1. In Conversation with Professor Michel Waldschmidt

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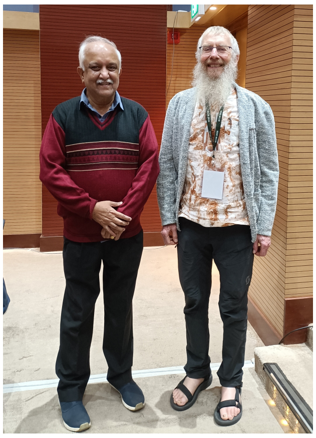
I had an opportunity, yet again, to meet Michel Waldschmidt, currently an Emeritus Professor at Sorbonne University, Paris, in the 'Indo-European Conference in Mathematics' jointly organized by The (Indian) Mathematics Consortium and the European Mathematical Society, held at SPPU and IISER Pune campuses during January 12-16, 2026. Our very long association of (at least twenty years) could make this interview easier and less formal. We had long chats over the days of the conference, whenever this 'polymath' was less busy.



Author with Michel Waldschmidt

Michel was born on June 17, 1946 at Nancy, France and he was closing on eighty years at the time of this meeting. So, our conversations started with a 'Happy Eighty' wishes in advance. He had visited India more than fifty times, Cochin, at least thrice. During his visits to Cochin, he was my celebrity guest at Cochin University of Science and Technology.

Michel Waldschmidt is an internationally acclaimed number theorist specializing in transcendental number theory. Waldschmidt was educated at Lycée Henri Poincaré and the University of Nancy until 1968. In 1972 he defended his thesis, titled 'Algebraic independence of transcendental numbers', guided by Jean Fresnel of the University of Bordeaux, France.

He was a research associate of the French National Centre for Scientific Research (CNRS) at the University of Bordeaux during 1971-1972. He was then a lecturer at Paris-Sud 11 University in 1972-1973. The same year he became a lecturer at the University of Paris VI (Pierre et Marie Curie) and in 1973, became a professor there. He is a member of the Institut de mathématiques de Jussieu. He was also a visiting professor at several places including the École normale supérieure, an elite public higher education institution in France.

From 2001 to 2004, he was the President of the Mathematical Society of France. He is a member of several mathematical societies, including the European Mathematical Society, the American Mathematical Society and the Ramanujan Mathematical Society.

He has published more than 200 research papers and has advised twenty-one PhD students. From 2019-2022, he was a member of the Commission of Developing Countries of the International Mathematical Union. Also, he is Doctor Honoris Causa from Ottawa University, Canada.

Waldschmidt was awarded the Albert Châtelet Prize in 1974, the CNRS Silver Medal in 1978, the Marquet Prize of Academy of Sciences in 1980 and the Special Award of the Hardy-Ramanujan Society in 1986. In 2021, he was awarded the Bertrand Russell Prize (established in 2016, awarded every three years) by the American Mathematical Society.

The Citation of this prize reads as follows.

'The 2021 Bertrand Russell Prize is awarded to Michel Waldschmidt in recognition of his outstanding contribution to graduate schools and mathematical research in developing countries in all continents and of his sustained commitment to building bridges between mathematical communities around the world. Throughout his career, Waldschmidt has worked tirelessly to the development of graduate schools in tens of countries, both through lecturing and on advisory committees. Waldschmidt is a world expert in transcendental number theory and Diophantine approximation'.

It is quite exciting to read his response as well.

"To succeed Christiane Rousseau, who received the inaugural 2018 Bertrand Russell Prize of the AMS, is an honor and a privilege for me. Among the various ways which are recognized with this prize are our understanding of climate change, which was the topic of the first prize related with Mathematics of Planet Earth, and education in developing countries, which is the topic of the second one. I am very grateful to the AMS for attracting attention to this issue. As a member of the CIMPA, of the EMS CDC (Committee for Developing Countries of the European Mathematical Society), and of the IMU CDC (Commission for Developing Countries of the International Mathematical Union), I meet many colleagues who are committed to the improvement of mathematics in the least developed regions of the world. This prize is an encouragement for all of us to pursue. There were mathematicians in ancient civilizations in many places. There are talents all over the world. It is unfair that, because of the location of their birth, so many bright young people are not able to develop their skills. Even if programs like the IMU Program for Graduate Research Assistantships in Developing Countries (GRAID) may be a drop of water to put out the fire, like in the Legend of the Hummingbird, let us do our bit".

Having known so much about Michel, let us now get his specific answers to some of my questions.

AV 1: Can you please brief us about your parents, upbringing, school education and college days?

