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**Oral History Project
Interview Transcript**

**Eugenio Calabi
Interviewed by Linda Arntzenius
January 21, 2016**

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Date: 21 January 2016

Eugenio Calabi, Professor Emeritus of the University of Pennsylvania, was born in Milan on 11 May 1923. He was a Member in the Institute for Advanced Study's School of Mathematics from 9.19.58 to 7.6.59; from 9.21.79 to 12.21.79; a Visitor from 1.7.80 to 3.28.80; and a Member from 1.2.83 to 4.15.83. He was interviewed in his home in Bryn Mawr, Pennsylvania, on January 21, 2016.

*Eugenio Calabi:*¹ We [my parents, siblings and I] left Italy for political reasons in 1938². With an American immigration visa I went to New York and I started at MIT in chemical engineering. Then I was drafted.

Linda Arntzenius: Oh, you were drafted.

Eugenio Calabi: I was drafted in 1943.

Linda Arntzenius: When you turned 18?

Eugenio Calabi: I was 20 then. We had deferment because we were students but I got drafted in '43 and I served for two and a half years. Then I was discharged and after the end of the war in Europe I came home. In 1946 I finished at MIT.

Linda Arntzenius: Did you benefit from the GI Bill?

Eugenio Calabi: That's right. After graduating I started looking for jobs and got some nondescript jobs, a couple of jobs related to chemical engineering, but by that time I had decided to study mathematics. My parents and two of my siblings had gone back to Italy.

Linda Arntzenius: So you were on your own here.

Eugenio Calabi: I was here on my own. But I had family, extended family and I kept in touch with them. I applied to graduate school and after a brief training period--sort of catching up at the University of Illinois--I entered Princeton in fall of '47.

Linda Arntzenius: Why did you choose Princeton?

Eugenio Calabi: Because I applied to Princeton and Harvard and got admitted [to both]. The question of housing was easier at Princeton. [*Laughter*]

Linda Arntzenius: Did you know anyone at Princeton?

¹ Eugenio Calabi (1923-), Member in the School of Mathematics, 1958-1959, 1979, 1983; Visitor, 1980.

² See two pages of text appended to this transcript from Prof. Calabi, in which he gives a brief summary of the early stages of his career.

- Eugenio Calabi:* Well, I had known Guido Fubini³ an Italian mathematician who had died three years earlier but otherwise, I didn't know anybody really.
- Linda Arntzenius:* Did you know anything about the Institute at that time?
- Eugenio Calabi:* Yes. With my family I had visited Guido Fubini.
- Linda Arntzenius:* He was a Member [of the Institute] at one point.
- Eugenio Calabi:* He was a Member, yes. But during the war, he did some government work at NYU, I believe. But he was a Member of the Institute and he had an office in the old Fine Hall⁴.
- Linda Arntzenius:* That's right.
- Eugenio Calabi:* I really got to know him when I was a student in my second year at Princeton when we started attending some of the seminars at the Institute.
- Linda Arntzenius:* The Institute, let's see, it had moved from the university and it was now in its new building, Fuld Hall.
- Eugenio Calabi:* Yes, by 1947 Fuld Hall was the only building.
- Linda Arntzenius:* Was it cramped with people? Were there a lot of people there?
- Eugenio Calabi:* There was quite a bit because about 50 percent of the Institute was the School of Mathematics. I even attended one or two lectures by Einstein.⁵
- Linda Arntzenius:* I understand you also lived very close to Einstein.
- Eugenio Calabi:* One year, the year 1950, I lived in a home--I think it was number 28--right next door. The family had extra space and rented it. They rented a room to people and next door was Einstein. The landlord was a lawyer himself or a businessman, I can't remember. Once he asked me if I would care to meet Einstein personally and I said sure and I had a little interview with him.

³ Guido Fubini (1879-1943), Member in the School of Mathematics, 1939-1942. Fubini, known for Fubini's Theorem and the Fubini-Study Metric, had fled Italy in 1939 when Mussolini's Fascists adopted the anti-Jewish policies advocated by Hitler's Nazis.

⁴ Until the Institute for Advanced Study finished construction on Fuld Hall, its Faculty and Members worked in Fine Hall on the campus of Princeton University.

⁵ Albert Einstein (1879-1955), Professor in the Schools of Mathematics and Natural Sciences, 1933-1946; Emeritus Professor, 1946-1955.

Linda Arntzenius: You didn't play the violin for him?

Eugenio Calabi: No.

Linda Arntzenius: But you played the violin, right?

Eugenio Calabi: Yes, I played the violin. We just spoke a little bit on generalities. After all, we both had a European background.

Linda Arntzenius: Did you speak in English?

Eugenio Calabi: In English with him. I speak a little German but not well.

Linda Arntzenius: The Institute had a reputation for being a haven for Jewish people in the early days. Is that the reputation it had in the early '50's?

Eugenio Calabi: We were aware of it as one of the motivating ideas behind its founding but it was not a dominant fact.

Linda Arntzenius: You were focused on mathematics?

