

The IHÉS at Forty

Allyn Jackson

Not far outside Paris, in a small village, along a busy road, there is a gate leading into a park. The sound of the traffic dissipates as one follows the footpath. The trees are abundant enough to give the impression that one is simply walking through a serene wood, which has a slight incline that amplifies the rustle of the breeze through the treetops. But soon one reaches a small parking lot, and beyond it a summer house that has been fitted with windows and turned into a library. Next to the summer house there is a nondescript two-story building, and down a lawn of trimmed grass, a low one-story building. This is no ordinary park. It is the Bois-Marie, grounds of one of the world's leading research institutes in mathematics, the Institut des Hautes Études Scientifiques (IHÉS).

Now forty years old, the IHÉS has spent nearly its entire lifetime in the Bois-Marie, in the Paris suburb of Bures-sur-Yvette. A special event was held last October to celebrate four decades of research at the IHÉS. Over this period, the institute has provided mathematicians with an idyllic, and in many ways ideal, setting for research. The story of the IHÉS, as befits its French heritage, is a story with a little of everything—romance, madness, tragedy, as well as triumphal intellectual achievements. It is also the story of a small, hardy institute that has survived, despite perpetual financial uncertainties, to become home to an illustrious permanent faculty and a major visiting center for researchers from all over the world.

The Founding of the IHÉS

The IHÉS was founded in 1958 by Léon Motchane. He was born in St. Petersburg in 1900 to Swiss parents. After the Russian revolution, Motchane moved to Switzerland with his family. He had studied mathematics and physics in Russia and served for a time as a physics assistant in Lausanne. However, he had to give up his studies to earn money for his family and went into banking and insurance. He settled in France in 1924. After World War II he continued to work in industry, but maintained an interest in scholarly work and published a few papers. Encouraged by the French mathematician Paul

Allyn Jackson is senior writer and deputy editor of the Notices. Her e-mail address is axj@ams.org.

All photographs for this article were provided courtesy of the IHÉS.

Montel, Motchane eventually received, at age fifty-four, a doctorate in mathematics.

In 1949 through his brother, who was an engineer in New Jersey, Motchane met the physicist Robert Oppenheimer, then director of the Institute for Advanced Study (IAS) in Princeton. It was around this time that Motchane conceived his idea of establishing in France an institute akin to the IAS. Until his death in 1967, Oppenheimer remained an important advisor to Motchane as the IHÉS developed. Motchane's original plan was to establish an institute dedicated to fundamental research in three areas: mathematics, theoretical physics, and the methodology of human sciences (the latter area never really took root at the IHÉS). The institute was to be an entirely private enterprise, supported through donations from French companies, and the researchers would have complete freedom in choosing whatever directions they wanted to pursue. Motchane's vision was highly unusual in France, where the government was the dominant force in the economy, in higher education, and in support of scientific research.

Unfortunately, the goodwill of industry did not last long. Some of the corporate sponsors pressed Motchane for more say in the directions pursued by IHÉS researchers, and when he held fast to his original concept of unfettered research, they withdrew their support. By the late 1960s industrial support had diminished considerably, but the IHÉS was able to secure funding from the French government, which became, and remains today, the major source of support. As this shift in funding sources took place, the financial situation of the IHÉS remained precarious and did not stabilize until the early 1970s. It was Motchane's business savvy, as well as his detailed understanding of the French system, that helped the IHÉS survive. For example, in 1962 he purchased at a very favorable price the Bois-Marie, which had come under state ownership after World War II. Later on, when the state laid plans for a new highway that would cut across an edge of the Bois-Marie, it compensated the IHÉS for the loss. This recompensation was larger than the price Motchane had paid for the whole property.

Prior to the purchase of the Bois-Marie, the IHÉS occupied a couple of offices in the Fondation Thiers in Paris, where Motchane and the IHÉS secretary, Annie Rolland, worked. Despite the meager facilities, the IHÉS succeeded brilliantly in its first



**Bust of IHÉS founder Léon Motchane,
installed during the IHÉS 40th
anniversary celebration in October
1998.**

long articles of fundamental character and has carried some of the most important work to issue from the institute. Dieudonné was the original editor of the series, and since 1979 Jacques Tits has been the editor in chief.

Over the years, Motchane came increasingly to depend upon Rolland, and she wielded considerable influence. Upon his retirement in 1970, Motchane divorced his wife and married Rolland. Still devoted to the IHÉS, he maintained an involvement in administrative and financial matters even after his successor, the Dutch mathematician Nicolaas Kuiper, had taken over as director. Motchane died in 1990, and a few years later Rolland committed suicide by throwing herself into the Seine River. One observer saw a link between Rolland's tragic death and the IHÉS, saying that she never got over her loss of influence at the institute. She is not the only secretary who was deeply affected by her time at the IHÉS. Kuiper's secretary, Nicole Gaume, was ousted after Kuiper's retirement, and she took her revenge by writing a novel about the IHÉS. Entitled *Dis-moi qui tu aimes (je te dirai qui tu hais)* (*Tell me whom you love (I'll tell you whom you hate)*), and written under the nom de plume Margot Bruyère, the book was ostensibly a murder mystery, but in fact attempted a thinly veiled exposé of life at the institute.

