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Oral History Project
Interview Transcript

Neta Bahcall
Interviewed by Linda Arntzenius
November 16, 2011

Institute for Advanced Study
The Shelby White and Leon Levy Archives Center

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Date: Feb. 22, 2012

Linda Arntzenius: It is Thursday, November 17th, 2011, and I'm here at the Institute for Advanced Study with Professor Neta Bahcall[1] of Princeton University, who was a Member in the School of Natural Sciences in 1982-1983 and widow of the late Professor John Bahcall[2] of the Institute. The focus of the interview is your experience as a professor at Princeton University, a Faculty spouse, and as a Member here. Still, I'd like to start, if I may, with a few questions relating to your years before coming to Princeton. Could you tell me a little about your background and how it was you became interested in cosmology?

Neta Bahcall: Sure. I'm originally from Israel. I was interested in the sciences when I was at high school, very interested in the sciences – especially physics and math. At that time, in Israel, there was no astronomy, no cosmology. It was a long time ago. It was in the – oh, gosh. I was born in 1942, so that was a long time ago, when I finished high school in Israel.

I majored in physics and math at the Hebrew University and then continued in graduate school at the Weizmann Institute in physics. This is when I met John. He came to visit. He was, of course, in the United States. He was then junior faculty at Cal Tech. He came to visit Israel for the first time – that was in 1965. I was then doing my master's degree in physics at the Weizmann Institute. He gave a talk at the Weizmann Institute. This is how we met. I can tell you later a little bit of the story.

Linda Arntzenius: Please do.

Neta Bahcall: John always liked to tell that story about how we met. We actually got married shortly thereafter. We fell in love very quickly. After we were married, the following year, I moved to Cal Tech, where John was. There, they have excellent astrophysics and cosmology and that's how I got started in these fields. It became absolutely a fascinating topic to me.

The way we met: it was 1965, John came for his first visit to Israel. He gave a talk. I went to hear his talk. As John always likes to tell that story, he said, "I saw you there and I saw this beautiful smile and I really wanted to get to meet you." He found out who I was. He talked to my advisor, whom he knew well, was a good friend of his, and told him he wanted him to introduce us.

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[1] Neta Bahcall (1942-), Member in the School of Natural Sciences, 1982-1983; Visitor, 1983-1987.

[2] John Norris Bahcall (1934-2005), Member in the School of Natural Sciences, 1969-1970; Professor, 1971-2005.

So, when I was putting my experiment together on the nuclear accelerator, my advisor, Prof. Gabi Goldring, brought John with him and said, “We have a distinguished visitor from the United States, could you show him your experiment and tell him about our lab?” Which, you know, we frequently did as students – so I did, I showed my experiments; I told him about the lab at the Weizmann Institute. Everything went fine. Then, at the end, John asked me if I was free that evening for dinner. That was kind of a new thing for me. I was busy with the experiment. I didn’t have time for a couple of days.

John was very persistent and he kept calling and calling and calling, until finally, I said, “Okay, I have time the following day.” That was our first date. We went to an opera in Tel Aviv. I still remember that very well. It was right by the Mediterranean Sea. Then we walked that evening along the Mediterranean; the moon was shining, it was beautiful. We walked and talked for a long time. We fell in love very quickly.

We spent a week together when John was in Israel, and then he went back to Cal Tech. We kept corresponding for a few months. And then one day, he sent me a roundtrip ticket to come and visit Cal Tech. He had asked me to come for a visit, but I had said, “No.” Then he sent me the ticket, which was a very clever thing [to do].

Linda Arntzenius: He wasn’t presuming anything.

Neta Bahcall: That’s right, that’s right. And he was very persistent. He sent the ticket and I decided to come and visit. I figured it was my only chance ever to visit the United States and Cal Tech, and of course to see John. It was the old days, when people didn’t fly from Israel.

Linda Arntzenius: And Feynman was there.

Neta Bahcall: And Feynman was there, and Gell-Mann[3] was there. It was a big, well-known place. So I did and I spent a few weeks there. John and I spent much time together; we traveled and had a wonderful time. Then, we decided to get married. We really didn’t know each other that long.

Linda Arntzenius: Sometimes that’s the best way.

[3] Murray Gell-Mann (1929-), Member in the Schools of Mathematics and Natural Sciences, 1951, 1955; Member in the School of Natural Sciences, 1967-1968.

Neta Bahcall: Sometimes it's the best way. We were really fortunate, very lucky, and had a wonderful, wonderful life together – forty years! We wish it was longer.

Linda Arntzenius: I find it interesting that you started from physics and moved into cosmology, astronomy. He had a similar – he started out in –

Neta Bahcall: He started in physics, that's right.

Linda Arntzenius: Originally, I read that he was interested in philosophy.

Neta Bahcall: In philosophy, that's right.

Linda Arntzenius: And then went to physics. Do you think it was Cal Tech that made him go into astronomy?

Neta Bahcall: Cal Tech is what got him into astronomy, but philosophy is where he started. John's path to science was a very unorthodox, unusual path. In fact, he discusses it, in his wonderful interview in *Big Ideas*.[4]

Linda Arntzenius: With Scott Tremaine[5]?

Neta Bahcall: Maybe it was also with Scott – it's a well-known story so it's repeated. John says it in his own words on his 2003 *Big Idea* interview with Ira Flatow.[6] It started the following way:

> When John was in high school in Shreveport, Louisiana – he grew up in the South – he did not take any science courses. He was not particularly interested in either the academics or the sciences. He did not come from an academic family. They're all in business. And he got into athletics, playing tennis. He became a very good tennis player, a champion of his high-school tennis team and of his state.

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[4] In 2003, Channel Thirteen/WNET New York produced and aired a series of documentary films exploring ideas currently studied by some of the Faculty and visiting scholars at the Institute for Advanced Study. Ira Flatow, host of National Public Radio's Science Friday, interviewed IAS Professor John Bahcall.

[5] Scott Tremaine (1950-), Member in the School of Natural Sciences, 1978-1981, 1983, 2002; Visitor, 1986-1988; Professor, 2007- .

[6] See also the 25-page memoir by IAS Professor Scott D. Tremaine, "John Norris Bahcall, 1934-2005," National Academy of Sciences, Washington, D.C., 2011; 23-page "The Scientific Life of John Bahcall" by Professor Wick Haxton, Institute for Nuclear Theory and Department of Physics, U. of Washington, Seattle, 2009; interview with John Bahcall in "Conversations with Famous Scientists" by Hargittai & Hargittai, Candid Science IV, 2004; article "John and Amanda" by Charles Liu, a professor of astrophysics at the City University of New York, Natural History magazine, 2007.

He was excused every afternoon, to practice tennis for the tennis team. He became champion of his state in tennis. All the science classes were taught in the afternoon when he was excused to play tennis. So he did not take science classes. When he finished high school, he decided to major in philosophy, because he thought maybe he'd become a rabbi.

Linda Arntzenius: Do you think that would have been a good choice for him, with hindsight?

Neta Bahcall: He probably would have been very good at that, because he was very good in relating to people -- as we know so well from his relations here at the Institute, and in the astronomical community. He was just wonderful with people.

Linda Arntzenius: He was probably a born rabbi, a teacher.

Neta Bahcall: And the reason he thought about it is because one of his heroes and mentors when he was young in Shreveport, was his rabbi – a Reform rabbi – who, he said, was the only intellectual he knew. He really admired him. That's what he thought philosophy could lead to. So he went into philosophy and he still didn't have any sciences. One summer, he had a summer job at U.C. Berkeley. He loved it there, so he transferred college from Louisiana to Berkeley – still studying philosophy.