Eugenio Calabi: Yes. It was quite dramatic. I mean it [the Institute] played a very important role in my education because I was learning parts of mathematics from people who were the pioneers.

Linda Arntzenius: Who were these people?

Eugenio Calabi: Some of the seminars I attended essentially because of the glamour of the names like Hermann Weyl,⁶ Carl Ludwig Siegel,⁷ and Kunihiko Kodaira⁸ who was sometimes visiting at the Institute and sometimes at Princeton University. Another person I had known as an undergraduate at MIT from the mathematics department, Donald Spencer, came to the University as a professor and I worked quite a bit with him. Although, we never published any joint papers, we worked on a problem that was done by other people. He was a longtime collaborator.

Linda Arntzenius: This was a formative experience for you.

Eugenio Calabi: Oh, yes.

⁶ Hermann Weyl (1885-1955), Professor in the School of Mathematics, 1933-1951; Emeritus Professor, 1951-1955.

⁷ Carl Ludwig Siegel (1896-1981), Member in the School of Mathematics, 1935, 1940-1945, 1960; Professor, 1945-1951.

⁸ Kunihiko Kodaira (1915-1997), Member in the School of Mathematics, 1949-1952, 1957-1961., known for work in algebraic geometry and the theory of complex manifolds, was awarded the Fields Medal in 1954.

Linda Arntzenius: Are we talking now about your year as a Member or when you were an undergraduate?

Eugenio Calabi: When I was a graduate student, when I got my doctorate in 1950. I stayed on for another year for half a term and then my first job was at LSU [Louisiana State University], but I came back again on a post doctoral to Princeton. That's when I met my wife who was visiting relatives.

Linda Arntzenius: So that would be 1958?

Eugenio Calabi: 1952. Marston Morse⁹ suggested I apply to the Institute at the time. I can't remember the first time he contacted me but I didn't get to become a visiting Member until 19—well--

Linda Arntzenius: I think it was 1958.

Eugenio Calabi: That's right. 1958 to 1959.

Linda Arntzenius: So you were married by that time.

Eugenio Calabi: Yes, I was married in 1952.

Linda Arntzenius: Did you have any children?

Eugenio Calabi: We had two children.

Linda Arntzenius: Did they come with you when you went to the Institute for the year?

Eugenio Calabi: One of them was there the other one wasn't born. Our daughter was one to two years old that year.

Linda Arntzenius: How wonderful. So she was at the Institute too.

Eugenio Calabi: Oh, yes, although she cannot remember it.

Linda Arntzenius: Do you remember what you worked on that year and who you worked with?

Eugenio Calabi: Yes, in fact that's when Kodaira was also visiting. He and de Rham¹⁰ from Switzerland had a joint seminar in 1950, in the early part of 1950. Kodaira was then at the University. He was a longtime collaborator with Spencer.

⁹ Marston Morse (1892-1977), Professor in the School of Mathematics, 1935-1962; Emeritus Professor, 1962-1977.

¹⁰ Georges de Rham (1903-1990), Member in the School of Mathematics, 1950, 1957-1958. Swiss mathematician known for his contributions to differential topology.

Linda Arntzenius: Don Spencer.

Eugenio Calabi: Donald Clayton Spencer, D.C. Spencer¹¹.

Linda Arntzenius: When you came to the Institute as a Member and when you were in Princeton as a graduate student, as a postdoc, Oppenheimer¹² was the director.

Eugenio Calabi: Yes.

Linda Arntzenius: Did he interview you when you came?

Eugenio Calabi: Yes, he interviewed me when I came as a Member.

Linda Arntzenius: Tell me about that.

Eugenio Calabi: He just asked me just general questions, nothing specific.

Linda Arntzenius: How was he perceived at that time? Can you remember?

Eugenio Calabi: My first piece of work was becoming slightly known. It was known as the Calabi Conjecture. It was a paper, an incomplete paper, with the idea of a program, that I had published in the abstracts both at the International Congress and at a meeting of the American Mathematical Society. I remember writing it to my advisor, Salomon Bochner¹³ [at Princeton University]. He was my thesis advisor. I didn't have the full theorem, so he said that's very nice but what can you do with it? [*Laughter*]

Linda Arntzenius: He wanted more.

Eugenio Calabi: I'm sorry, I have to go into specifics here. I came at the problem from its geometrical aspects but the difficulties were really from partial differential equations and analysis. My training was not very strong in that; I was learning it. I was on leave from my then permanent job at LSU and while there I had started learning a little bit more, sort of rounding off my graduate training. And I also got an offer, a visiting offer at the time--this was 1952--at Caltech. I spent

¹¹ Donald Clayton Spencer (1912-2001) had positions at MIT and Stanford before his appointment in 1950 at Princeton University, where he was involved in a series of collaborative works with Kunihiko Kodaira.

¹² J. Robert Oppenheimer (1904-1967), IAS Director, 1947-1966; Professor in the School of Natural Sciences, 1966-1967.