It was Kuiper who persuaded scientific societies from other countries to contribute funds to the IHÉS, and today such contributions remain a small but important part of the institute's budget. However, he never really understood the intricacies of obtaining support through the French system in the way that Motchane did. Rather, Kuiper excelled on the scientific side. According to David Ruelle, who has been a permanent professor at the

two appointments in mathematics: Jean Dieudonné and Alexandre Grothendieck. The two worked at their homes and presented seminars in a room lent by the Fondation Thiers or at one of the universities nearby. Even at this time the IHÉS managed to attract as visitors some of the top mathematicians of the day, including Michael Atiyah, S. S. Chern, Friedrich Hirzebruch, and André Weil. In 1960 the IHÉS launched its now famous series of blue-covered books, *Les Publications de l'IHÉS*. The series emphasizes

IHÉS since 1964, Kuiper understood that in-depth discussion of research matters was the best way to make decisions about whom to invite. These discussions, says Ruelle, "were more interesting and effective than a case-by-case discussion of individual applications, with the usual guesswork of how to read between the lines of letters of recommendation." Still, there was dissatisfaction over Kuiper's lack of attention to physics and his inability to penetrate the workings of the French bureaucracy. The two directors who came after Kuiper are both French: Marcel Berger, who served from 1985 until 1994, and the present director, Jean-Pierre Bourguignon. Interestingly, the three directors succeeding Motchane all worked in differential geometry, an area that fell somewhat out of fashion as the world of French mathematics came to be dominated by Grothendieck and Bourbaki.

The Early Golden Years

The creation of the IHÉS took place at a time when the Bourbakists were exerting a deep influence on mathematics, particularly in France. Dieudonné was one of the founding fathers of Bourbaki, and Grothendieck was one of its members. Many other Bourbaki members, such as Claude Chevalley, Jean-Pierre Serre, and Armand Borel, attended Grothendieck's seminars at the IHÉS. And in 1971 Pierre Cartier, another Bourbakist, began his long association with the IHÉS as a visitor. Thus, as Cartier puts it, in the first ten years of the IHÉS, "the Bourbaki spirit was there, if not the institution of Bourbaki."

The Bourbaki spirit was also reflected in what is arguably the most famous work to be published in the IHÉS blue series, the collection of six volumes that make up *Éléments de Géométrie Algébrique*, written by Grothendieck in collaboration with Dieudonné. According to Cartier, there was an explicit agreement between Grothendieck and Bourbaki that the books by Bourbaki on commutative algebra would leave off exactly where EGA began. All told, Grothendieck was the sole author or a coauthor on some thirty volumes in the IHÉS blue series, most of which ran over 150 pages. He also wrote *Séminaire de Géométrie Algébrique*, which ran twelve volumes, ten of which were published by Springer-Verlag. EGA and SGA total approximately 10,000 pages, and the rest of his works run a couple of thousand more. There was a sense of a revolution under way as Grothendieck, through his writings and his lectures at the IHÉS, transformed the landscape of a wide swath of mathematics. He was not merely boasting when he replied to a visitor's complaint about the inadequacy of the IHÉS library, "We do not read books, we write them." His prodigious output was cut short in 1970, when he abruptly resigned from the IHÉS [see sidebar].

Bourbaki and Grothendieck brought a new viewpoint to mathematics that emphasized the power

of general structures, especially category theory. In particular, Grothendieck found a way of introducing general structures to unify commutative algebra and number theory. Through the language of categories and schemes, many important mathematical problems could be recast in such a way as to elucidate their main features. In his book *Undergraduate Algebraic Geometry*, Miles Reid notes that the period from about 1955 to 1970 was one “in which tremendous conceptual and technical advances were made, and thanks to the systematic notion of a scheme ..., algebraic geometry was able to absorb practically all the advances made in topology, homological algebra, number theory, etc.” Grothendieck’s influence on algebraic geometry is perhaps the most clear. In the past one could make a living in that field by doing calculations with particular equations. With the advent of Grothendieck’s ideas, algebraic geometry evolved into one of the most abstract and technical fields in mathematics.

That for twelve years Grothendieck kept a loosely knit group of mathematicians focused on developing his vision testifies to the forcefulness of his personality. His influence extended well beyond this group and had a major impact on an entire generation of French mathematicians. As Reid points out, this influence was not always positive, for the “Grothendieck personality cult,” as Reid calls it, induced many mathematicians to pursue a rather sterile elaboration of Grothendieck’s theories and to ignore their use in important problems. The mathematicians who put these theories to the most fruitful uses were those such as David Mumford and Michael Artin, who visited the IHÉS but had some distance from the Grothendieck school.

