there anything that you think that has been said about von Neumann that's really wrong, that's been in the literature, things that you would like to correct?

WIGNER: I think some of the literature criticized him. Is that true?

ASPRAY: A little... One book in particular that I...

WIGNER: Which one?

ASPRAY: The Steven Himes book.

WIGNER: Yes.

ASPRAY: A very bad book.

WIGNER: I think so. That's what I wanted to tell you.

ASPRAY: Okay.

END OF INTERVIEW