Interview with Professor Ngô Bảo Châu

Neal Koblitz

In January 1989 I interviewed Hoàng Tụy, who was then Vietnam's most prominent living mathematician; that interview was published in *The Mathematical Intelligencer* the following year. At the time, a particular point of pride for friends of Vietnam — a point that I asked Hoàng Tụy to comment on — was that the previous year at the International Mathematical Olympiad (IMO) in Australia the Vietnamese team had had its best performance since Vietnam started competing in the IMO in 1974; Vietnam came in 5th, ahead of the 6th-place American team. What I did not know was that this result was in large part due to the perfect score achieved by a 16-year-old by the name of Ngô Bảo Châu.

Fast-forward 22 years, and on August 19, 2010, at the International Congress of Mathematicians in Hyderabad, the President of India formally bestowed the Fields Medal on Professor Ngô Bảo Châu. The Medal was given in recognition of his proof of the "Fundamental Lemma" about automorphic forms that had been a central unsolved problem in mathematics since it was conjectured by Robert Langlands and Diana Shelstad in the early 1980s.

Ngô Bảo Châu reached adulthood during a transition period from a time when most top math students in Vietnam went to the Soviet Union or Eastern Europe for advanced study to a time when they are more likely to go to Western Europe, Australia, or North America. Although he received his undergraduate and graduate education in France, Ngô Bảo Châu has maintained close ties to Vietnam, and he has a longstanding association with the Hanoi Mathematical Institute. In 2005 at the age of 33 he became the youngest person ever given the title of Full Professor in Vietnam. In recent years he has been a professor at Université Paris-Sud and at the Institute for Advanced Study in Princeton. In September 2010 he took a position at the University of Chicago.

NK: Please tell us about your early life — what schools you attended and who had important influences on you. At what age did you decide to become a mathematician?

NBC: I went to an experimental elementary school that had been created by a revolutionary pedagogue named Hồ Ngọc Đại. While one can debate whether the rudiments of set theory should be introduced before elementary arithmetic and whether multiplication should be defined using the cartesian product, our experience at this elementary school was particularly refreshing. The teacher-student relationship was not based on authority as it is in traditional Vietnamese schools, and we were encouraged to express ourselves very freely.

Figure 1. Smt. Pratibha Devisingh Patil, President of India, presents the Fields Medal to Prof. Ngô Bảo Châu at the ICM meeting in Hyderabad.

6. Let a and b be positive integers such that $ab + 1$ divides $a^2 + b^2$. Show that $\frac{a^2+b^2}{ab+1}$ is the square of an integer.

Figure 2. Problem 6 of the 1988 International Mathematical Olympiad.

At the end of my elementary school years, my father came back from the Soviet Union after getting his doctorate in applied mathematics. He was not enthusiastic about Hồ Ngọc Đại's approach to education, and he decided to pull me out of the experimental school. I then started a more traditional curriculum in the "chuyên toán," the special classes for gifted students in mathematics. At first this was at the Trưng Vương Middle School next to our house, and later it was at a selective high-school attached to Vietnam National University. It was not easy for me to adapt to the concrete and challenging problems in the chuyên toán, since I was more familiar with the pretty abstract mathematics taught in the experimental school.

NK: I understand that both your parents are scientists. Did they influence you to want to become a mathematician?

NBC: My parents' influence on me was quite indirect. My father's young colleagues enjoyed coming to our house and having animated conversations with my parents. During the breaks, they taught me mathematics. It was quite a revelation. I realized that I liked doing mathematics.

NK: Tell us about the International Mathematical Olympiad in Australia in 1988. Were you surprised that you got a perfect score and a Gold Medal?

NBC: I still remember that I was stunned when I succeeded in carrying out an elaborate Fermat descent in the difficult 6th problem. Ten years later, I tried again to solve it, but I couldn't. Otherwise, I was not really surprised with the Gold Medal because at that time I was good at solving Olympiad problems.

NK: In Vietnam there is a great deal of popular interest in the team's performance at the IMO. Did you become a celebrity after the 1988 IMO, and again after you received another Gold Medal at the 1989 IMO? I've heard that in Vietnam the top math competitors are as famous as movie stars in the West. Is this true?

NBC: In those years in Vietnam there were not as many movie stars as there are now, and consequently there was more room for high-school math competitors to become personally famous. I think that your comparison is exaggerated, but it is true that some of our math team members were featured in the media to such an extent that their names remained in the public memory even if they never became professional mathematicians.