Despite the influence of Dieudonné and Grothendieck, the IHÉS was no Bourbaki stronghold: in 1963 René Thom accepted a professorship at the institute. Grothendieck and Thom, each brilliant in his own way, embodied the yin and yang of research. For Grothendieck a theorem had to be exactly right, with every detail accounted for. Thom, who had been educated in the Bourbaki tradition, nevertheless had a much more qualitative and intuitive approach to mathematics. Ruelle recalls one session in Thom’s seminar in which Thom stated a theorem. Adrien Douady, who was in the audience, asked “Have you proved this theorem?” “Non, mais j’en mettrais ma tête à couper,” Thom replied (“I will put my head to be cut off if it’s not true”). “Avec toutes les têtes de Thom qu’on a déjà coupées,” Douady murmured (“Just like all his other heads that have already been cut off”). Someone of lower caliber than Thom would likely have produced nonsense with such an imprecise approach. As Ruelle notes, Thom “did produce excellent mathematics, but in this sort of lazy style, which was not at all fashionable then.”

When he arrived at the IHÉS, Thom already had in hand his 1958 Fields Medal. During the 1950s he did foundational work in differential topology and in particular invented cobordism theory. In his famous IHÉS seminar, which, like Grothendieck’s, attracted many participants from Paris and beyond, Thom began developing the theory for which he is probably most famous, that of the classification of singularities of smooth maps. This forms the heart of what is known as catastrophe theory, which attempted to elucidate the mechanisms involved in sudden changes in smoothly varying systems, such as when an eroding cliff disintegrates or a cell divides to become two. Thom’s 1972 book *Stabilité Structurelle et Morphogenèse (Structural Stability and Morphogenesis)* became the bible of catastrophe theory. In it he presents his views on a tremendous variety of subjects, including embryology, linguistics, and evolution. At times philosophical and highly speculative, the book nevertheless testifies to Thom’s striking originality and his deep intuition about the nature of things. That he was aware of the imprecise nature of his work is clear in many passages of the book. “Many of my assertions depend on pure speculation and may be treated as day-dreams, and I accept this qualification,” he writes near the end of the book. “At a time when so many scholars in the world are calculating, is it not desirable that some, who can, dream?”

Nowadays the term catastrophe theory inevitably calls to mind the controversy that surrounded attempts to apply the theory in a wide range of scientific fields. At the center of the controversy was the British mathematician Christopher Zeeman, who was a frequent visitor to the IHÉS in the 1960s and 1970s and an enthusiastic proponent of Thom’s ideas. It was Zeeman who went the furthest in attempting to apply catastrophe theory in physics and biology, and even in sociology and politics. These applications were enthusiastically taken up by practitioners in other sciences and heralded in the press. What ended up happening was that the unsuccessful attempts were labeled applications of catastrophe theory, and the successful attempts were labeled more neutrally, as applications of singularity theory. Indeed, many of the ideas that originally came under the rubric of catastrophe theory are still alive in singularity theory, which remains today an active area of mathematical research. In his 1998 doctoral thesis entitled *A Cultural History of Catastrophes and Chaos: Around the Institut des Hautes Études Scientifiques, France*, mathematical historian David Aubin argues that Thom’s work in general, and catastrophe theory in particular, had an important impact on the development of new ideas for mathematical modeling, especially chaos theory. Thom’s work also had a major influence on Ruelle, who before coming to the IHÉS had worked in statistical me-

Grothendieck: The Genie of the Bois-Marie

Though he left the IHÉS nearly thirty years ago, Alexandre Grothendieck remains an eerily strong presence at the institute. His name surfaces frequently in conversations with IHÉS visitors and professors, even when one is talking to those who never knew him. His viewpoint profoundly changed mathematics and had a deep influence on mathematicians in France and beyond. The potency of his ideas and the forcefulness of his personality have left a lasting mark on the institute.



Grothendieck lecturing at the IHÉS.

Nancy, where he received his doctoral degree under the direction of Jean Dieudonné. Grothendieck then spent a number of years traveling in Brazil and in the United States. In 1958 he and Dieudonné accepted appointments as permanent professors in the newly established IHÉS.