¹³ Salomon Bochner (1899-1982), Visitor on the Electronic Computer Project and Member in the School of Mathematics, 1945-1948.

a year at Caltech, 1954 to 1955. That's when I really started learning a little bit about analysis. They had a running seminar.

At the end of that year I had the first invitation, I think from Dr. Morse, to visit the Institute. At the time I thought of going to the Institute but then I also got an offer of a tenure track job. I was not going to go back to LSU and I accepted the offer from the University of Minnesota, which was at the time an important center in partial differential equations. Two people who had been at the Institute also, Paul Rosenbloom¹⁴ and Arthur Milgram¹⁵ essentially persuaded me to go to Minnesota and I asked to postpone my appointment at the Institute by one year. That year our daughter was born so we stayed on an extra year. So that's why we didn't get to the Institute until 1958.

Linda Arntzenius: Now when you go to dinner parties and you tell stories about the Institute, which I'm sure you have done, do you have any favorite stories about André Weil¹⁶ or Hermann Weyl or any of the people you worked with?

Eugenio Calabi: André Weil was a more intimidating person to approach.

Linda Arntzenius: I've heard that.

Eugenio Calabi: Hermann Weyl and Carl Ludwig Siegel were more accessible. Siegel worked in number theory. I didn't learn much from his seminar because it was a little over my head but the style of lecturing was great for both of them. Hermann Weyl was the host of the seminar that I attended or at least he started off on harmonic intervals but it was really conducted by de Rham and Kodaira. That was one of the formative things of my career.

There's a little story I have on that one. The mimeographed notes [became available] a few years later—it must have been around 1953 or 1954. I saw the announcement. I was in Louisiana and it was \$3.00 for the set of mimeographed lecture notes plus 14 cent postage. You could consider that a unique opportunity.

Linda Arntzenius: Yes, well worth the postage and well worth the \$3.00 presumably.

¹⁴ Paul C. Rosenbloom (1920-2005), Member in the School of Mathematics, 1953-1954, 1971-1972.

¹⁵ Arthur Milgram (1912-1961), Member in the School of Mathematics, 1946-1947.

¹⁶ André Weil (1912-1998), Member in the School of Mathematics, 1937; Professor, 1958-1976; Emeritus Professor, 1976-1998.

Eugenio Calabi: Yes, but the opportunity was even better! I wrote the check for “[symbol] Pi dollars.” When I got the cancelled check back, I saw that somebody had penciled in \$3.14. It was the same figure.

Linda Arntzenius: Ah, Pi dollars. I just got that, it took me a little while. I'm not a mathematician, obviously.

The other thing I wanted to ask you was if you came across John von Neumann¹⁷ at that time?

Eugenio Calabi: Yes, but I didn't have any contact with him. He was interested mostly in the development of the computer. He had an influence on some of my classmates at the graduate school because of his book with Morgenstern¹⁸ on games and economic behavior

Linda Arntzenius: Would Nash¹⁹ have been one of those [classmates]?

Eugenio Calabi: Yes, he was one of the people and so was David Gale who later went to Berkeley. And then another one and I can't remember, I cannot remember the name.²⁰ He [Lloyd Shapley] was the son of a well known astronomer from Harvard and he also went to work on the West Coast, also on game theory, and Martin Shubik, an economist. Together they developed a simple game to illustrate economic behavior. They called it “So Long, Sucker.”²¹ That was Nash. It was not a serious game to be publicized it was just played with poker chips, nothing else.

Linda Arntzenius: It must have been a very exciting time to be a young mathematician.

Eugenio Calabi: It was. Yes. It was the feeling of working in new areas of mathematics that were just being developed.

Linda Arntzenius: One of the remarks you made at the commencement speech at U. of Penn was that mathematics had changed a great deal. Was it changing at that point?

¹⁷ John von Neumann (1903-1957), Faculty in the School of Mathematics, 1933-1957.

¹⁸ *Theory of Games and Economic Behavior* by mathematician John von Neumann and economist Oskar Morgenstern, published by Princeton University Press in 1944, is considered the groundbreaking text upon which modern-day game theory is based.

¹⁹ John Forbes Nash, Jr. (1928-2015), Member in the School of Mathematics, 1956-1957, 1961-1964.

²⁰ In reviewing this transcript, Prof. Calabi recalled the name of Lloyd S. Shapley.

²¹ The board game, *So Long Sucker*, was invented in 1950 by John Forbes Nash, Mel Hausner, Lloyd S. Shapley and Martin Shubik. It is a four-person bargaining/economic strategy game. Each player begins the game with 7 chips, and in the course of play, attempts to acquire all the other players' chips. This requires making agreements with others that are ultimately unenforceable; to win, players must eventually go back on such agreements.

Eugenio Calabi: It was changing. It has evolved even since then, not only objectively but also subjectively. That is one thing that I recognized in myself that even my perspective on the subjects I was interested in was evolving as well as objectively. The fields were becoming popular; of interest in the general public.

Linda Arntzenius: You also made a remark about mathematics being in the field of science fiction.