NK: Why did you decide to go to a university in France?

NBC: I was prepared to go to study in Hungary because I liked combinatorics very much. But the agreement between Hungary and our country went kaput after the fall of the Berlin Wall. It also happened that a French professor visited the Institute of Mechanics, where my father worked. My father's colleagues talked to him about my Gold Medals in the Olympiads, and he decided to fight to get me a scholarship to study in France.

NK: Did you already know French when you left for the university? Did you have any difficulties adjusting to student life in France?

NBC: I knew only some of the rudiments of French from my grandfather. The first year in France was rough because I was not prepared for the gap between an isolated country that had been through thirty years of war and a brilliant country like France.

NK: How did French students compare with the students you had known in Vietnam?

NBC: In the first year I was in a regular class at Paris VI. The math and physics taught to first-year students at Paris VI were not difficult, fortunately, and so it left some time for me to improve my French. The students were obviously not as good as the ones in my selective high-school in Hanoi; but the following year I was sent to the Ecole Normale Supérieure, and that was a completely different story.

NK: When you were a student, what were your interests outside of mathematics?

NBC: I read a lot of books. Reading has always been my favorite leisure activity.

NK: At what point did you become interested in the Langlands program?

NBC: At that time a lot of students at Ecole Normale were attracted to arithmetic geometry and the Langlands program. This was probably a side effect of Wiles's proof of the Shimura-Taniyama-Weil conjecture.

NK: Can you describe the general idea of the Fundamental Lemma in words that a nonspecialist can understand?

NBC: The Fundamental Lemma is basically an identity of two numbers, each of them defined by a complicated integral. This identity is deeply rooted in the arithmetic structure of the Arthur–Selberg trace formula. At the beginning it was thought to be a technical problem that

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Neal and his wife Ann have been visiting Vietnam regularly since 1978, working mainly with the Hanoi Mathematical Institute and the Vietnam Women's Union. Two chapters of *Random Curves* are devoted to Vietnam, as are several opinion pieces on Neal's webpage. http://www.math.washington.edu/~koblitz.

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needed to be solved by a great deal of hard but direct computation. This turned out not to be the case. In the meantime, the Fundamental Lemma has also acquired more and more importance, since many of the advances in the Langlands program rely on its validity.

NK: In 2004 you were given the prestigious Clay Research Award (along with Gérard Laumon) for your success in proving the Fundamental Lemma in the unitary case. At that time did you think that you would be able to go further? At what point did you start to believe that you would be able to prove the Fundamental Lemma in its entirety?

NBC: In my Ph.D. thesis I solved a problem quite similar to the Fundamental Lemma and came to understand that the key to a solution may be a geometric model for the trace formula. In 2003 I realized that the geometric model for the trace formula for the Lie algebra is actually the Hitchin fibration. At that time I was convinced that I was on the right track for a proof of the Fundamental Lemma. In some sense, I absorbed the ideology, but the realization remained very difficult.

The most difficult part of the proof was a certain technical statement about perverse sheaves. Laumon and I were able to prove it in the unitary case in 2004. After that the general case still had to wait a long time.

NK: Did the main idea for your final proof in 2008 come to you all at once, or gradually over a period of time?

NBC: I kept trying to generalize the proof in the unitary case, until the end of 2006, when I became convinced that it was impossible. At that time a conversation with Mark Goresky of IAS provided me with the missing piece of my puzzle. It took me one more year to come up with the complete proof.

NK: Some people have noted the comparison between you and S. S. Chern, and have even started to think of you as the "S. S. Chern of Vietnam." There are some interesting similarities — for example, Chern also became a professor at the University of Chicago at age 38. Would you like to play a role in Vietnam that is similar to what Chern did in China?

NBC: The comparison with Chern is very flattering. He is certainly a model for me to follow.

NK: Deputy Prime Minister Nguyễn Thiện Nhân has said that he hopes that you will become the head of the new Advanced Mathematics Institute in Hanoi that is being planned. Will you agree to take on this responsibility?

NBC: There will be a Board of Directors, and it seems likely that I will serve on it.

NK: How will you divide your time between the University of Chicago and Hanoi?

NBC: I plan to spend summers in Hanoi. During the year I will fly to Hanoi for short visits one or two times. I can help the Board of Directors to select members for the new institute without being physically in Hanoi. Other colleagues will help to run the Institute on a day-to-day basis.