After twelve years at the institute, in which he ran a celebrated seminar that reshaped the foundations of algebraic geometry, Grothendieck suddenly resigned. One reason was a dispute with the director, Léon Motchane, over the fact that a small proportion of the IHÉS budget had come from military sources. There had been earlier indications of Grothendieck's strongly held political views. For example, in 1966 Motchane traveled to Moscow to collect Grothendieck's Fields Medal because Grothendieck himself refused to attend for political reasons. Three years later Grothendieck's insistence that the IHÉS refuse military funding infuriated Motchane, who had always maintained a clear division between scientific matters, which were left up to the permanent professors, and financial ones, which were the director's domain. Grothendieck's stance found some sympathy among the other IHÉS professors, who at one point told Motchane they would rather do without military funding than lose Grothendieck. However, his naiveté must have been vexing. Retired IHÉS physics professor Louis Michel recalls that around this time he showed Grothendieck a poster advertising a conference in which he, Grothendieck, was the main speaker. Michel pointed out that the talks were sponsored by NATO and asked him if he knew what NATO was. No, Grothendieck replied. Michel explained it to him and recalls Grothendieck saying, "They never told me!" True to his convictions, Grothendieck wrote to the conference organizers, who refused the NATO support and kept Grothendieck as a speaker.

While the issue of military funding was perhaps the most obvious explanation for Grothendieck's departure, those who knew him say that the causes of the rupture ran deeper. Pierre Cartier, a *visiteur de longue durée* at the IHÉS, wrote a piece about Grothendieck for a special volume published on the occasion of the IHÉS's fortieth anniversary. In it Cartier notes that, as the son of an anti-military anarchist and one who grew up among the disenfranchised, Grothendieck always had a deep compassion for the poor and the downtrodden. As Cartier puts it, Grothendieck came to find Bures-sur-Yvette "*une cage dorée*" ("a golden cage"). While Grothendieck was at the IHÉS, opposition to the Vietnam War was heating up, and Cartier suggests that this also reinforced Grothendieck's distaste at having become a mandarin of the scientific world.

In addition, after several years at the IHÉS Grothendieck seemed to cast about for new intellectual interests. By the late 1960s he had started to become interested in scientific areas outside of mathematics. David Ruelle, a physicist who joined the IHÉS faculty in 1964, said that Grothendieck came to talk to him a few times about physics. Biology interested Grothendieck more than physics, and he organized some seminars on biological topics. Ruelle suggests that Grothendieck's interests were changing because he was starting to believe he would never finish the mathematical

Grothendieck's father was an ally of Lenin and took part in some of the major political upheavals in Europe in the early part of this century. In the 1920s he lived in Germany, where he worked with groups opposed to the Nazis and also met Hanka Grothendieck, who gave birth to their son in 1928. The parents did not remain together long, as the father left to take part in the Spanish Civil War and in 1943 perished in the concentration camp at Dachau. Though Alexandre Grothendieck never knew his father, he held him in great esteem. Grothendieck's office at the IHÉS had no decoration except an oil painting of his father.

During World War II Grothendieck and his mother lived in a detention camp in France, but he was able to attend a school organized by a group of Protestant resistors of the Nazis. In 1948 he went to Paris carrying a letter that the school had written for him as an introduction to Henri Cartan. Later he went to

edifice he had started. “Grothendieck was working on the foundations of algebraic geometry 7 days a week, 12 hours a day, for 10 years,” Ruelle notes. “He had achieved level -1 and was working on level 0 of something that must be 10 levels high. At a certain age, it becomes clear that you will never be able to finish the building.”

After leaving the IHÉS, Grothendieck tried and failed to get a position at the Collège de France. He then went to Université de Montpellier, where he became increasingly estranged from the mathematical community. Around this time, he founded a group called Survivre, which was dedicated to antimilitary and ecological issues. His mathematical career, for the most part, ended when he left the IHÉS. In 1984 he wrote a proposal to get a position through the Centre National de la Recherche Scientifique. The proposal, entitled *Esquisse d'un Programme* (*Sketch of a Program*) describes new ideas for studying the moduli space of complex curves. Although Grothendieck himself never published his work in this area, the proposal became the inspiration for work by other mathematicians and the source of the theory of *dessins d'enfants* (children's drawings). *Esquisse d'un Programme* was published in the two-volume proceedings *Geometric Galois Actions* (Cambridge University Press, 1997).

In 1985 Grothendieck produced his notorious *Récoltes et Semailles* (*Harvests and Seeds*), a beautifully written but bitter treatise of some 1,000 pages in which he lays out his dissatisfactions with the mathematical world. Grothendieck deeply resented the fact that, after he left the IHÉS, other mathematicians took up his ideas and carried them forward, adding their own imprint along the way. This resentment eventually metamorphosed into a paranoia which is evident in the pages of *Récoltes et Semailles*.

Grothendieck, who turns seventy-one years old in March 1999, lives in a remote hamlet in the Pyrénées. Some reports hold that his psychological condition has deteriorated over the years. For example, Cartier writes that according to two mathematicians who visited Grothendieck in the last couple of years, he is “obsessed by the devil, which he sees at work everywhere in the world, destroying the divine harmony, and replacing 300,000 km/sec by 299,887 km/sec for the speed of light!” The severance of his ties to the mathematical world is nearly complete, and he has made it clear that he does not wish to renew them. However, nothing can expunge Alexandre Grothendieck from the IHÉS, where his spirit and his genius continue to haunt the Bois-Marie.