Eugenio Calabi: Yes. Well that is also another idea. Historically geometry was born out of, essentially, building--making structures, buildings and so forth--the idea of making models and then enlarging them. You can enlarge tenfold from a model to fifty-fold; from a model to a building you can enlarge yourself fifty thousand fold ideally. So that is fictional but my best way to illustrate it to the public is with both hands and the fingers draw in midair two vertical lines.

Linda Arntzenius: Yes.

Eugenio Calabi: And then I ask the person well, I mean you can't see them but you imagine seeing them, right.

Linda Arntzenius: Yes.

Eugenio Calabi: And then I ask: "Are you sure they're perfect?" You can never see the lines really. You could see a scattering of chalk dust on the board or pencil marks on paper. And I would start asking make sure they're absolutely vertical. Are they parallel? Yes? You just proved to me you believe the earth is flat.

Linda Arntzenius: Indeed. But isn't Euclidian geometry good enough?

Eugenio Calabi: Nothing's good enough in mathematics. You idealize the world in which nothing is good enough. I mean the square root of two is a number nobody has seen, if you think of a number as an infinite succession of decimals. If we give you an ordinary number and ask is it an even or an odd number it takes two seconds.

Linda Arntzenius: Yes, that I can do.

Eugenio Calabi: Anybody can do that. My joke on that is this. If I give you a bean bag: is the number of beans in this bag even or odd? Well, my point is the concept of what is a Natural Number comes from counting first then finding short hands by digital. We now identify the digital short hand for numbers. Number purity is what makes us say three oranges with three apples. That notion is more primitive and we

have learned a more sophisticated [notion] with the decimal point. This is how mathematics evolves in our own mind, at any level.

Linda Arntzenius: It's quite extraordinary. I've interviewed a few mathematicians and I often get the feeling that mathematicians have a lot of fun.

Eugenio Calabi: Oh, of course. I mean it's the favorite subject of our conversation. The frustration of retirement is being cut off from it.

Linda Arntzenius: Are there many mathematicians that you still have contact with?

Eugenio Calabi: Some. But mostly through social contact.

Linda Arntzenius: Right. I don't suppose you have much contact with the Institute. What about the U of Penn?

Eugenio Calabi: Again, friends that we socialize with; some of the ones I know are mostly retired also. I don't really have any contacts at the Institute, except for Ed Witten.²²

Linda Arntzenius: Interesting. How did you and he come to be in contact?

Eugenio Calabi: He contacted me, at one point, apropos of this business that is known as the Calabi-Yau manifolds.²³

Linda Arntzenius: Does it have relevance for string theory?

Eugenio Calabi: It was based on it. In fact what gave me the largest amount of fame was when it became known outside of the field because of that.

Linda Arntzenius: That's interesting.

Eugenio Calabi: I've seen sketches of painting and sculptures based on Calabi-Yau. There was even an off-Broadway play in New York a musical with the title *Calabi-Yau*²⁴.

Linda Arntzenius: Oh, for heaven sake, I'm going to have to Google that.

²² Edward Witten (1950-), Member in the School of Natural Sciences, 1984; Professor, 1987- .

²³ A Calabi–Yau manifold, also known as a Calabi–Yau space, is a special type of manifold that is described in certain branches of mathematics such algebraic geometry and yields applications in theoretical physics, particularly in superstring theory. So-named by Candelas et al (1985) after Eugenio Calabi (1954, 1957) who first conjectured that such surfaces might exist and S. T. Yau (1978) who first proved the Calabi conjecture.

²⁴ The play, *Calabi-Yau*, was written by Susanna Speier with songs and music by Stefan Weisman in 2001. It was based on the bestselling book *The Elegant Universe* by Brian Greene. Directed by Michael Kraskin, it was performed at 145 Sixth Avenue, New York City, in 2002.

- Eugenio Calabi:* The musical was just fun. By chance I was at a meeting [in New York City] and I saw it in the paper so I went over there and said “do I get a free ticket.” No, I paid fifteen dollars!
- Linda Arntzenius:* Okay, you could subsidize them.
- Eugenio Calabi:* The character by the name of Calabi-Yau a woman singer of Chinese extraction, an Oriental. There was some kind of allusion to something very abstract.
- Linda Arntzenius:* That's amazing. Well, you never know how your work is going to influence someone else; that's quite extraordinary.
- Eugenio Calabi:* Yau²⁵ has been a frequent visitor at the Institute.
- Linda Arntzenius:* Yes, he has. Are you still in contact with him?
- Eugenio Calabi:* A little bit. I just say hello to him. Another person among the people at Harvard I used to know well or at various times at the Institute as well, is Raoul Bott.²⁶
- Linda Arntzenius:* Raoul Bott, yes.
- Eugenio Calabi:* And John Tate.²⁷
- Linda Arntzenius:* John Tate.
- Eugenio Calabi:* Emil Artin was one of the teachers at Princeton who influenced me. He was from Vienna. He was of Armenian extraction. I think his original name was Artinian but that I heard much later, I didn't know at the time, he was very German, very Germanic, actually.
- Linda Arntzenius:* When you were at the Institute, can you tell me something about the day to day working of the place. I know that the lunchroom was on the fourth floor in Fuld Hall.
- Eugenio Calabi:* Isn't it still there?
- Linda Arntzenius:* No, they have a completely new dining hall. So maybe you could draw a picture for me of what it was like in Fuld Hall with everyone there, even engineers on the electronic computer projects. Did

²⁵ Shing-Tung Yau (1949-), Member in the School of Mathematics, 1971-1972, 1979-1980; Professor, 1980-1984.