U.C. Berkeley had a requirement that you had to complete a science course in order to graduate. So he selected a physics course, because he was interested in the philosophy of physics and he was interested in the topic of physics. When he took the physics course, he said it totally changed his life. He just fell in love with physics. He all of a sudden realized that, as he says in his own words in the *Big Ideas* interview, you can understand how things work in the world and what makes the sky blue and what makes a rainbow and how things work. And he loved it. He then switched his major from philosophy to physics, and from then he continued in physics.

He got his Ph.D. at Harvard in atomic physics and then continued in nuclear reaction rates and weak interactions, which very quickly led him to, actually, the same person that I ended up doing my Ph.D. with at Cal Tech; this physicist contacted John and got him involved in using and applying his atomic and nuclear physics knowledge in astronomy. That was Prof. Willy Fowler – a wonderful, wonderful scientist and man. Very enthusiastic – a born leader who worked on

nuclear reaction rates in the stars. He received the Nobel Prize[7] for his work.

A few years earlier, in the 1950s, Fowler did his very famous work about nuclear reaction rates in stars and in the Universe. I came from nuclear physics, so I did my Ph.D. with him, again in nuclear physics in the stars. He got John involved in using John's work in atomic physics and weak interaction physics and applying it to the stars. So that's how he brought John to Cal Tech. Then, John brought me to Cal Tech and we both worked with Willy Fowler.

Linda Arntzenius: In the very early days, did you know anything at all about the Institute for Advanced Study?

Neta Bahcall: No. I did not know anything about the Institute for Advanced Study. I'm not sure John knew much about the Institute for Advanced Study in those days. We came to visit here in 1969. When we were married in 1966, I moved to Cal Tech from Israel. I finished my PhD with Willy Fowler in 1970. John was already a young faculty there. Then he was offered a job [at the IAS] when he was very young. He was only about 34/35, which is very young for a Faculty position here at the Institute.

Linda Arntzenius: Yes, and I note from the list that he was a Member in the School of Natural Sciences in 1969-1970.

Neta Bahcall: That's right.

Linda Arntzenius: Was that to feel –

Neta Bahcall: To feel him out, yes, that's right. I sent you a copy of Freeman Dyson's[8] historical article. Freeman talks about it. That's a talk he gave at the 80th anniversary of the Institute for Advanced Study.[9] Ask him for a copy of that. That was about the history of when he was here and invited John to the IAS. He is the one who talked to the Faculty and the Director to bring John to the Institute, because they had no astrophysics at that time. The physics group was small and they had no astrophysics. That was in the late 1960s.

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[7] William Alfred (Willy) Fowler (1911-1995) shared the Nobel Prize in 1983 with shared with Subrahmanyan Chandrasekhar who was an Institute Member in the fall of 1941 and again in the summer of 1976.

[8] Freeman J. Dyson (1923-), Member in the Schools of Mathematics and Natural Sciences, 1948-1950; Professor in the School of Natural Sciences, 1953-1994; Emeritus Professor, 1994- .

[9] See remarks by IAS Professor Emeritus Freeman Dyson at the celebrations for the 80th anniversary of the Institute's founding in 2010.

Linda Arntzenius: Did you come to Princeton with John at that time?

Neta Bahcall: Yes.

Linda Arntzenius: When he was a Member?

Neta Bahcall: Yes.

Linda Arntzenius: So you had a chance to check it out, too?

Neta Bahcall: To visit. That is correct. So the way Freeman describes it – and that's something that I actually didn't know until he told the story. I know that they did not have astrophysics. They wanted to build a group in astrophysics because astrophysics was, at that time, and still is, an important and booming field. Very exciting. Lots of discoveries and it's part of physics. It's built on physics.

Freeman – a very clever, very smart scientist – tried to think what would be good for the Institute and he thought that astrophysics was one of the fields that was very important to develop and he wanted to bring a leader, somebody who can build a group and do important science and put the Institute in this field in the top category in the world. So he talked to various people on who to bring and the suggestion was to try and bring John Bahcall.

He said it was risky, because John was very young and he was not yet very famous. But people who knew John knew he was a leader and an outstanding scientist. So he [Freeman] invited John; first, for one year, as a Member in 1969. John was only 34 then. And I came with him.

Linda Arntzenius: What did you think about the idea? You must have been quite happy at Cal Tech.

Neta Bahcall: I loved Cal Tech.

Linda Arntzenius: And John, too, I imagine.

Neta Bahcall: And he, too. He loved Cal Tech. I really loved Cal Tech. It was a wonderful place for me. When we visited here, I was just finishing my Ph.D. then. When we visited here, John liked it very much. It was a very unique – it is still - a unique place. There's really nothing like this. Many places are trying to replicate it, to mimic it, to copy it. No place has succeeded. It is unique in its focus on excellence. It's not a university. It's not a department. It's unique in how it's

structured. It's unique in its goal to focus on post-graduate science and some of the humanities.

And focus on excellence and let people do the absolute best they can without being distracted by other things. You cannot do that at any university department, because there are so many other activities we need to do. So John immediately saw the uniqueness of the place and the excellent possibility in creating something special, something unique in astrophysics in this place that was after all, the place where Einstein was. That's what everybody knows.

Linda Arntzenius: Yes, that's true, but I have to say, it's a place that Feynman didn't want to come to. Was there anybody saying, "Don't go"? Was there anyone arguing?

Neta Bahcall: No; I don't think there was anybody saying: "Don't go." And also, I think, now that I look back, at that young age, which not many Faculty are offered positions here, at that time, I didn't appreciate it that much. But at that young age, to be offered such a position, that is really pretty amazing.

And John was really a visionary. I mean he saw well into the future the possibilities, much more than I could see at that time. John really liked it right away. He could see what it can become. He could see that he would have the opportunity to do it *his* way, build a strong and excellent astrophysics group, and do a good job in that. For me, it was a whole different story, because I had just finished my Ph.D. I was younger. In fact, I was later offered a postdoctoral position at the university [i.e. Princeton University], starting in the department where I'm still now as a faculty[10].

When I visited Princeton, I must admit that I liked Pasadena and Cal Tech better. I found Princeton to be a very small place, a very small town. I didn't know the East Coast. I came from Israel to California, which was kind of a little similar. It was warm weather, it was outdoors, it was informal. The East Coast was cold, more formal, and Princeton was a very small old town. So that part, I did not particularly appreciate or like or knew much about it. I sort of preferred to stay at Cal Tech.

But in the end, we talked to people and consulted with people, and I remember some people, including Marshall Rosenbluth,[11] whom

[10] Neta A. Bahcall is the Eugene Higgins Professor of Astrophysics at Princeton University.

[11] Marshall Rosenbluth (1927-2003), Professor in the School of Natural Sciences, 1967-1982.

John got to know well, and he was already here. John became a very close friend of his. We both became very close friends with him. He said, “Look, don’t think about it as permanent, something that will determine the rest of your life. Come. Spend a few years. If you don’t like it, you can move. That’s what people do.” In fact, after some years, Marshall moved, and we stayed here for the rest of our lives. We love the place!

Linda Arntzenius: He [Marshall Rosenbluth] went back to California.

Neta Bahcall: That’s right, he went back to California. So that actually made the decision for me much easier. Well, you know, if it’s a few years, it doesn’t mean it’s the rest of our life.