MW: I was born in Nancy, East of France, where I studied until I was 22 years old. I have been fortunate to have good teachers, at the high school (Lycée Henri Poincaré, where I studied during 9 years) and at the University. My mother Henriette (1920-2022) was from a peasant family, she was only 7 years old when her mother passed away, she grew up in an orphanage. My father Pierre (1913-1966) lost his father in 1914 at the beginning of world war I, later he became an engineer.

AV 2: What attracted you to Number Theory?

MW: During the academic year 1967-68, Shokichi Iyanaga (1906-2006), a renowned Japanese Number Theorist who had served in the University of Tokyo, Nagoya University etc., was invited at the University of Nancy by Jean Delsarte (1903-1968) for one full year. He was supposed to teach a course in Algebra. I liked it so much that I decided to work in this direction. Then I found that his course was based on Samuel's book Théorie algébrique des nombres (translated later from French to English as 'Algebraic theory of numbers').

Prof. Leopoldt

I had a permanent position at the University of Bordeaux in 1968, I started doing research under Jean Fresnel (1939-2025) one year later. He suggested me to investigate **Leopoldt's Conjecture (Box 1)**, named after the German mathematician Heinrich-Wolfgang Leopoldt (1927 - 2011), on the non vanishing of the p-adic regulator of a number field. After a few weeks during which he taught me how to do research, he suggested me to study the solution by Baker and Brumer of the abelian case of Leopoldt's Conjecture. This is how I started to work on transcendental number theory.

Box 1: Leopoldt's Conjecture

This conjecture, states that the p-adic regulator of a number field K does not vanish. The p-adic regulator is an analogue of the usual regulator defined using p-adic logarithms instead of the usual logarithms, introduced by H. W. Leopoldt (1962).

Leopoldt's conjecture is known in the special case where K is an abelian extension of $\mathbb{Q}$ or an abelian extension of an imaginary quadratic number field. Ax, James (1965) reduced the abelian case to a p-adic version of Baker's theorem, which was proved shortly afterwards by Brumer (1967). Mihăilescu (2009, 2011) has announced a proof of Leopoldt's conjecture for all CM-extensions of $\mathbb{Q}$. The proof uses Iwasawa's methods – especially Takagi Theory – for deriving his skew symmetric pairing, together with Kummer- and Class Field Theory.

AV 3: Did Srinivasa Ramanujan's works influence you?

MW: My first attempt to prove a new result (a very special case of Leopoldt's Conjecture) was for the first problem in Schneider's book on Transcendental Numbers (translated from German to

French by my earlier professor in Nancy, Pierre Eymard (1929-2010)). This problem is also called the **Four Exponentials Conjecture (Box 2)**, it was investigated by Alaoglu and Erdős (Trans. AMS 1944) in connection with Ramanujan's paper on Highly Composite and Similar Numbers. They asked this question to Siegel, who answered that he was not able to prove the full result but only a weaker statement, the Six Exponentials Theorem (Box 2) which was also proved by Serge Lang (1927-2005). Atle Selberg (1917-2007) told me that he tried to prove the Four Exponentials Conjecture but succeeded only to obtain the **Six Exponentials Theorem**. Atle Selberg (1917 - 2007) was a Norwegian mathematician known for his work in analytic number theory and the theory of automorphic forms, and in particular for bringing them into relation with spectral theory. He was awarded the Fields Medal in 1950 and an honorary Abel Prize in 2002, its founding year, before the awarding of the regular prizes began. He generally worked alone. **His only coauthor was Sarvadaman Chowla**.

In 1969, I thought that I had proved the Four Exponentials Conjecture, shortly after that I found a mistake. Fortunately, later, I had a new idea which enabled me to solve the eighth of Schneider's problems. As a matter of fact, this eighth problem was solved at the same time independently by Dale Brownawell. Both of us were surprised when we found that our solutions were published at about the same time in the Journal of Number Theory.

There are several other instances of my journey through number theory where Ramanujan's work occurred, for instance in connection with Yuri Nesterenko's proof of the algebraic independence of π, e^{π} and $\Gamma(1/4)$, where Ramanujan's modular functions P, Q, R play a key role.