²⁶ Raoul Bott (1923-2005), Member in the School of Mathematics, 1949-1951, 1955-1957, 1971-1972.

²⁷ John T. Tate (1925-), Member in the School of Mathematics, 1959-1960.

people still sit, as they do now, the mathematicians here and [the historical studies people there...]

Eugenio Calabi: Yes.

Linda Arntzenius: Really?

Eugenio Calabi: I hardly ever spoke with them. I met one of the people, I can't remember his name, he was in school of Classics; he was a friend of a friend. I can't remember his name anymore.

Linda Arntzenius: Someone in the School of Historical Studies.

Eugenio Calabi: Yes.

Linda Arntzenius: But normally you would have behaved almost as if it was just a School of Mathematics?

Eugenio Calabi: That's right. There was a very distinct separation. Some people would come to the Institute for the purpose of completing some work that they were already compiling. Others were there for the purpose of sort of supplementing their own learning. As far as I was concerned it was more of a learning experience to sort of amplify on fields that I knew.

I have some funny episodes even going back to when I was a graduate student. I'm still trying to remember the name of the game theorist [Lloyd S. Shapley] who was the son of the Harvard astronomer [Harlow Shapley]; one the best known astronomers in the country at the time. I could probably look him up. He worked for this big government research agency in California. Not IDA, that's the Institute for Defense Analysis. But anyway, he, John Nash and a couple of others, we were interested in going to this seminar at the Institute that was run by de Rham and Kodaira on harmonic intervals. But there was a transportation problem because we were also attending classes at Fine Hall and from Fine to Fuld . . .

Linda Arntzenius: --is a good walk.

Eugenio Calabi: Well, we had the energy to walk but not the time, given our schedules. There was only one of us who had a car and that was the astronomer's son [Lloyd S. Shapley]. He was a late sleeper. Ordinarily he would sleep until 3 p.m. so we had to figure out ways to wake him up. John Nash, I think, at one point took a candle and as he was sleeping started pouring the molten wax into his ear!

I had a subtler method. I had a three-speed record player and I got one of his, what they called “lollipop records,” the 45 rpm. I took off the spider in the middle so it would be off center and played some music on it. So the frequency would go up and down.

Linda Arntzenius: I bet that woke him up. That would be awful.

Eugenio Calabi: Yes, well, it got him to drive us to the Institute from the graduate college, which was about halfway [between Fine and Fuld].

Linda Arntzenius: That's funny. We'll have to figure out who that was. So those were happy times?

Eugenio Calabi: Sure it was.

Linda Arntzenius:: Did you have any Eureka moments at the Institute?

Eugenio Calabi: Yes, I think so. The paper I wrote with Vesentini²⁸ at the end of 1959.²⁹ This was partly influenced by Kodaira's work on deformation theory. But the paper that I wrote with Vesentini is now largely forgotten because the main theorem was then supplemented by work by Mostow³⁰ at Yale.

Linda Arntzenius: Were they having afternoon tea then?

Eugenio Calabi: They did, both at Fine Hall and at Fuld Hall. So depending on where we were, we'd take one or the other.

Linda Arntzenius: What brought you back to the Institute later on? You came back in '79 and then you came back again in '80 and then in '83.

Eugenio Calabi: In 1979 I was also taking time off from teaching. I'd just had a coronary bypass operation.

Linda Arntzenius: So young.

Eugenio Calabi: The operation was in 1978 but I just was on sabbatical leave from Penn. I was in Minneapolis from '55 to '64.

²⁸ Edoardo Vesentini (1928-), Member in the School of Mathematics, 1958-1959.

²⁹ “On Compact, Locally Symmetric Kahler Manifolds” by Eugenio Calabi and Edoardo Vesentini, published in *Annals of Mathematics*, Second Series, Vol. 71, No. 3 (May, 1960), pp. 472-507.

³⁰ George Daniel Mostow (1923-1917), Member in the School of Mathematics, 1947-1949, 1956-1957, 1975, 1990. Mostow, the Henry Ford II (emeritus) Professor of Mathematics at Yale University, served as a Trustee of the Institute for Advanced Study from 1982 to 1992. In 1993 he received the AMS Leroy P. Steele Prize for Seminal Contribution to Research and, in 2013, he was awarded the Wolf Prize in Mathematics.

Linda Arntzenius: And then Penn.

Eugenio Calabi: And then Penn.