Linda Arntzenius: Did you have children by this time?

Neta Bahcall: Yes. By 1969, we had one child. Our oldest was born in 1968. Then, when we moved here permanently, when John became a professor, our second son was just born. John accepted the Institute position when we had one child, but by the time we moved here, we had two, and our third was born when we were here. When he was offered the job, we thought about it. John was ready to accept. I was the one who was oscillating for the reasons that I said. Finally, we accepted, moved and we just loved it.

Linda Arntzenius: Where did you live?

Neta Bahcall: We lived right here, at the Institute housing project.

Linda Arntzenius: For how long?

Neta Bahcall: We lived there for about three years. The usual thing, I think, was that you were supposed to live there, as a Faculty, for one year only. But we came with two babies and it was a wonderful place to be. The kids had friends there with other children. I was working and John was working, so we stayed for about three years. Carl Kaysen[12] was then the Director. He and his wife became close friends of ours. John became very close with Carl Kaysen. To the end of their lives, they were very close. We frequently spent time together.

Linda Arntzenius: I wanted to ask you about Carl Kaysen. Because when you were being invited to come, that was the period when there was some upset for Carl Kaysen, because of the establishment of the School

[12] Carl Kaysen (1920-2010), IAS Director, 1966-1976.

of Social Science. Did that factor into your decision in any way? Did you think, maybe it's an unhappy place?

Neta Bahcall: I remember that incident very vividly. I don't remember all the details, but I remember the incident. It was a big scandal. It appeared in the newspapers, *The New York Times* and so on. I know John talked to Carl quite a bit about it. I was not directly involved. John did talk with Carl about it. I'm sure he had his opinions about the directions to go – I'm pretty sure he supported Carl on that.

He really admired Carl Kaysen. He saw him as an extremely bright, able, interesting person. Loved talking with him. I think supported him in probably just about everything. I don't know. But I don't think it influenced John in any negative way. I thought he saw the Institute as an outstanding place, full of special possibilities for making the most out of the scientific and scholarly activities for top people and creating a top scientific place in astrophysics.

Linda Arntzenius: So you come. You spend three years living in the housing. Presumably, at that point you're looking to find a house.

Neta Bahcall: Yes, we were looking for *(laughter)* – I was looking – John didn't bother with it very much. He was very busy. I was looking for quite a while. I started slowly, because there was no rush. I started slowly and we were looking and looking. I liked the more contemporary places with lots of windows and light. Most places were not like that.

Again, I was not used to much of the East Coast style. Finally, Carl kept telling us, "You know, you guys have to start moving, start thinking of getting a place of your own and move. We need the places here for Members." So we finally found that house. In fact, it was the first house we ever saw in Princeton, which I didn't remember. Then, it came back on the market two or three years after that.

Linda Arntzenius: Is that the house you're still in?

Neta Bahcall: That's the house we bought and that's the house we're still in.

Linda Arntzenius: You're kidding!

Neta Bahcall: That's the house we bought right by the lake, in the Riverside section. We bought it about three years after we came to Princeton, in about 1973.

Linda Arntzenius: You chose the house because you liked the house. You couldn't find anything closer to the Institute?

Neta Bahcall: We looked closer to the Institute. In some ways, we really wanted to be close to the Institute and we looked at several of the houses that the Institute had. I remember one of them was one where the Lavins[13] now live. We looked at that. The reason at the end we decided not to live here is we had two little kids and this area was a bit isolated. There were no kids. There was no way to walk any place for kids and so on.

The only kids to play with were mostly Members in the Institute housing, and they were coming and going. So I didn't think that was the best thing for our kids. Where we found the house was in the Riverside section, which was a younger environment, a younger area with many young families and young kids. The kids can walk to the school and the school was very good. That was the reason we decided to look mostly in that area.

Linda Arntzenius: Did your kids go to Riverside and then on to Princeton High School?

Neta Bahcall: They all did. They went to Riverside, then the middle school, then Princeton High School. So yes, we lived in this house for 40 years.

Linda Arntzenius: When you first came to the Institute and Carl Kaysen was director – I'm going to, of course, ask you about how the Institute has changed over the decades – but I wonder if you could describe the culture of the Institute at that point in time, as you observed it.

Neta Bahcall: The overall culture has not changed. The overall culture of the Institute and the structure and the focus on excellence, on bringing the top people, of having as much resources as possible made available to them – that has not really changed. What has changed, and, again, I'm not familiar with everything, I'll just tell you what I can see. Clearly, some of the emphasis, especially in the field of natural sciences and obviously in the other fields as well, has changed and strengthened.

Astrophysics – there was nothing when we came in 1969, 1970. There was no astrophysics. It has now become – John has created and it has now become the number one leading astrophysics group for postdocs and for research in the world – not just in the country.

[13] Irving Lavin (1927-), Professor in the School of Historical Studies, 1973-2001; Emeritus Professor, 2001- ; and Marilyn Aronberg Lavin (1925-).

So astrophysics has become a top place here. Physics has also changed. This is probably the number one place for string theory now, with Ed Witten[14] and Nati Seiberg,[15] Nima Arkani,[16] and Juan Maldacena.[17] These scientists have really changed the field of physics.

The Institute is a center for astrophysics, cosmology and string theory. John has been not only the leader in creating the astrophysics group, but he was also, I think, very helpful in bringing the people in string theory into the program, together with Freeman Dyson and others. John put all of himself into the life of the Institute and got involved strongly. He loved it. It was a second home for him, in addition to his family.

John did everything he could to make the place the best that it can be. Not just in astrophysics, but in physics and other fields. Later, he was one of those who advocated strongly for bringing biology – theoretical biology – into the Institute; and he helped make it happen!

In fact, as you know, we have a developing strong biology group. John was the one who brought Arnie Levine[18] to the Institute to start biology; worked with him to try and develop biology. John worked on developing biology for quite a few years before that.

Linda Arntzenius: How is the astronomy group at the Institute today, without him? Is his legacy secure?

Neta Bahcall: The answer is yes. John's legacy is secure. I think the Institute has done an excellent job in bringing two people to take John's place. Both of them were postdocs of John's. John was an outstanding mentor, everybody knows that he was an inspiring mentor to many generations of outstanding astrophysicists. He had over 200 or 250 young astrophysicists that he helped mentor and train. Scott Tremaine was one of them. Matias Zaldarriaga[19] was another.

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[14] Edward Witten (1950-), Member in the School of Natural Sciences, 1984; Professor, 1987- .

[15] Nathan Seiberg (1951-), Member in the School of Natural Sciences, 1982-1985, 1987-1989, 1994-1995; Visitor, 1993-1994; Professor, 1997- .

[16] Nima Arkani-Hamed (1972-), Professor in the School of Natural Sciences, 2008- .

[17] Juan Maldacena (1968-), Member in the School of Natural Sciences, 1999; Professor, 2000- .

[18] Arnold J. Levine (1939-), Professor in the School of Natural Sciences, 2003-2011; Emeritus Professor, 2011- .

[19] Matias Zaldarriaga (1971-),), Member in the School of Natural Sciences, 1998-2002; Professor, 2009-.

John thought the world of both of them. In fact, John talked with people at the Institute about who he would like to bring, eventually. Both of those names are names that he mentioned, among a few others. They are both outstanding; both continuing the tradition of running a top rate astrophysics group. They bring outstanding Members to the group.