NK: What are the objectives of the new institute, and how will it be different from the Hanoi Mathematical Institute?

NBC: We will try to attract Vietnamese mathematicians from abroad as well as mathematicians of other nationalities to our institute to work on projects, with preference for joint projects with Vietnamese mathematicians. The visits can be for 3 months, 6 months, or a year. There will be no permanent members except for the Board of Directors.

NK: What are the main steps that must be taken in order to improve mathematical research in Vietnam?

NBC: The first step will be to construct an alternative for young Vietnamese mathematicians. It should be possible, at least on a temporary basis, for them to earn their living by doing research in mathematics in their own country. We hope that enough scientific and personal ties can be built during their stay at the new institute that some of them will take a job in a Vietnamese university. At the same time we will have to convince the universities to make reasonable offers to young scientists so that accepting a job is not scientific suicide.

NK: Traditionally, Vietnam has been much stronger in the theoretical areas of mathematics than in the applied areas. What should be done to improve research in applied areas? How much of the focus of the new institute will be on applied research?

NBC: We will very much welcome joint projects between mathematicians and researchers in related areas such as computer science, theoretical physics, biology, economics, and so on.

NK: What would you do to improve undergraduate education at the leading Vietnamese universities, such as Vietnam National University (VNU)? Although VNU has some good mathematicians on its faculty, there seem to be many problems. For example, because salaries are low, many professors need to work at a second job in order to supplement their income. Also, they do not have their own offices. As a result, math professors almost never meet with students outside of formal lectures. What can be done to improve conditions at VNU and other universities?

NBC: This is a topic that can be debated at length, but in my opinion the main reason for the problems in undergraduate education here in Vietnam is that there are not enough good professors. It should be made clear to the Vietnamese university presidents that their top priority should be the recruitment of young and talented people. And at a higher level, the science and education ministries should encourage the universities to do this using a strong system of grants.

NK: Often the most competitive international applicants to U.S. Ph.D. programs are students who have already obtained a Masters degree in their own country. But Vietnam does not support strong Masters level programs in mathematics. For example, Masters students cannot easily find financial support for their studies. Are there any plans to expand Masters programs in mathematics at Vietnamese universities (with financial support for students), and will the new Advanced Mathematics Institute give Masters degrees?

NBC: I agree that it is very important to develop good Masters level programs in Vietnam. We already have an International Masters program run jointly by the Institute of Mathematics and the Hanoi Pedagogical University (HPU). We recruit around 20 students each year. They spend the first year in Hanoi and the second year in Europe, and are

supported by fellowships from the Ministry of Education. Upon graduation they are granted Masters degrees from the European university where they spend their second year. We would love also to be able to grant them our own Masters degrees, but this is impossible under the current administrative rules. The new Advanced Mathematics Institute will not have its own Masters program, but obviously we will encourage its members to give lectures in the existing Masters programs as well as participate at a modest level in the undergraduate programs at VNU and HPU.

NK: In the Soviet Union and in France, most of the leading mathematicians worked in institutes that had little or no role in undergraduate education; in contrast, in the U.S. most mathematicians work in universities and teach at the elementary as well as advanced level. For obvious reasons, Vietnam's system is closer to the Soviet and French systems than to the American one; that is, many of Vietnam's leading mathematicians do little or no undergraduate teaching. Do you see this changing? How would you propose to better integrate teaching and research in Vietnam?

NBC: It is true that in Vietnam research and teaching are still regarded as separate activities supervised by two different ministries. This is not an ideal situation for mathematics and the basic sciences, since research and teaching are sources of inspiration for each other, and in fact it is very difficult to separate teaching at advanced levels from doing research. But we'd rather spend our time and energy on concrete projects that involve both teaching and research than fight against an administrative rule.

NK: The mathematics examination for entrance to Vietnamese universities is extremely difficult. To an American it seems absolutely astonishing that a large number of graduating high-school students in Vietnam are able to get high marks on such an exam. On the positive side, this shows the high mathematical ability of young people in Vietnam. On the negative side, most of them see mathematics as a hurdle that must be surmounted in order to be admitted to a good university, and they have no interest in continuing their study of mathematics after that. So there is a big drop in mathematical activity after high-school. Are you in favor of changes in the entrance examination?