Linda Arntzenius: So you came to the Institute for a brief time in '79 and then again in '80 and '83. Were you working on particular problems?

Eugenio Calabi: In '83 I was still working on some problems in complex differential geometry. We called it complex differential geometry or numbers. It was also called Kähler geometry.

Let's see if I remember anything else that may be worth remembering. I was taking years of leave in various places. One year I spent also at the IHES [Institut des Hautes Etudes Scientifiques]. I was there on two occasions, another time I think I was recovering from another procedure.

I remember meeting Veblen but he was already past his prime.

Linda Arntzenius: Oswald Veblen³¹.

Eugenio Calabi: Yes, also from 1959 there was one of the permanent members [i.e. Faculty] of the Institute what was his name?

Linda Arntzenius: Gödel?³²

Eugenio Calabi: No, not Gödel. Whitney.³³

Linda Arntzenius: Was it Hassler Whitney?

Eugenio Calabi: Yes. He was there at that time. I remember playing some piano quartets at one of the Members' [homes] and there was a photographer from *The National Geographic* and it appeared around 1960 in *The National Geographic*, an article called "From New Jersey" and it included the Institute as one of the features in that number of the *Geographic* magazine.

Linda Arntzenius: I shall look for that.

Eugenio Calabi: The picture was taken early 1959 and appeared in 1960. Although I didn't have mathematical contact with Whitney, he was a musician.

³¹ Oswald Veblen (1880-1960), Professor in the School of Mathematics, 1932-1950; Emeritus Professor, 1950-1960.

³² Kurt Gödel (1906-1978), Member in the School of Mathematics, 1933-1935, 1938, 1940-1953; Professor, 1953-1976; Emeritus Professor, 1976-1978.

³³ Hassler Whitney (1907-1989), Professor in the School of Mathematics, 1952-1957; Emeritus Professor, 1977-1989.

- Linda Arntzenius:* Yes, they often say that mathematicians and musicians have something in common.
- Eugenio Calabi:* Well there is an overlapping interest but again, there are some mathematicians who have no taste for music and vice versa. Some people correlate the two.
- Linda Arntzenius:* Harry Woolf³⁴ was the director when you were [at the Institute] in the later years. Do you remember him?
- Eugenio Calabi:* I remember the name vaguely.
- Linda Arntzenius:* You didn't have much contact with him.
- Eugenio Calabi:* No.
- Linda Arntzenius:* Freeman Dyson³⁵ has described scientists and perhaps by extension we could include mathematicians . . .
- Eugenio Calabi:* Well, he started off as a mathematician. He was a number theorist, a very English field in mathematics, the geometry of numbers.
- Linda Arntzenius:* He said that scientists are either leaders who form groups around them or they are "lone wolves." Would you agree with that? Do you think you could categorize your colleagues in that way?
- Eugenio Calabi:* These are the two extremes. I'm not very sociable but I depend on contacts. There are people who work in groups. The most famous example, you've probably heard of, is Bourbaki³⁶.
- Linda Arntzenius:* Bourbaki, I have, yes.
- Eugenio Calabi:* The name was borrowed from the name of one of the people, originally North African, who became one of the big generals, field marshals, in France under Napoleon the Third. His first name was a more common French name, Nicolas. Nicolas Bourbaki was the name of the fictional mathematician that was invented for the group in France. Andre Weil was one of the founders of the group.

³⁴ Harry Woolf (1923-2003), IAS Director, 1976-1987; Professor-At-Large, 1987-1994; Emeritus Professor, 1994-2003.

³⁵ 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- .

³⁶ Nicolas Bourbaki is the collective pseudonym for a group of, mainly French, 20th-century mathematicians officially known as the *Association des collaborateurs de Nicolas Bourbaki* (Association of Collaborators of Nicolas Bourbaki), who aimed to ground mathematics in set theory. They wrote a series of books and their work led to several discoveries and influenced modern branches of mathematics.

- Linda Arntzenius:* Who stands out in your mind as being the most influential person on *your* career?
- Eugenio Calabi:* Well, Bochner, Spencer, Kodaira and de Rham. And then later another one who shaped one of my later interests in mathematics was one I never met actually, Blaschke.³⁷ He was from Austria. He died around 1960 but I never met him.
- Linda Arntzenius:* So his work influenced you.
- Eugenio Calabi:* Yes. By chance I came across one of his books. When I first arrived in Louisiana one of the senior members there had just passed away and his widow was selling his books. I bought one of them and it played a big influence.
- Linda Arntzenius:* Do you think places like the Institute are necessary even today?
- Eugenio Calabi:* Well, nothing is necessary but they play a positive, beneficial role.
- Linda Arntzenius:* I guess what I'm getting at is what role does it play now? Because I know when it started it was unique but now there are other places...
- Eugenio Calabi:* Oh, yes, it has been imitated.
- Linda Arntzenius:* Yes. And there are also places for research in most universities. So what unique role does the Institute play *now*?
- Eugenio Calabi:* It's still continuing. The role has evolved probably. I cannot assess how it has evolved from the time when I was there but it was a place where you could bring yourself up-to-date. That was the impression I had when I was there. I was learning in fields that were being developed, whatever we were able to follow at the time. I'm sure it has the same role but there are fields that I don't understand.
- Linda Arntzenius:* Yes, there are many more. There are four schools now.
- Eugenio Calabi:* Yes, but even in mathematics I cannot . . . I still get the "Notices of the American Math Society" that has the abstracts of some of the papers and most of them I don't understand anymore.
- Linda Arntzenius:* That's fascinating. There's also a new program in biology.
- Eugenio Calabi:* Oh yes, I think you are referring to mathematical biology.