—A. J.

chanics and afterward became a leading figure in the burgeoning area of dynamical systems. In the 1970s Ruelle and the Dutch mathematician Floris Takens produced a new model for turbulence, and it was Ruelle who invented the concept of a strange attractor in a dynamical system.

Still Golden after All These Years

Some things have changed at the IHÉS since its early golden years. For one thing, there are no longer seminars in the style of Grothendieck and Thom, in which each was the main speaker. However, there is much that has not changed, such as the quality of the IHÉS mathematics faculty, which has remained extremely high. Of the nine people who have been permanent mathematics professors at the IHÉS, six of them—Grothendieck, Thom, Jean Bourgain, Alain Connes, Pierre Deligne, and Maxim Kontsevich—have received Fields Medals; two others, Dennis Sullivan and Mikhael Gromov, are often counted among those who should have received Fields Medals but by some fluke did not. At present there are three mathematics professors at the IHÉS: Connes, Gromov, and Kontsevich. (Connes is the Léon Motchane Professor at the IHÉS, where he spends a good deal of his time, and is also a professor at the Collège de France, which

pays his salary.) Bourgain and Deligne are now at the Institute for Advanced Study in Princeton, and Sullivan is now half time at the State University of New York, Stony Brook, and half time at the City University of New York. Some of the mathematical themes of the early years of the IHÉS have been carried forward in the interests of faculty appointed in later years. This can be seen most clearly in the work of Pierre Deligne, who developed and extended many of Grothendieck’s ideas. It can also be seen in the research of Sullivan, who like Thom has worked in geometry, topology, and dynamical systems theory. Sometimes these themes merge to produce new results, as can be seen in the application of rational homotopy theory to the topology of algebraic varieties, which uses ideas from the work of both Deligne and Sullivan.

Another attribute of the IHÉS that continues to this day is the way in which the scientific life at the IHÉS carries the imprint of the faculty. “The way the institute runs is very much determined by the people who are here,” Gromov remarks. “The personalities shape the place to a great extent.” In particular, Sullivan, an ebullient Texan, was a master at orchestrating activity and interest among visitors and was especially effective with young people. Recent Fields Medalist Curtis McMullen is a

good example of Sullivan's influence: Although McMullen received his Ph.D. from Harvard, he was really Sullivan's student, and it was while visiting the IHÉS that McMullen got the idea for his thesis problem. Another example is Gromov himself: It was Sullivan's invitation that first brought Gromov to the IHÉS as a visitor in 1977, three years after Gromov had gotten out of the Soviet Union. He became a permanent professor at the IHÉS in 1982, and in 1986 his book *Partial Differential Relations* was published. The book contains elaborations on many of the ideas from his doctoral thesis. In the introduction Gromov thanks Kuiper, who was director of the IHÉS during Gromov's early years at the institute, for his "unrelenting criticism" of early drafts. Gromov is best known for his work in differential geometry, especially Riemannian geometry, and he has also had a large influence on symplectic geometry. His interests are very wide ranging and most recently have centered on complexity theory, particularly as it connects to biological systems, and on DNA nanotechnology, which may hold the key to new ways of organizing complex processes.

That two Russians, Gromov and Kontsevich, are permanent professors at the IHÉS testifies to the strength of Russian mathematics. This strength can also be seen in the seminar run by I. M. Gelfand, which takes place at the IHÉS over about a month during the summer. Gelfand brings to the IHÉS the same style that made his Moscow seminar famous. Rather than allowing a speaker to drone on as the audience sits impassively, understanding little, Gelfand constantly asks questions and presents ideas, with the aim of insuring that communication really takes place. Views differ on the successfulness of this style. Some contend that Gelfand does not allow speakers to have their say, and some are offended by what they see as his combative style. Another drawback is the fact that the eighty-five-year-old Gelfand has developed hearing problems. On the other hand, many appreciate Gelfand's approach. Gromov, who witnessed sessions of Gelfand's seminar in Moscow, says the IHÉS version is not the same, but still believes the approach has merit. "Mathematicians' talks are often extremely bad," says Gromov. "They get carried away by a desire to say something, with very little regard for the audience...Gelfand tries to break this, to make talks more comprehensible."

As befits a research institute devoted to mathematics and theoretical physics, two of the current mathematics professors at the IHÉS, Connes and Kontsevich, work in areas with deep ties to physics. Last year Kontsevich received his Fields Medal for work centered on a variety of ideas from the frontiers of mathematical physics, including mirror symmetry and deformation quantization. Connes created noncommutative geometry, and lately he has studied its relations to quantum chromodynamics,

the so-called standard model of particle physics. He has also explored mysterious connections between physics and the Riemann Hypothesis. From the beginning the IHÉS has had a component in theoretical physics, but it has always been outshone by the mathematics. This points not to a lack of quality within the physics faculty but to the fact that the mathematics faculty has been so outstanding.