Box 2: Four Exponentials Conjecture

In transcendental number theory, the four exponentials conjecture is a conjecture which, given the right conditions on the exponents, would guarantee the transcendence of at least one of four exponentials. The conjecture, along with two related, stronger conjectures, is at the top of a hierarchy of conjectures and theorems concerning the arithmetic nature of a certain number of values of the exponential function. The conjecture was considered in the early 1940s by Atle Selberg who never formally stated the conjecture. A special case of the conjecture is mentioned in a 1944 paper of Leonidas Alaoglu and Paul Erdős who suggest that it had been considered by Carl Ludwig Siegel. An equivalent statement was first mentioned in print by Theodor Schneider who set it as the first of eight important, open problems in transcendental number theory in 1957.

The related six exponentials theorem was first explicitly mentioned in the 1960s by Serge Lang and **Kanakanahalli Ramachandra**, and both also explicitly conjecture the above result. Indeed, after proving the six exponentials theorem Lang mentions the difficulty in dropping the number of exponents from six to four - the proof used for six exponentials "just misses" when one tries to apply it to four.

Six exponentials theorem is a result that, given the right conditions on the exponents, guarantees the transcendence of at least one of a set of six exponentials.

AV 4: How was your nomination as the President of the French Mathematical Society?

MW: When I was approached to become President of the Société Mathématique de France I was a bit reluctant; I do not regret that I accepted. During these four years from 2000 to 2004 I started to have many contacts, both in France and internationally. This is the time where I started to be involved with the CIMPA of which I served as a Vice President (from 2005 to 2009) while Michel Jambu was the Director. My connection with CIMPA goes back as early as 1983 (CIMPA was then only 5 years old) when I participated to a CIMPA School in Nice with John Coates (1945-2022). I still continue to be very active with CIMPA.

AV 5: Who all do you acknowledge your award to the Bertrand Russell prize by the American Mathematical Society?

MW: This prize that I received in 2021 is an acknowledgement of the activities of a large number of colleagues, either in CIMPA, in the CDC of EMS or IMU, in ICTP, or individually, who are devoted to the promotion of mathematics in countries which need it the most.

AV 6: Which do you consider to be your best paper?

MW:'Transcendance et exponentielles en plusieurs variables' Inventiones Mathematicae 63 (1981) N°1, 97-127. This is the paper where I answered a question of André Weil on Hecke characters of type A_0 and where I prove "half" of Leopoldt's Conjecture.

AV 7: How do you rate the Indian research in general, Number Theory in particular?

Prof. K. Ramachandra

MW: I first visited India in 1976, when I was invited by the late Professor K. Ramachandra (1933-2011) at the Tata Institute of Fundamental Research, Bombay. At that time TIFR was essentially the main centre for research in mathematics in India. Now, there are plenty of excellent research centers everywhere in the country. In particular, Number Theory is well developed; several mathematicians from abroad contributed to this development.

AV 8: There are plenty of simple looking conjectures in Number Theory. Goldbach's Conjecture (Box 3), Collatz Conjecture etc. What according to you, are major hurdles in solving such problems?

MW: I started to do research in 1969, I have witnessed amazing progress in mathematics. Among the main achievements, many have involved tools from parts of mathematics which were looking far from the precise open problem. I expect it will be the same for the solutions of the conjectures you mention. The most important point is that new ideas are needed.

Box 3: Goldbach's Conjecture

Goldbach's conjecture is one of the oldest and best-known unsolved problems in number theory and all of mathematics. It states that every even natural number greater than 2 is the sum of two prime numbers.

The conjecture has been shown to hold for all natural numbers less than 4×10^{18}, but remains unproven despite considerable effort.

The **Goldbach partition** function associates to each even integer the number of ways it can be decomposed into a sum of two primes. Its graph looks like a comet and is therefore called **Goldbach's comet**.

Goldbach's comet is the name given to a plot of the function $g(E)$, the so-called **Goldbach function** (sequence A002372 in the OEIS, see Box 4). The function, studied in relation to Goldbach's conjecture, is defined for all even integers $E > 2$ to be the number of different ways in which E can be expressed as the sum of two primes. For example, $g(22) = 3$ since 22 can be expressed as the sum of two primes in three different ways as $22 = 11+11$, $5+17$, $3+19$.

AV 9: Can you please share your experiences of meeting / interacting with Paul Erdős (1913-1996) and other legendary mathematicians?

MW: I met Paul Erdős several times, I invited him to have a lunch at my home - I missed the opportunity to have a joint paper with him. My Erdős number is only 2.(At this point I intervened and told him that my Erdős number is also 2, through Professor S. B. Rao, former Director of the

Indian Statistical Institute).