³⁷ German mathematician Wilhelm Johann Eugen Blaschke (1885-1962) made major contributions to geometry.

Linda Arntzenius: And that's a field that was unheard of maybe 15 or 20 years ago. It's quite extraordinary isn't it? If you were a young man starting out again today what field in mathematics would you go into?

Eugenio Calabi: I don't know. I would have to be sparked by something. The interest gets sparked by something that you learn. The process of learning is a process of finding something you can do better than the person you're learning from. That's the best incentive for research. You're learning and you grasp something and you partially understand it maybe and then in reconstructing it you develop it further. It is unrelated to the recognition you get. The result, the one mathematical result that I'm most proud of is one that got some notice at the time but it is surpassed now.

Linda Arntzenius: Why was it so satisfying to you?

Eugenio Calabi: Because I had put together information and techniques that I learned from different sources. It was in partial differential equations and it was my first result in a field that I had not studied where I brought in contributions that were inspired by geometry. But again, that was not a novel idea. You've heard of the term, partial differential equations?

Linda Arntzenius: I have, yes.

Eugenio Calabi: The most prominent technique in establishing solutions of partial differential equations is--using another technical term--*a priori* estimates. I learned the expression at a meeting, having never heard it in the graduate courses, and I started focusing on that and asking how do you get the ideas. You know that an equation cannot have more than one solution. I put it in very simple terms. And then, does a solution actually exist? Examples were given already of equations that have no solutions.

Linda Arntzenius: Did Gödel's work have an impact on your work?

Eugenio Calabi: No, Gödel worked mostly in mathematical logic, a field that I never studied.

Linda Arntzenius: I think I have come to the end of my questions so if there's anything you wanted to tell me about the Institute before we conclude?

Eugenio Calabi: It is an inspiring place. It's a place where, again, on a personal level I would find it difficult to make a career there as a permanent [Faculty] member. It is a refreshing experience for most people who are drawn to a change of venue to develop new areas of interest

and expand on their own. And then I feel the need to return to my own cubbyhole.

Linda Arntzenius: Did you like teaching? A lot of people say they wouldn't want to be on the permanent faculty of the Institute because they love to teach.

Eugenio Calabi: That is something I came to realize only later in life. My interest in teaching was very limited. I was more interested in the research aspect. Later in life as I became aware of the evolving perspective of mathematics I think teaching became more important. In other words, you have to develop ideas by expressing them. That's part of the aging process. You get ideas by absorbing first and by developing later.

Linda Arntzenius: Has teaching given you a lot of pleasure over the years or has that mostly come from your research.

Eugenio Calabi: Yes [mostly from research], my teaching achievements have been very limited.

Linda Arntzenius: I want to thank you very, very much for participating in the oral history project. Are there any people that you can recommend that I should speak to further about their experiences connected to the Institute?

Eugenio Calabi: In Princeton, there is Joe Kohn,³⁸ Joseph Kohn.

Another name I remember was a fellow student. Your accent reminds me of him, Murray McBeath. He was Scotch-Irish. He was from Belfast.

Linda Arntzenius: And is he still around?

Eugenio Calabi: I don't know. He moved to Pittsburgh. I haven't heard about him.

Linda Arntzenius: And when did you know him?

Eugenio Calabi: He was a graduate student.

Linda Arntzenius: I wonder if you knew John Milnor.³⁹

³⁸ Joseph John Kohn (1932-), Member in the School of Mathematics, 1957-1958, 1961-1962, 1976-1977, 1980-1981, 1988-1989, 2000, 2001.

³⁹ John Willard Milnor (1931-), Member in the School of Mathematics, 1966; Professor, 1970-1990; Visitor, 1999, 2002. Milnor, known for his work in differential topology and a distinguished professor at Stony Brook University, is to date one of only four mathematicians to have won the Fields Medal, the Wolf Prize, and the Abel Prize (along with Pierre Deligne, Jean-Pierre Serre and John G. Thompson).

Eugenio Calabi: Jack Milnor, yes. He was a few years younger but he became known because of his work; he was “discovered” when he was still officially an undergraduate and became a beacon in his field.

Linda Arntzenius: Was he at the University when you were there?

Eugenio Calabi: Yes. He graduated about a year after, he got his degree just slightly after I did.

Linda Arntzenius: What was he like?