That's something that John worked very hard to develop, the membership of the astrophysics group. He had a very good, large group of about ten to fifteen Members and Visitors each year. They were the top in the world. They are continuing with that. In fact, the Trustees of the Institute, together with many of John's students – scientists that he mentored – created the John Bahcall Fellowships here at the Institute. All the five-year members in astrophysics are now named after John. They are called John Bahcall Fellows. This program is continuing very nicely with excellent young scientists.

Linda Arntzenius: Yes, when I was working here in the Director's office, I would see him traveling with his group from the science building to the Dining Hall. It's no secret that he spent a good portion of each day with his young researchers.

Neta Bahcall: He did. He loved the young scientists in his group. He really devoted his life to them, among many other things he devoted his life to. He was very dedicated to the well-being of these young people in his group. It was important to him that they do well, that they be mentored well. He would advise them. He would go knock on their doors every day to find out how they were doing, are they making progress in their research, advise them on directions, make sure they finished their papers.

He would make sure they all come to lunch with him and sit and talk about science. He would make sure they met all the visitors that come. He took care of them like his own kids. He also would care very much about what happened in their personal life.

Linda Arntzenius: I was going to ask you about that.

Neta Bahcall: Their families, their children. John helped create the "nursery school" here, for taking care of babies, because some of his Members had babies and they had no place to go. So he helped create the nursery school. He bought a playpen to put in the meeting room at the Institute, because sometimes the Members had to bring their baby to work. He would have parties for the birthdays or special events in the postdocs' life. He was very

strongly involved with them. They felt it. When John passed away, some of the most moving things were told to me by his postdocs; they said, “We lost our father.”

Linda Arntzenius: I’m sure. Yes. But he also, I read, kept them on their toes. Those Tuesday lunch seminars, apparently he had some quite strict rules. They sound a little bit scary. Members could only have one sheet of paper and they couldn’t use the blackboard. No visual aids at all. Anyone could be asked to speak or contribute at any time. He wasn’t soft on them, was he?

Neta Bahcall: No. Everybody who knew him knows that he had this amazing combination of being on one hand very strict and in some ways very intimidating to young people, people who didn’t know him well. He was very famous. He had extremely high standards. He demanded a lot from people, because he demanded a lot from himself, too. He strived for excellence. He did not suffer fools very easily.

In his young days, he would even say so. He was much tougher. He mellowed a little bit with age. Once he came to the Institute and developed his group, he combined extremely high standards and demanding excellence, with a huge amount of caring and love for people – nurturing the scientists as well as the science. John had this very interesting combination of keeping the highest standards and being an excellent mentor; people were somewhat intimidated. He never understood why people were intimidated.

Linda Arntzenius: I read somewhere – it was very funny when I was reading about him – he had been compared to *The Godfather*.

[Laughter]

Neta Bahcall: I think it was for the following reasons: he inspired intense loyalty, he had a huge network of contacts, he was a true leader and he had a commanding presence. So in that respect, perhaps, he was a little bit like the godfather.

One of our colleagues – a science writer – told us this story. I heard it for the first time when he told it. He said he came to interview John for something he was writing. He said it became the best lesson he learned in his life. He came to interview John, and he started asking him questions about the science part. He told us, “I was very arrogant, I thought I knew what I was talking about, but I was really not very well prepared. I was in John’s office. John started answering [my questions]. After a few questions, John stood

up and said, 'Okay, this interview is finished. I think you have to go home. Prepare your topic better, and then come back. There is no point in continuing this interview.' I was stunned," he said. "That had never happened to me before. But it's the best lesson I've ever learned. John was absolutely right," he said. "I didn't know what I was asking. I went back. I prepared well. I then came back to talk with John. We had a wonderful interview." So John would do that.

Linda Arntzenius: That's amazing. He was a born teacher.

Neta Bahcall: He was a born teacher. He was a born leader. He was never afraid to tell the truth, call it as it is. People knew that he would never lie about anything. He had a huge amount of integrity, honesty. People loved him. Some felt intimidated until they got to know him well. Then, everybody who got to know him well understood he had a very warm, kind heart.

Linda Arntzenius: What was his relationship with the Board of Trustees over the years?

Neta Bahcall: I was going to mention this. Not only was John really loved by his students and colleagues, and by the Directors - he had very close relationships with all the Trustees here. He has served under several directors: [Carl] Kaysen, Harry Woolf,[20] [Marvin] Goldberger.[21] Goldberger was a close friend. They were close friends to the end. Closest friends. He was close friends with Phil Griffiths.[22]

Linda Arntzenius: And then Peter.[23]

Neta Bahcall: Peter, he knew for a little bit, for a short time.

Linda Arntzenius: What did you think of Harry Woolf? Because Harry Woolf was quite a controversial figure.

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[20] Harry Woolf (1923-2003), IAS Director, 1976-1987; Professor-At-Large, 1987-1994; Emeritus Professor, 1994-2003.

[21] Marvin L. Golberger (1922-2014), Member in the School of Natural Sciences, 1966-1970, 1976-1977; IAS Director, 1987-1991.

[22] Phillip Griffiths (1938-), Member in the School of Mathematics, 1968-1970; Visitor, 1981-1982; IAS Director, 1991-2003; Professor, 2004-2009; Emeritus Professor, 2009- .

[23] Peter Goddard (-), Member in the School of Natural Sciences, 1972-1974; Member in the School of Mathematics, 1988; IAS Director, 2004-2012; Professor in the School of Natural Sciences, 2012-2016; Emeritus Professor, 2016- .

Neta Bahcall: John worked well with all of them. I think the others became close personal friends of his. He admired all of them. He admired Kaysen, Murph Goldberger, Phil Griffiths. He worked with them and became close personal friends. Harry Woolf – he did well with him, but I don't know if they became as close.

Linda Arntzenius: Were you and he, he alone, or you both together – were you ever asked to be involved in any sort of fundraising activity?

Neta Bahcall: Oh, John was. John was frequently involved with fundraising and did that gladly. He worked quite a bit with the different Directors in fundraising activities. I think mostly towards the astrophysics group and towards computing. He worked very hard to develop top level computing, increasing the computational capabilities here. That was one other thing that has changed a lot over the years. There was very little computation. It's ironic, because the phenomenon started here with the first computer and then, of course, it disappeared. There was not much high level computational facilities at the Institute, and John worked hard with other people to bring it to the Institute. He worked on fundraising towards that.

Linda Arntzenius: Tell me about Piet Hut,[24] because I know John championed Piet Hut in the beginning. I think Piet had some designs for bringing computers here or doing something like that.

Neta Bahcall: That is correct. Piet Hut is a very bright scientist. He moved from the direction of astrophysics more into the computational aspect. He moved out of the astrophysics group and he's in a special group now working with the Director. He is an outstanding computational scientist and worked on bringing computers into the Institute and doing large computational programs with computers. I'm not so familiar with exactly what he does now. But I know he was a postdoc with John. John thought very highly of him.

Linda Arntzenius: Was John disappointed in how that worked out?

Neta Bahcall: I think he was a little disappointed. He always thought very highly of Piet Hut. I don't know exactly what happened there, but Piet Hut started working on things that were not in astrophysics. John was focused on developing astrophysics; at the same time everything else at the Institute, computing and computational capabilities was also very important for him.

[24] Piet Hut (1952-), Member in the School of Natural Sciences, 1981-1984;), Professor in the School of Natural Sciences, 1985-2002; Professor in the Program in Interdisciplinary Studies, 2002- .