Often people ask me whether I had met Alexander Grothendieck; the answer is yes, but there are plenty of other famous mathematicians that I met. I wish to mention Shokichi Iyanaga, Paul Turan, Carl Ludwig Siegel, André Weil, Atle Selberg, Theodor Schneider, Kurt Mahler, Laurent Schwartz, K. Ramachandra, Alan Baker, John Coates, Pierre Cartier and many others, including some who are still alive: Enrico Bombieri, Jean-Pierre Serre, Wolfgang Schmidt.

AV 10: How was your feeling when you heard that Fermat's Last Theorem was finally settled by Andrew Wiles and Richard Taylor?

MW: There was important progress already in this direction, but the achievement by Wiles is really great.

AV 11: What according to you are major challenging problems in Number Theory and the whole of Mathematics?

MW: You have the list of Clay prizes, there are many more. For me **Schanuel's conjecture** is one of the most important challenges. You may know that, Schanuel's conjecture is about the transcendence degree of certain field extensions of the rational numbers, which would establish the transcendence of a large class of numbers, for which this is currently unknown. It is due to Stephen Schanuel and was published by Serge Lang in 1966. Schanuel received his Ph.D. in mathematics from Columbia University in 1963, under the supervision of Serge Lang. Later, he served also as a Professor Emeritus of Mathematics at University at Buffalo.

AV 12: Present generation in India are not keen on choosing Mathematics as a major topic of study. They get attracted with AI techniques. Any advice to such students?

MW: Unfortunately this is not only in India. But fortunately some members of the present generation are enthusiastic about mathematics. **I am not sure that the people who are spending their life trying to get as much money as possible have a more happy life than those who devote their time to do research in mathematics**.

AV 13: What are your thoughts on the recent AI boom? Quantum Computing?

MW: Mathematicians like Euler, Gauss and others, were also able to perform amazing computations, this was very important for their research. With the occurrence of computers, this skill is no more important for mathematicians nowadays. It seems to me that AI will have a similar effect on the way that mathematicians will do research, the skills which are essential now will not be the same as the ones which will be necessary later. We are not yet at that stage: **the answers to mathematical questions given by AI need to be checked very carefully, they often contain mistakes**.

As far as quantum computing is concerned, apparently even when quantum computers will exist, mathematics will be necessary for cryptography.

AV 14: What are your thoughts on Great Internet Mersenne Prime Search (GIMPS) project? I mean the techniques used in finding larger primes. I mean is it mathematically significant?

MW: It is an interesting project, I doubt that it will lead to significant progress. In a different vein, I often use and quote the **Online Encyclopedia of Integer Sequences (OEIS) (Box 4)** of Neil Sloane. This is a very useful tool, it helps also for making conjectures.

Box 4: On-Line Encyclopedia of Integer Sequences

The On-Line Encyclopedia of Integer Sequences (OEIS) is an online database of integer sequences. It was created in 1964, first as a handbook till 2009, by Neil Sloane, a British American Mathematician, then researching at AT & T Labs.

OEIS records information on integer sequences of interest to both professional and amateur mathematicians, and is widely cited. As of November 2025, it contains over 390,000 sequences. Every sequence in the OEIS has a serial number, a six-digit positive integer, prefixed by A. As examples A000040 -the prime numbers, A000045- the Fibonacci sequence, A000108 - the Catalan numbers etc.

A000602 is interesting to chemistry researchers also. This represents both the number of trees and alkanes. The entries, A003678, A018226, A174284 are useful to Physicists also. OEIS is a multifaceted facility. Integer sequences of interest to Economics, Biology, Linguistics etc. are also in OEIS.

Besides integer sequences, the OEIS also catalogs sequences of fractions, the digits of transcendental numbers, complex numbers and so on by transforming them into integer sequences. Sequences of fractions are represented by two sequences (named with the keyword ‘frac’): the sequence of numerators and the sequence of denominators.

AV 15: Which are the institutions abroad that you recommend to a math aspirant from India to choose a math career?

MW: First of all, India is now a strong country for mathematics, there are many excellent mathematicians, going abroad may not be the best choice. On the opposite, **I suggest new Ph.D. holders from outside the global south (as one says nowadays) to look at Indian institutions for postdoc positions.**

AV 16: Any other question that you would have loved to answer had I asked you?

MW: Above, I implicitly answered this last question by replying to questions slightly different from the ones you were asking.

Both of us laughed together at the last question and the unexpected answer.

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IECM-2026 (TMC Meeting)

Profs. Michel Waldschmidt and Ambat Vijayakumar (President, ADMA) being felicitated by Prof. J. K. Verma. Others: Profs. Sudhir Ghorpade, Vinod P. Saxena, S. A. Katre