Eugenio Calabi: Very quiet. Very modest. He was still an undergraduate when he actually solved a problem in one of the classes in Fine Hall. And then I remember when he did his work which made him really famous in 1965--the fact of the early existence of the non standard spheres.

Linda Arntzenius: That's not a field that I'm acquainted with I'm sorry to say.

[End of Audio]

[Audio continued after a few minutes to capture Prof. Calabi's comment on John Nash]

Eugenio Calabi: [Nash] had been invited to give a talk on his work which was well known in geometry.

Linda Arntzenius: This was in '59?

Eugenio Calabi: Yes. It was a meeting to come at Columbia. But he had shifted his interest and thought he had some ideas on the Riemann Hypothesis. And he came to consult with [Atle] Selberg.⁴⁰ Selberg told me later that he had told Nash that these ideas had been tried before and were known not to work. Nash couldn't take it. He was not an easy person to have as a guest. He had come down from MIT. That weekend I was up actually up at MIT giving a talk and I came back—I hurried back because Giuliana, my wife, said it was very hard to handle him. He was there with his wife [Alicia] and he was a bit unsettled.

Linda Arntzenius: So he was already showing signs of his breakdown.

Eugenio Calabi: Oh yes. We didn't realize that he was mentally sick until he broke down actually in the next two days.

⁴⁰ Alte Selberg (1917-2007), Member in the School of Mathematics, 1947-1951; Professor, 1951-1987, Emeritus Professor, 1987-2007.

Linda Arntzenius: How sad. Could you have predicted that? I mean were there signs of that when he was younger?

Eugenio Calabi: He was peculiar, it was clear, because he was always asking strange and unexpected questions. But we accepted peculiar--people with peculiar behavior and traits.

[End of Audio]

I penciled some corrections and clarifications in the notes of our dialogue, and am adding below a brief summary of the earlier stages of my career.

My family (my parents, siblings, and I) left Italy in 1938 to escape from the racial laws being enacted, and immigrated to the United States in 1939. That fall, I entered as a freshman at MIT, and started my studies in Chemical Engineering. In 1943 I was drafted into the US Army, where I served during World War II. Upon my discharge, early in 1946, I returned to MIT (under the GI Bill) to get a B. S. degree in June 1946.

For the next few months, I worked briefly as a chemist, but soon decided to shift my education to Mathematics; the GI Bill at this point helped me substantially. I attended the University of Illinois, in Urbana, IL, and obtained an M.A. degree in September 1947: it was there that I found that the focus of my mathematical interests was going to be in Geometry.

In the fall of 1947 I was admitted to Princeton University; the following year I attended a course in Differential Geometry, given by Prof. Salomon Bochner offered: it was there that I had my first exposure to the field of Kähler Geometry, the special area of Mathematics in which I wrote my doctoral dissertation in 1950, under Bochner's direction; much of my later research continued to be in that special field.

It was during this period (1947 – 1950) that I had my first contact with the I.A.S. I remembered especially a seminar, in 1948-49, consisting of a series of lectures by Hermann Weyl and Carl Ludwig Siegel on the Riemann Hypothesis. In the last year (1949-50) there was a celebrated seminar at the I. A. S., introduced by H. Weyl, and conducted by Georges deRham and Kunihiko Kodaira, on Harmonic Integrals. As far as I can remember, it was the first exposition in this country of a theory developed by W. V. D. Hodge in the 1930's. I was part of a group of Princeton graduate students that followed it faithfully, and then studied notes that were distributed, first as mimeographed notes, later edited into a classic textbook on the subject.

In February 1951 I was accepted an Assistant Professorship at Louisiana State University, but went on leave the following academic year (1951 – 52), on a post – doctoral research fellowship, back to Fine Hall, Princeton. Several important events in my life took place in the course of that year: I met and married my wife, my first research papers were published, and I started on a program in Kähler geometry, in the variational calculus of Kähler metrics, and published the first abstract of what became known later as the Calabi conjecture.

After two more years at L. S. U., I accepted a visiting position at Caltech for the year 1954 – 55. During that period most of my professional efforts were directed to studying the field of Elliptic Partial Differential Equations (P. D. E.), hoping to complete a proof of my Conjecture. Toward the end of that year Prof. Marston Morse suggested for the first time that I apply for a visiting position at the I. A. S.: at that time I declined, because I had just accepted a tenure track position at the University of Minnesota, where there were already two well known specialists in P. D. E., Arthur N. Milgram and Paul C. Rosenbloom.

It took three more years before I could finally come to spend a year (1958 – 59) at the I. A. S. My main activity then was to follow a seminar course by K. Kodaira on his work in Deformation Theory: that study resulted in a joint paper with E. Vesentini,

another visitor at the Institute, in which we proved the rigidity of irreducible, compact, locally symmetric Kähler manifolds.

In conclusion, I want to express my gratitude for the repeated opportunities I have had, while on leave from my regular teaching duties, to spend periods of just study and research at places like the I.A. S., the I. H. É. S., and in Germany, and for the contacts I could cultivate with colleagues and leaders in my academic specialties.