Linda Arntzenius: You and John wrote many papers together. What was it like working with him?

Neta Bahcall: Oh, it was wonderful. It was just wonderful. I didn't realize we wrote as many joint papers as we did. I thought we wrote a few, but in one of the articles about John, they looked at it and said that we wrote about 30 papers together.

Linda Arntzenius: Wow! He wrote a lot.

Neta Bahcall: John wrote a lot of scientific papers and books[25]. He was extremely productive. Amazing output of excellent work.

Linda Arntzenius: What was his secret? Did he sleep? Did he ever sleep?

Neta Bahcall: That's what many people ask. Did he ever sleep? How could he do that? He was enormously focused and efficient. He did things quickly. He didn't spend a lot of time agonizing and worrying about things. He just went straight and did what he wanted to do: his research, his writings, his lectures, his mentoring, his leadership of the astronomical community.

Linda Arntzenius: Was his judgment ever wrong? Because sometimes people who operate that way can be overly quick and –

Neta Bahcall: I'm trying to think of anything I know where his judgment was wrong. I cannot think of any example where his judgment was wrong. I really cannot. So many people ask me, "How did he succeed in doing so many things?" Because not only did he create a group here and run it, he did all the research and leadership on solar neutrinos, which took him – worked on it for 40 years, since I met him in 1965 to the very end, and many other topics in astrophysics. He also was a national and international leader in astronomy. He was president of the American Astronomical Society, he was president-elect of the American Physical Society when he passed. He was a leader in the National Academy of Sciences. He ran the important Decadal Survey of what the country should do for the next decade in astronomy in the 1990s. It became known as The Bahcall Report. Everyone refers to it as an exemplary report that was extremely successful. He kept working with Congress on implementing it and with NASA and other agencies – implementing all those telescopes that were created from that report. He was one of the fathers, one of the two fathers –

[25] Professor Bahcall added the following note when reviewing the transcript of this oral history interview: John Bahcall authored over 600 scientific papers and nine books.

together with Lyman Spitzer – of the Hubble Space Telescope. He was well known for working tirelessly to make the Hubble a reality.

In fact, Hubble has an annual lectureship series in John's name. They also named their main science auditorium the John Bahcall Auditorium. They want to name a space telescope after him. Our wedding rings went up to the Hubble. Our wedding rings - the astronauts took them two years ago, when they went for the last time to the Hubble. They took them up to the Hubble, because they wanted to take something personal of John's to the Hubble. John was a hero to them, they said he saved the Hubble. John did all of those things and still was one of the most productive astrophysicists in the last century.

Linda Arntzenius: I read something else about him that his priorities were – and given what we just said about him, this is rather striking - I read that his priorities were family first, astrophysics second, and all the rest third. Is that really true?

Neta Bahcall: That is exactly true. He says it in one of the many videotapes that we have of John.

Linda Arntzenius: Would you say this is unusual in academia?

Neta Bahcall: In academia? I think that for the top scientists, you always know that the science, the research, astrophysics or physics or whatever they do, is a huge part of their life. For some of them it may come before their family. For some of them it comes second to family. That's very individual. For John, family was absolutely first. For me, too, family was always first. John always said it. He always acted it, too. He didn't just say it.

Linda Arntzenius: Was there ever a time when that presented him with a difficult dilemma?

Neta Bahcall: I don't think so. I think the choice was always very clear to him. The kids always remember that John could be on an important telecon or an important interview or in an important meeting, but when a call came from one of the children, he would stop and deal with whatever was needed, or he couldn't go to a meeting because he had to do something with the family. That always came first. There is no question about it.

Linda Arntzenius: That's really quite remarkable.

Neta Bahcall: He really practiced what he said and what he believed.

Linda Arntzenius: You have three children –

Neta Bahcall: We have three children.

Linda Arntzenius: Safi, Dan, Orli – and they've all become researchers.

Neta Bahcall: They've all become scientists.

Linda Arntzenius: Is Safi in theoretical physics?

Neta Bahcall: Safi got his Ph.D. in theoretical physics. He had a faculty job offer in theoretical physics, but he decided to switch some years ago into biomedical. He started a company, he and a colleague from the Harvard Medical School some years ago, started a biotech company searching for the discovery of new drugs against cancer. Safi is the the President and CEO of that company, Synta, and has been leading it. He has built it into an excellent company. He loves it and he's doing very well.

Linda Arntzenius: And Dan?

Neta Bahcall: Dan got his Ph.D. in cognitive psychology and Orli got her Ph.D. in biology. Orli is, and has been for several years now, Senior Science Editor for *Nature Genetics*. She loves her work. All our kids are in some aspect of research.

Linda Arntzenius: And you are the Eugene Higgins Professor in Astrophysics at Princeton University and a member of the National Academy of Sciences.

Neta Bahcall: Yes and that's very interesting. I think John and I are the only couple in astrophysics, maybe in physics, too – I'm not sure. There may be some other couples in biology, but in astrophysics we are the only couple.

Linda Arntzenius: That's quite remarkable.

Neta Bahcall: It is. It is nice. And of course, John received the National Medal of Science from President Clinton, which was a wonderful, wonderful, very exciting event. John was also a serious candidate and should have received and shared the Nobel Prize in Physics in 2002 for the solar neutrinos[26].

[26] The 2002 Nobel Prize in Physics 2002 was awarded to Raymond Davis Jr., Masatoshi Koshiba, and Riccardo Giacconi.

Linda Arntzenius: What happened? That must have been a disappointment.

Neta Bahcall: If you ask me, I think the committee has done an inappropriate and unfair thing not to award John his deserved share of the Nobel Prize. Many people said that. Steve Weinberg said that very clearly and very publicly. As he and many others have said there would not be a solar neutrino discovery or a solar neutrino problem, nor the main discovery of the neutrino mass, without John's pioneering and persistent results for over 40 years on this topic. .

Linda Arntzenius: How could that happen?

Neta Bahcall: How could that happen? People said, "There would not be a discovery if it was not for John's calculation that showed the data didn't agree." Because if you just measure the data, it has no interpretational meaning; it doesn't tell you anything about the neutrinos. I think it was an inappropriate and unfair decision to give the prize only to the experimentalists.

Linda Arntzenius: Was he disappointed himself?

Neta Bahcall: He was disappointed, of course, but did not take it too much to heart. He was truly delighted that the subject was recognized by this prize. But they really did an unfair thing and I hope they regret it.

Linda Arntzenius: I hope so, too.

Neta Bahcall: Science-wise, they did not do the right thing. Everybody expected the three leaders in solar neutrinos to be John [Bahcall], [Raymond] Davis and [Masatoshi] Koshiba.

Linda Arntzenius: Nonetheless, he had many, many awards and accolades.

Neta Bahcall: He received, basically, all the other awards. One thing I can tell you is that before the Nobel Prize was announced, *The New York Times*, the media, usually tries to list their guesses of the expected winners. They published their guess for that year would be Davis, Koshiba, and Bahcall. Other newspapers as well. So after it was announced, John and I received hundreds, hundreds of e-mails and letters from scientists all over the world, including many Nobel Prize scientists, who said that it's clear that the committee did the wrong thing by not including John. There would be no solar neutrino discovery if it was not for his work. Some of the letters were really moving. They said, "In our minds, you have won the Nobel Prize. For us, you have led it from the beginning to the end." It was

moving. I still have a collection of all these e-mails. And the other thing which I find quite amazing – sometimes we see to this day, in a newspaper article referring to the named Bahcall-Davis Fellowships, a statement that "Bahcall and Davis shared the Nobel Prize in 2002." *(laughter)*

Because it was so much expected, so much ingrained in people's minds. John did not take it badly at all. I think I was much more upset than John was. Was he disappointed? Yes. Clearly, he would have been happy and it would have been appropriate. But he was enormously happy that the topic received the recognition.