NBC: My impression is that the pressures of the entrance examination have been easing in recent years. The Ministry of Education should be given credit for this evolution. There are more and more children from poor backgrounds who succeed at the entrance exam. I think that currently the entrance exam is not the crucial problem. The problem is the overall state of the house, not the size of the door.

NK: Vietnamese schools teach formal mathematics at a very high level, but in a way that makes the subject seem far removed from practical life. As a result, on the one hand young people are extremely competitive in theoretical mathematics. For example, Vietnam has often done well at the IMOs—and you personally played a big role in this success in 1988 and 1989. But on the other hand, Vietnam does not participate in the Mathematical Contest in Modeling (in contrast to China, which has had many successful teams in the MCM). What can be done to help young people better understand mathematics as an area with important applications in the real world?

NBC: It is true that a lot more has to be done so that mathematics is not perceived by the public as a selection tool, but as a way to understand the world. We will have to learn more about what has been done in other countries before implementing concrete projects in Vietnam. We will think about how this can be worked out in our national plan for mathematics. Separately, we are also setting up a "Foundation for the Joy of Learning," which may also become involved in such projects.

NK: At present there are relatively few women mathematicians in Vietnam. For example, over 30 women scientists have received Vietnam's Kovalevskaia Prize over the years, but none of them have been research mathematicians.

NBC: I don't think that the developed countries do any better on this.

NK: What you say is undoubtedly true of *some* of the developed countries, but it is certainly not true of France or the U.S. In the United States, where women earn about 30% of the Ph.D.s in math, experience has shown that positive steps to encourage girls and women can have a major impact. That is why the percentage of women has climbed from roughly 5% to 30% over the last 40 or 50 years. In Vietnam's case, you mentioned that progress has been made in increasing the number of children from poor backgrounds who obtain a higher education. So it is somewhat surprising that similar progress has not been made in increasing female participation in advanced mathematical studies. Would you be in favor of special efforts to attract more women to mathematics and support and encourage them at various stages of their careers?

NBC: It happens too often that a Vietnamese woman has to make a painful choice between engaging in a scientific career and having a family life. Something should be done so that they do not need to face such a choice. I have to admit that I have never thought about this problem seriously enough to offer you a sensible answer.

NK: For many years Vietnam has had more mathematical ties with Western countries such as France, Germany, and the U.S., than it has had with other countries of Asia. What ideas do you have for increasing Vietnam's mathematical collaboration with other Asian countries, such as India and China?

Figure 3. Ngô Bảo Châu with his mother, Trần Lưu Vân Hiền, and his father, Ngô Huy Cẩn.

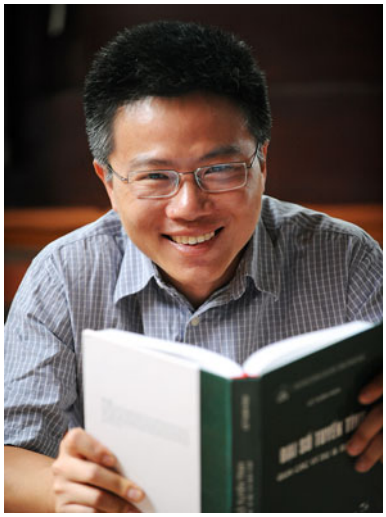

Figure 4.

Figure 5.

NBC: This year the second of the annual Pan Asian Number Theory conferences is being organized in Kyoto. There will be more and more regional cooperation in the coming years because everybody agrees on its importance.

Figure 6. Ngô Bảo Châu is third from the left in this photo of Vietnam's 1988 IMO team.

NK: In an interview with the Vietnamese newspaper *Tuổi Trẻ*, you said that one of your top priorities will be giving opportunities to young people. However, at present there are very few activities in Vietnam that put senior Vietnamese scientists in direct informal contact with young people. When in school and even at the university, Vietnamese students have very little idea of what it's like to be a researcher. They do not have role models, unless their own parents are scientists. The danger is that the youth will be influenced entirely by imported youth culture that comes from the mass media, and will not carry on the scholarly, scientific, and mathematical traditions of Vietnam's older generations. What ideas do you have for transmitting these traditions to the younger generation, and stimulating their desire to lead the life of a mathematician or scientist?

NBC: I agree with you that we need to do more to popularize science to the younger generation, either by direct contact or through the mass media. I have been agreeably surprised to find that the Vietnamese mass media are quite receptive to our message.