In the early years of the IHÉS, Motchane, using the intuition that served him so well in his first appointments in mathematics, made an offer to the young physicist Murray Gell-Mann, who was later to receive a Nobel Prize. Gell-Mann, after much consideration, turned down the offer and remained at the California Institute of Technology. Harry Lehmann, who had been important in reviving theoretical physics in postwar Germany, was offered a permanent professorship at the IHÉS and spent a few years there in the early 1960s but eventually returned to his home institution of the University of Hamburg. In 1962 elementary particle physicist Louis Michel became the first IHÉS appointment in physics, and David Ruelle became the second in 1964. During the late 1970s and early 1980s, Oscar Lanford III and Jürg Fröhlich both held permanent appointments in physics, and both eventually left to take positions in Switzerland. Today there are two permanent professors in physics, Ruelle and Thibault Damour, who works in cosmology and general relativity. String theorist Michael Douglas is listed on the IHÉS faculty as a permanent professor in physics, but as late as the fall of 1998 it was not entirely certain that he would leave Rutgers University to move to the IHÉS. The offer to Douglas is one indication of the priority the IHÉS is now placing on strengthening theoretical physics.

The IHÉS is able to attract and retain excellent mathematicians despite the fact that it does not pay especially well: all the professors have the same salary, which does not increase over time except for adjustments for inflation. The pay is equivalent to the top salary for mathematics professors in France, which is quite a bit less than the corresponding salary would be in the U.S. They are required to spend at least six months a year in residence at the institute. Dennis Sullivan was the first IHÉS professor to supplement his paycheck with a permanent position in the U.S.; for years he had a second job holding the Einstein Chair at the City University of New York. For a number of years Gromov held a part-time position at the University of Maryland, and he has recently shifted to the Courant Institute at New York University, where he spends the spring each year. Kontsevich has a similar arrangement with Rutgers University. Of course, mathematicians of this caliber could easily get highly paid jobs elsewhere. What keeps them at the IHÉS? Kontsevich puts it simply: "It's a place with the maximum amount of freedom." He appreciates

the absence of teaching, the ability to invite many visitors, the lack of bureaucracy, and even the fact that there are no concerns about promotions or salary raises. "In my profession, these are the best possible conditions," he says.

Life for the IHÉS Visitor

As an institute, the IHÉS bears more resemblance to, for example, the Max Planck Institute for Mathematics (MPI) in Bonn than to, say, the Mathematical Sciences Research Institute (MSRI) in Berkeley. Like the MPI, the IHÉS is organized around a core of permanent faculty who make decisions about which visitors to invite, either based on their own interests or on applications received. By contrast, thematic programs and conferences form the main part of the activity at institutes like MSRI, and individuals apply to participate in these events. Generally, the IHÉS has a more rarefied atmosphere than an institute like MSRI. This is due in part to the high level of the IHÉS permanent faculty, but also to the fact that there is a cadre of people who have been visiting the IHÉS regularly for years. There are advantages and disadvantages to having the same people visit regularly. On the one hand, if a certain researcher is of high caliber, it is advantageous to have his or her visits continue over the years, and these regular visits establish a certain tradition. On the other hand, it has sometimes happened that regular visitors are offended when, for one reason or another, a request to visit is turned down.

The IHÉS hosts around two hundred visitors per year, with no more than about forty in residence at any one time. In the past it was common for visitors to come to the IHÉS for an entire sabbatical year and bring their families along. However, with the increase in the number of families in which both parents work, such arrangements are less common. Today IHÉS visitors stay an average of about three months. Visitors from the U.S. predominate, accounting for more than one-third of the total. The majority of visitors are housed in the Résidence de l'Ormaille, which is a set of small houses and apartments a short walk from the Bois-Marie. The houses and the studio apartments are neat and pleasant, and each has a full bath and kitchen. However, visitors have complained about the Ormaille's shared quarters, in which several visitors have single rooms and share bathroom and kitchen facilities. Those in the know request apartments in another nearby residence called the Gratien, where some of the IHÉS permanent faculty live and where the IHÉS owns a number of units (plans are under way for the IHÉS to sell all but one of these). Staying in Paris means a commuter rail trip of about forty minutes to reach the IHÉS.