Because he said and he truly believed it: "Look, I've never worked on it for a prize. We don't work on what we work on for prizes. We work on what we want because of the excitement of the science; because of the fun of doing it; because of the amazing discovery and pleasure that you get out of finding out how the Universe works. That's the prize. It's not whatever they give you." That's truly what John cared about and he absolutely felt that way and believed it.

Linda Arntzenius: Of all the other prizes and awards that he did receive, do you remember any particular one that he found especially pleasing?

Neta Bahcall: I think many of them. I think the National Medal of Science from President Clinton – that's the highest recognition in this country. He was very touched and moved by that. Especially at the time of this Nobel Prize, there was a whole flood of prizes that John received: the Fermi and the Franklin Medal and the Medal of the Royal Society, the Gold Medal.

Linda Arntzenius: The Gold Medal of the Astronomical Society.

Neta Bahcall: That's right. It was roughly at that time, too, he received the Dan David Award[27].

Linda Arntzenius: And the Dannie Heineman[28].

Neta Bahcall: Yes, from the American Astronomical Society. He received all the awards of the American Astronomical Society.

Linda Arntzenius: The complete set!

[27] John Bahcall received the Dan David Prize in 2003.

[28] He received the Dannie Heineman from the American Institute of Physics/American Astronomical Society in 1994.

Neta Bahcall: He received the complete set! He received the prize for the youngest outstanding astrophysicist in the 1960s, the Warner Prize; and the Dannie Heineman Prize for mid-career scientists; and their top prize, the Russell Prize for Lifetime Achievements. He received the Dan David Award, which is like the Nobel Prize Israel gives. So many. He was touched by all of them.

Linda Arntzenius: Did his parents live long enough to see their son achieve?

Neta Bahcall: Yes, they lived long enough to see him achieve great success. His father died around 1977. By then, John already did very well. His mother lived longer, maybe another ten years after that. She collected a lot of the articles about John and was so proud of his achievements.

Linda Arntzenius: How about you? Are your parents still alive?

Neta Bahcall: No. My father died when I was young. I was 19. My mother lived and saw her grandchildren grow and saw me do very well and saw John do very well and she loved it. That was very nice. But John always said – and he said it to his last day, which always really inspires me and inspires our kids and everybody else who hears about it – he always said what an incredibly wonderful life he had. He said, “I never could have imagined growing up in Shreveport, Louisiana, in a poor family, a family without college education, (well, his mother had college education but did not continue in that direction) I could never have imagined that I would do what I did in my life, that I would have the opportunity to work in the best place in the world, with such amazing people as my colleagues, and the Board, and the Members, and the students. To have such an incredibly wonderful family, such a wonderful wife, such wonderful children. To succeed and do such exciting science.” He said: “I had the best possible life; I am a lucky man.”

I’m so happy that he saw the success of the solar neutrinos. He worked on many different topics, but that was something he worked on his entire career, and he saw it succeed. That meant a huge amount to him. To see the Hubble – he worked so much on the Hubble - succeed so well. In fact, TIME magazine did an obituary for John, and the picture they used was a picture of the Hubble. People connected John’s name with the Hubble.

John said, “I have done everything I’ve wanted to do in my life. My life has well exceeded my expectations.” He had a good life. It was a little too short. That’s the only tragedy. He could have lived

another ten years or twenty. It was too short. He accomplished a huge amount. When people try to say something good to me, they say, “Yes, it was short, but he did in his life three times as much as anybody else could do.” I think that’s true.

Linda Arntzenius: The amazing thing is he did so much with his time, and yet he could be quite generous with his time. When I was working here, 2005, I believe, was the PhysicsQuest. It was the Year of Physics. The Institute was approached by a high school teacher who was organizing PhysicsQuest. The prize they wanted to give was a visit to the Institute. I told John about this. I went to his office. I have to confess, I was a little daunted by him. I told him about it.

I didn’t realize how ill he was. This was in May and he died in August. The kids were coming on to the campus. That was their big prize – to come to Princeton. They were going to do a treasure hunt and have pizzas. And John, I didn’t expect him to come, although I had told him about it. At 1:00 PM, he came walking by.

Neta Bahcall: I have the picture.

Linda Arntzenius: I took that picture of him! With all the kids on the wall. I was so moved that he took – and it was a Saturday – and he took the time to do that. It was amazing. I’ll never forget that. He was very generous with his time.

Neta Bahcall: And that’s what many, many people said – we had hundreds, thousands of letters after he passed away, and it’s a story that unbelievably kept repeating, how much people loved him, how dedicated he was with his time. Many of the young people said, “He gave us the courage to succeed, to go ahead, because of what he said, because of a little note he wrote us – handwritten note. He took the time to write us about our paper, about our research, about our talk.”

I could not believe how many people, which I didn’t know. For so many, that influenced their entire life. He had that sort of ability to do almost anything that most of us don’t. Most people don’t have that ability. You asked me about how he related to the Board members, because that was another thing. He related so amazingly well to so many different types of people, all the way from astronomers who admired him for his scientific achievements and knowledge to a broad range of non-scientists, from Congressional people to reporters to those involved with fundraising-related activities and to Institute Board members; he became good friends with many of them.

Many scientists don't know how to talk or relate to non-scientists. John loved them. He became best friends with many of them. He became best friends with Jim Wolfensohn, really close friends with Jim and Elaine Wolfensohn. With Leon Levy and Shelby White. We went to their house for dinner. We went to the theater with them in New York. Charles Simonyi. The Simons became good friends. He loved them. He genuinely liked the trustees. Michael Bloomberg, Mort Zuckerman and other Board members.

He appreciated how smart, and able, and dedicated they are; people who are trying to do good things for the country, for the Institute, for science, for education. He had this wonderful ability to connect with so many people.

Another group of people that really loved John and connected with him – that not many people can connect with – were Congressmen. He worked a lot with Congress when he went to talk about Hubble, but also for many other things – for education, for science, for funding, and for other projects. Congress loved him. And he liked them. Many scientists don't know how to relate to Senators or Congress people well. They don't appreciate or understand the efforts they make to improve the country, science education. John didn't have this feeling. He felt that many of them were very smart. They wanted to do the right thing. And he went there to help them do the right thing. They loved talking with him, because they felt he was honest, that he would not try to spin it around or twist it. He will tell them the truth. They trusted him and they felt that he liked them. That was true.

Linda Arntzenius: Tell me, was John a religious person?

Neta Bahcall: Not really, no. He was not very religious. He was very Jewish. He felt very close to the Jewish tradition, but not in a religious way.

Linda Arntzenius: I want to move to some more general questions about the Institute, but I have one other question about John I would like to ask you. When the Prospects in Theoretical Physics program was here – probably in about 2004, you and he gave a talk. I'll never forget it, because it was so accessible and understandable and obviously geared for a wide audience. John was very entertaining. He told us that you and he had a prenuptial arrangement. He quoted you as having said to him, "John, you can have the sun, but the rest is mine." I wondered if there was any truth in that.

Neta Bahcall: Well, that's very, very interesting. John loved to tell that story in many places where he was introduced or gave a talk when it was relevant. People loved that story. No, it was not true, but John loved to tell this story; he sometimes would make up such stories to have fun and that was one of them. I think Jerry Ostriker[29] wrote an article about John, maybe in *Nature*, a beautifully written article. He tells that story about John...

But he tells it not only about me, but he said that when John would introduce some other people, like when he'd introduce Jerry or other well known people, he would tell the same story. He said, "When I came to Princeton, Jerry and I had an agreement." He said, "John will work on the sun, and Jerry will work on everything else." It's something that John had fun with.

Linda Arntzenius: It was a little icebreaker.

Neta Bahcall: It's a little icebreaker and he loved that story.

Linda Arntzenius: He did have an enormous sense of fun, I think.

Neta Bahcall: That's one of the things that people loved about John. That in addition to all those other qualities that we talked about, he enjoyed life and had fun with everything. He loved to joke. He used humor and was very funny. People will tell you about all kinds of humor that he would talk to them. He connected with people with that. When he would get his group to go to lunch – you said you saw them walking – he would collect them all by going to the top of the stairs, and he would yell, "Lunch!" When I was there, I would get startled. All of a sudden, this really loud yell. Many people tried to imitate it. It never worked as well. He was really good!

Linda Arntzenius: One of a kind.

Neta Bahcall: He was one of a kind. He would yell, "Lunch!" Everybody would gather. If somebody doesn't come, he would knock on their door and get them out to lunch. That was every day. The Tuesday Astrophysics lunch, which was the big astrophysics lunch he ran at the Institute for many years –

Linda Arntzenius: Did you come to that?

Neta Bahcall: Oh, I would always come to that.

Linda Arntzenius: And others, too?

[29] Jeremiah Ostriker (1937-), Visitor in the School of Natural Sciences, 2004-2007.

Neta Bahcall: And others. It was a big event. It was the one day a week that we would all gather together – the Institute, the University, the astronomy department, and the astrophysicists from the physics department, including Jim Peebles[30] and Paul Steinhardt[31] and so on, would all come to this lunch. John ran it for 35 years. They now call it the Bahcall Lunch – it's continuing. Scott Tremaine does it and it's still continuing very nicely.

Linda Arntzenius: As I said, I wanted to move to some more general questions about the Institute. Creative curiosity is one of the hallmarks of the Institute, going back to the founders. I wonder if, looking back, does it seem inevitable that John would end up here?

Neta Bahcall: I think John would have done extremely well no matter where he went. He was that type of person. He takes whatever he has and he will develop it into the best that he possibly can. He was an initiator, a leader. Freeman Dyson describes it very well in his historical write up. He said, "There are two types of scientists. Those that are leaders, and those that are" – I think he called it – "lone wolves." Those two kinds of scientists. Freeman says he, himself, is a lone wolf. Outstanding, brilliant scientists who like to sit in their office and do their own work. They can interact with people, but they don't create a group or a scientific empire. They don't start something from nothing to create a group. They create a research project, but not a group.

So there are leaders and there are lone wolves. John was a leader, so I think no matter where he would have ended up – whether it's Cal Tech, or here, or some other university – he would have created something that suits that place. I think the Institute was an outstanding match for John and I am sure John felt so too.

Again, I think he would have found his voice any place. I think it was an outstanding match for him and an outstanding match for the Institute. I think it achieved success well above expectation. John produced, at the Institute, the number one group in astrophysics in the world. We all hope it stays like that. Freeman says, again, in his talk – Freeman is sometimes known to go to a little exaggeration or put himself down a little bit – but he said in his talk that he feels his

[30] Phillip James E. Peebles (1935-), Member in the School of Natural Sciences, 1977-1978; Visitor, 1990-1991, 1998-1999.

[31] Paul Steinhardt (1952-), Member in the School of Natural Sciences,1984-1985, 1989-1990, 1994-1995, 2003-2004.

most important contribution to the Institute, was bringing John here, which I thought was really sweet and kind.

He said it a year or two ago at the 80th anniversary. I was there when he gave that talk, it was very moving, because John really put that topic on the map here, but not only that, I think he helped the Institute in many other ways, as we talked, in computing, in biology, in bringing the other physics people here and was helping develop the other divisions here, too.

Linda Arntzenius: What did John think of the Orion Project that Freeman had been involved in? Did he have any thoughts on that?

Neta Bahcall: I don't really know. I don't know what John thought about it.

Linda Arntzenius: Now, the founding director, Abraham Flexner, thought that the sort of speculative research that goes on here needed a special environment. Did John think that, too? Or could he have done what he did anywhere? I'm sensing, perhaps, that the latter is true.

Neta Bahcall: I think he probably could have done it anywhere. I think John's work was not, I would not call it speculative. I think it was cutting edge research. It was real cutting edge research in different sub-fields of astronomy and astrophysics. Amazing discoveries – I mean solar neutrinos was a huge discovery. It changed the physics books. It changed our understanding about what neutrinos are.

Linda Arntzenius: I've heard it described as he was the one who brought astronomy and particle physics together.

Neta Bahcall: That is correct. Some of the biggest discoveries in physics, in particle physics, in the last few decades have come from astronomy. One is the neutrinos, the solar neutrinos that John worked on and was the theoretical leader in this field. Another fundamental discovery that came from astronomy is the existence of dark matter – some new particles that have not yet been detected directly. The last transformational discovery is the existence of dark energy, which also came from astronomy, from cosmology. These discoveries tell us something fundamental and unexpected about physics.

John did very cutting edge research in solar neutrinos, in discoveries about quasar properties, discoveries about dark matter, about black holes, about the structure of our galaxy. He did superb research that led to very important discoveries, but I think he probably could have done those anywhere. What the Institute

provided, and helped greatly, is the environment of not being distracted by many other duties such as formal teaching and committees and so on, although John did a lot of teaching by example and mentoring.

Linda Arntzenius: But that was his choice.

Neta Bahcall: He also headed many national and international committees and societies, but he could manage all these major activities at the same time. The Institute provided an atmosphere of no distractions, of support and resources, of being able to create such an outstanding group of scientists that he can collaborate with, and helped foster some of this work. The Institute is unique in the resources they provide to bring outstanding people to make it all happen.

Linda Arntzenius: It doesn't suit everyone, though. Would you have liked to have been at the Institute? Would it suit you?

Neta Bahcall: It doesn't suit everyone, no. In fact, you see some people that are made an offer to come to the Institute, and as mindboggling as it is – why would they say no? – they say, "No."

Linda Arntzenius: Some people really like to be involved with undergraduate teaching.

Neta Bahcall: Exactly. Sometimes that's the reason. They like to be involved in undergraduate teaching, in having the young students around and teach and work with them, and serve on committees and big university administration. John could have done that very well, but I think that this style at the IAS suited him extremely well. He benefitted from it. Also the Institute greatly benefitted from John. I think it was an extremely wise decision of Freeman Dyson and Carl Kaysen and the rest of the Faculty to bring John here. We are certainly very thankful to them for doing so. I think the Institute and astrophysics have blossomed under John's influence.

Linda Arntzenius: You mentioned the 80th anniversary of the Institute was celebrated recently. So this is a very general question, why do you think the Institute is here after 80 years and still thriving? How has it changed? Do you think there is still a need for an Institute such as this?

Neta Bahcall: The answer is absolutely yes. I think the Institute has been thriving because it has been doing such an excellent job, such an outstanding job. The founders wanted a place of excellence – the top that you can reach in all these fields.