When it comes to the facilities at the IHÉS itself, there are pluses and minuses. One of the biggest drawbacks is the inadequacy of its library; indeed,



The IHÉS library.

some visitors report being rather shocked at the fact that it lacks even the most important journals. The IHÉS relies on the excellent mathematics library at the Université de Paris-Sud in Orsay, which is a twenty-minute walk from the institute. One of the aspects visitors appreciate most is that, unlike at many other institutes where one must share an office, the IHÉS gives everyone an individual office. Each is equipped with its own workstation, a relatively new development at the IHÉS; indeed, it was only a couple of years ago that computers were available only in a common computer room. Some visitors note that the IHÉS computer systems did not always work properly and lacked some standard features. Reports varied on the helpfulness of the IHÉS staff: some found it exasperating that the secretaries, rather than revealing that they spoke English, would let visitors stumble along in broken French; others said these same secretaries went out of their way to be helpful, even booking airline tickets and helping with translating letters into French.

The informality and lack of regulation are among the attributes that IHÉS visitors appreciate the most. However, these same attributes have sometimes left visitors without basic information, such as how to check books out of the library or the time at which afternoon tea is served. One of the most notable expressions of the IHÉS informality is the communal lunch, where postdocs and professors, visitors and permanent faculty sit down together to enjoy food and conversation. The canonical outcome of a group of mathematicians having lunch is several paper napkins filled with pictures and equations. At the IHÉS the napkins are cloth, but paper and pens are available on all the tables. In fact, the lunchtime conversation, helped along by carafes of wine, might as easily be about politics as about mathematics. The IHÉS lunch is probably the tradition that inspires the fondest memories among visitors. Not only does it foster a community spirit, but it also serves the practical purpose

of making it convenient for visitors to remain at the institute all day.

The usual rate at which visitors' expenses are reimbursed is 200 FF (approximately \$35) per day. The amount is quite meager, even given the fact that visitors usually receive free lunch and housing. Some senior visitors, especially those who want to live in Paris and not at the Ormaille, have complained about the low pay, and such cases are handled individually by the director, who can increase the pay at his discretion. Bourguignon says that usually such exceptions are made in cases where visitors come from poor countries and cannot cover their own travel expenses, which are generally not paid by the IHÉS, or in the case of postdocs without another source of income. One of the things visitors often find surprising is that they are paid in cash. Visitors are told in advance the amount they are to be paid, but some report being uncertain about how and when they would be paid, only to be suddenly handed an envelope stuffed with hundreds of francs. Once they get over the sense of surprise, most visitors find the cash payments a great convenience over setting up a French bank account.

In addition to the visitors who come from outside the IHÉS, there are also a number of *visiteurs de longue durée* (long-term visitors). The long-term visits are open-ended in duration and in some cases have lasted twenty years or more. Usually, these *visiteurs de longue durée* have come into their positions through having a sustained association with the IHÉS, perhaps through collaboration with one of the permanent professors. Until recently there were six such visitors: Jean-Benoît Bost, Ofer Gabber, Christophe Soulé, and Shih Weishu in mathematics, and Henri Epstein and Krzysztof Gawedzki in physics. At the present time there are only three, since Epstein retired, Shih passed away, and Bost left to take a position at the Université de Paris-Sud. The long-term visitors' salaries are paid through the Centre National de la Recherche Scientifique (CNRS), the principal science funding agency of the French government. Such CNRS positions are lifetime appointments that require no teaching and are tenable at institutions where there is a CNRS unit, which for mathematics is usually within a teaching institution. Pierre Cartier holds such a CNRS position attached to the École Normale Supérieure, and he has a longstanding "gentleman's agreement" with the IHÉS that allows him to have an office at the institute, where he has spent a good deal of time over the last twenty-five years.

Although CNRS positions might sound like a mathematician's dream come true, one must bear in mind that, like most positions in the French public sector, the pay is fairly small. Throughout France, there are many excellent mathematicians in CNRS positions. However, the system bears the

stamp of French socialism, and in a few cases these positions have become sinecures for people who are no longer productive.

For many years the status of the long-term CNRS visitors at the IHÉS was unclear because the institute had no CNRS unit with which such positions could be officially affiliated. Director Jean-Pierre Bourguignon has sought to regularize the status of these positions. There is now a special agreement between the CNRS and the IHÉS whereby such long-term visitors can be officially affiliated with the IHÉS. Bourguignon has also made efforts to integrate the long-term visitors into some of the scientific decision-making of the IHÉS. They now attend meetings of the Scientific Committee—consisting of the director, the permanent professors, and a number of mathematicians and physicists from outside the IHÉS—and provide input into decisions about which visitors to invite. The long-term visitors do not take part in decisions about appointments of new permanent professors. Although there are good relations between the long-term visitors and the IHÉS permanent faculty, there is some uneasiness too. Within the Scientific Committee there is some feeling that it would be preferable to have specified durations for all CNRS visitors rather than indefinite stays that can essentially become lifetime appointments. And generally there is the worry that the IHÉS, a small private foundation, could be swallowed up by the much larger CNRS.