Linda Arntzenius: So it was well conceived?

Neta Bahcall: It was well conceived and it was well executed. It is being well executed. The Faculty are just outstanding. All of them. The Institute has outstanding Faculty, outstanding Members and Visitors, outstanding research is being done. Just look at all the honors that people here are getting, all the prizes that Faculty and Members are being awarded. Members that have been here are leaders in the world of their different fields – in physics, in astrophysics, in mathematics, in history. I know less of the humanities, but I assume the same is true in history and the social sciences.

Linda Arntzenius: If John and you and he had received the Bambergers' gift – as Abraham Flexner did, and set up the Institute with it – if you had received such an enormous gift today, what do you think John and you might have done with it?

Neta Bahcall: I certainly think that doing something like what the Bambergers did in establishing the Institute – or what Jim Simons and Charles Simonyi did recently by providing tremendous support to the Institute, as do all the other Trustees and donors that support the Institute so remarkably well – this would clearly be at the top of priorities. There are many other needs as well, but having a unique place like this where you can make discoveries and push the science and scholarly boundaries farther out, better than any place can do, is a no-brainer.

Linda Arntzenius: Do you think that the key element in its success – well, I don't want to put words in your mouth *(laughter)* - but it seems to me that one of the key elements is independence.

Neta Bahcall: I think the key element for success is bringing in the best people and giving them the resources and freedom to do what they do best! There's no question about it. If you don't bring the absolutely top, if it becomes a second-rate place, then you lose everything. So the main goal to strive for is to always bring the absolutely A+ people. The Einsteins, the von Neumanns, the John Bahcalls. [To bring] all those very top people to the Institute. If that ever deteriorates, and I certainly hope it never does, then I think all those other benefits don't really mean very much.

If you bring second-rate people you will not get the same effect. As long as you can bring the most outstanding people, and then provide them with what the Bambergers wanted, and what the

Institute continuously does, and what the Board of Trustees is doing, and the Directors – providing independence, resources to do the best they can, money to bring the top scientists and scholars that one needs to create excellent groups that can exchange ideas, that's what creates the success that the Institute has achieved.

I think it has only improved over time. Again, there have been outstanding people here all along, but if we look at what the Institute is doing today in the fields that I'm familiar with – in astrophysics, in string theory, in mathematics – it's just amazing and inspiring. And with a small number of faculty and members. In astrophysics, it was just one faculty, John; now it's two; look at the impact that it has.

Linda Arntzenius: Can you predict any new directions for the Institute?

Neta Bahcall: Well, biology is the newest direction. It's picking up. The Institute is not a place to build experiments and laboratories. It's theoretical. Theoretical biology is still a new field that is developing – very, very important – and the connection with the natural sciences and physics and math is very important. That is still being developed, still needs work to help expand it. The Institute is doing that. I don't know of new directions. I have not thought about it. That's clearly something to think about, if there are new directions to go into. I think, clearly, astrophysics and physics are very, very important and need to be strongly supported.

We still have to see where it's [theoretical biology] going to lead. It's still a developing field, but the connection between physics and cosmology and astrophysics is very important; these fields are now united in Bloomberg Hall, which is great. There's lots of talks and exchange of ideas and collaborations among them as well as the mathematicians. I have not thought about other fields, but that's obviously something to think about, always.

Linda Arntzenius: Now that John is gone and his legacy continues, what sort of relationship do you have with the Institute? Is it a social relationship? Do you come to events?

Neta Bahcall: Yes. I continue a close relationship with the Institute. For me, it's still home; will always be home. The University is also home for me. When I come here, I can still see John walking the pathways. That always will remain. I have both professional and social connections. Because of the astrophysics, I of course still come to the seminars, to the lunches, and I talk with many of the astrophysicists here.

There are sometimes discussions about directions. I participate in that, whenever I'm asked to do that. And, of course, many social events – I'm still going to the Board of Trustees events and other lectures and concerts. It's continuing – it's not the same for me, obviously, but I continue with both professional and social connection. It will always be a home for me.

Linda Arntzenius: What do you know of the new Director[32]? Is he someone that you…

Neta Bahcall: No, I don't know him, but it sounds very exciting.

Linda Arntzenius: He's so young.

Neta Bahcall: He's very young. He sounds wonderful. Sounds like an outstanding scientist in his own right, and that's always very, very important. All the Directors that I have known over the time have been just wonderful.

Linda Arntzenius: Do you think the Institute changes with each Director? Do you think the Director has a sort of impact on the culture of the place?

Neta Bahcall: Directors have a big impact on the Institute. They can ensure that the atmosphere of the Institute is a good and supportive and friendly and collegial one. They bring the resources needed to ensure the successful operation and activities of all the IAS groups; making sure that the Institute continues to bring the best scientists and scholars and providing them with the resources and freedom to do their outstanding work; continuously thinking about new directions to open at the IAS; raising funds, bringing enough resources, working with the Board of Trustees. Each Director does it in their own way; they've all been wonderful. I've been friends with many of them.

I've dealt with Peter Goddard quite a bit and I'm enormously impressed with him. Just like in any field, you have your imprint in your own way if you are very good at what you do. They've all been very good at what they did. I'm very impressed with them. The Board has been, from what I can tell, and from all the years when John was here, an extremely remarkable group of people – just an amazing group of people.

I know when John passed away, they asked me, "What can we do? What should we do in astrophysics now? How do we make sure that it continues? What can we do to keep John's name and legacy

[32] Robbert Dijkgraaf (1960-), Member in the School of Natural Sciences, 1991-1992; Visitor, 2002; IAS Director and Leon Levy Professor, 2012- .

alive here?" We came up with the John Bahcall Fellowships to all the long-term Members in astrophysics, among other things. They have been just amazing. Rick Black – John was the Richard Black Professor - has been wonderful. He helped establish the John Bahcall Fellowships. Charles Simonyi has been wonderful. Shelby White, Jim Wolfensohn, Jim Simons – so many of them have been remarkably helpful, supportive, and caring. They loved John.

Linda Arntzenius: Well, I've come to the end of my questions. I do have one other, which is simply to ask you if there's a question that you had expected me to ask, which I haven't. Or is there a topic you expected me to cover, which we haven't? So if there's anything you want to add, if you want to look over your notes.

Neta Bahcall: No, I think you covered everything very well. I know one thing that you were thinking, that you asked me by e-mail, was, "What was John's legacy here?" I think we sort of covered that, but I can say that John's legacy for the Institute and for astrophysics is the creation of a world-class, top-ranked astrophysics group at the Institute, of being an inspiring mentor to generations of astrophysicists. Many of them went through the Institute, but many not. John's legacy as an inspiring mentor who helped change young scientists' careers and lives is well known; they are now leading scientists all over the world. John's legacy is his scientific discoveries and his leadership of the national and international astronomical communities as president of different societies, the Decadal Surveys, Congressional advice of the Hubble Space Telescope and other space missions. And of his scientific contributions -- from the solar neutrino, an amazing discovery that he was fortunate to bring to a spectacular conclusion after 40 years of hard work and exciting and fun work, but also many other fields: dark matter, quasars, galaxy, and many other research fields. All of these are John's legacy, which will live forever. Some are summarized in his 600 publications and books. These are his legacies; and of course, his family, his children!

Linda Arntzenius: Thank you very, very much for giving me your time.

Neta Bahcall: It was a pleasure.

[End of Audio]