Raising the Visibility of the IHÉS

In addition to regular seminars in mathematics and theoretical physics, the IHÉS has a series of lectures entitled "Les Vendredis de l'IHÉS" ("Fridays at the IHÉS"), which features a pair of lectures on related mathematical themes. In the nearby Paris area there are hundreds of seminars and lectures given throughout the academic year. Some IHÉS visitors take part in the especially French tradition of *groupes de travail*, which are small working groups that meet to study the details of specific books or papers. The IHÉS does not run conferences on a regular basis, but in the past few years, under the directorship of Jean-Pierre Bourguignon, there have been a few such events. In particular, the IHÉS is establishing a series of conferences called "Entretiens de Bures" ("Bures Discussions"). The first one, held in December 1997, focused on pattern formation and brought together biologists, physicists, computer scientists, and mathematicians. According to Bourguignon, many of the participants had never even heard of the IHÉS before coming to the conference.

Holding such conferences is one of the ways in which Bourguignon is trying to enhance the visibility of the IHÉS. For many years he has been involved in popularizations of mathematics, and these efforts have continued in his time at the

IHÉS. For example, he organized a public event called “Les Mathématiques dans La Ville” (“Mathematics in the City”) together with the cultural center in Bures-sur-Yvette. A fifteen-minute informational videotape program about the IHÉS was produced last year, and there are plans to produce another, longer program about the scientific work done at the institute. In addition, the IHÉS will be involved in an international science film festival this year. The IHÉS fortieth anniversary celebration, held in early October 1998, featured not only talks about mathematics, physics, and the history of the IHÉS but also an open house for the general public.

One purpose of all of these outreach efforts is fundraising. The IHÉS has the status of a private foundation in France, and its budget is about 25 million FF (about \$4.4 million) per year. The Education Ministry of the French government is the major supporter, accounting for about 60 percent of the total. Foreign scientific institutions—including Germany’s Max Planck Society, the Swiss Academy of Sciences, and the Engineering and Physical Sciences Research Council of the UK—together contribute funds comprising about 10 percent of the IHÉS’s budget, on the grounds that many researchers from these countries visit the IHÉS. Based on its large number of visitors from the U.S., the IHÉS holds a grant of about \$80,000 from the U.S. National Science Foundation (there was also a small grant from the Foundation to support the conference on pattern formation). Recently, some U.S. companies have made donations to the IHÉS. About 7 percent of the IHÉS budget comes from French companies, and a small amount comes from the European Union.

It is sobering to realize that the IHÉS has managed to survive for forty years by patching together funds from different sources. It has about 10 million FF saved in the bank but essentially no endowment. (There is a small endowment from the Sackler Foundation that supports one Sackler Fellow each year at the IHÉS.) Unlike, for example, the IAS in Princeton, which could continue operations using income from its endowment should outside sources dry up, the IHÉS would have to close down. Indeed, the financial history of the IHÉS has been rocky—in some years it has had to borrow money from banks to stay afloat; in other years professors actually gave up their salaries to ease financial strains. A recent indication of the ups and downs of its fortunes is the fact that the director has resumed his CNRS civil servant position. With the fortieth anniversary, the IHÉS started a donor group called Les Amis de l’IHÉS (Friends of the IHÉS), and Bourguignon says that he has been surprised to find that many former IHÉS visitors were willing to donate substantial amounts of money. A U.S. subsidiary of Les Amis de l’IHÉS is in the works. “We are really fragile,” says Bourguignon.

On the other hand, “maybe being fragile is a virtue.”

Despite these difficulties, the IHÉS managed last year to purchase the Résidence de l’Ormaille, which it had leased for thirty-one years (the purchase has necessitated the sale of four of the five Gratien units owned by the IHÉS). In addition, it has secured funding from the French government for the construction of a new wing to its main building. The library will be moved to the new wing from the summerhouse, where the weight of the books has taken a toll on the old building. The summerhouse will then revert to being a lecture room, as it was in the days of the seminars of Grothendieck and Thom. In this way, these changes represent not only a step into the future but also a hearkening back to the greatness that took root early at the IHÉS. Like the trees of the Bois-Marie, this institute is here to stay.

Bibliography

- [1] DAVID AUBIN, *A Cultural History of Catastrophes and Chaos: Around the Institut des Hautes Études Scientifiques, France*, Ph.D. thesis, Princeton University, January 1998.
- [2] DAVID AUBIN, Un pacte singulier entre mathématiques et industrie, *La Recherche*, No. 313 (October 1998), 98–103.
- [3] PIERRE CARTIER, La folle journée, de Grothendieck à Connes et Kontsevich, *Les Relations entre les Mathématiques et la Physique Théorique*, Festschrift for the 40th anniversary of the IHÉS, Publications de l’IHÉS, October 1998.
- [4] MILES REID, *Undergraduate Algebraic Geometry*, London Math. Soc. Stud. Texts, vol. 12, Cambridge Univ. Press, 1988.



Henri Cartan, age 94, was one of the attendees at the 40th anniversary celebration of the IHÉS.