# A Trio of Institutes

*Allyn Jackson*

"[I]nstitutes for advanced study modeled in some measure or another along the lines of the Princeton Institute are [multiplying] and will multiply throughout the western world."

— *J. Robert Oppenheimer, in a December 17, 1959, letter to the French Education Minister, suggesting the French government support the Institut des Hautes Études Scientifiques*

In mathematics, Oppenheimer's prediction has come true: Over the past couple of decades, mathematics institutes have proliferated worldwide. While all share the goal of fostering mathematics research, each has its own unique history and traditions. Europe boasts several major institutes that loom large in international mathematical affairs, from the elegant Institut des Hautes Études Scientifiques, whose activities are mainly organized by its small but outstanding permanent faculty, to the beloved Mathematisches Forschungsinstitut in Oberwolfach, Germany, a bustling conference center with a different event every week. But Europe also has several smaller institutes known for their high-quality mathematical programs and their distinctive characters. Three of them are profiled here: the mathematics department at Aarhus University in Denmark, the Centre de Recerca Matemàtica in Barcelona, and the Centro di Ricerca Matematica Ennio De Giorgi in Pisa.

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## Aarhus University

Svend Bundgaard is not a household name among mathematicians. Looking him up in MathSciNet reveals that he published just seven papers in his lifetime. He does not appear at all in the Mathematics Genealogy Project because he had no Ph.D. students—and in fact did not have a Ph.D. himself. And yet Svend Bundgaard had a significant impact on mathematics by establishing Aarhus University in Denmark as an international focal point for mathematics research, with a thriving visitor program and excellent facilities. The traditions he fostered there starting in the 1950s have continued ever since and find their most recent expression in the establishment of two centers within the mathematics department, the Center for the Topology and Quantization of Moduli Spaces (CTQM) and the Thiele Center for Applied Mathematics in Natural Science.

Bundgaard was born in 1912 and received a master's degree in mathematics from the University of Copenhagen. On the faculty at the time were the physicist Niels Bohr and his brother, mathematician Harald Bohr, and the two made Copenhagen a lively center for mathematics and physics. It was there that Bundgaard made contacts with leading mathematicians from around the world. In 1954 he became the first mathematician to be appointed to Aarhus University's division of science, which had been established a few years earlier (the university itself was founded in 1928). There was no mathematics building; a small office was cleared out for him in the anatomy building. But Bundgaard had been hired to launch the mathematics department, and for this he had big plans. From the beginning he envisioned an international dimension for the department, and

when he got funds to hire faculty, he used some of the money to bring in long-term visitors from abroad.

Bundgaard's genius for administration can be seen most clearly in the current mathematics department building, which was completed in 1967. Aarhus mathematicians say that Bundgaard sat in on all the weekly meetings of the architects and builders to make sure that the design features he wanted were carried out. When higher-ups nixed his plan to install sinks in all the offices so that people could wash chalk dust from their hands, Bundgaard had the builders put the sinks in anyway; they are discreetly hidden behind cabinet doors, possibly to avoid being seen by government inspectors. In another instance of bucking authority—and one that could not be so easily hidden—he directed the builders to put guest rooms and apartments on the top floor of the mathematics building, even though the authorization for this construction had been turned down. It was a prescient move: having these lodgings available made it easy for the department to invite many short- and long-term visitors from abroad. A set of apartments was also added to the computer science building when it was constructed. The Aarhus mathematics department today has sixteen guest rooms and six apartments.

The mathematics building is a lively place, bustling with faculty, students, and visitors. "The infrastructure fills all of our needs," states department chair Johann P. Hansen. Apart from some interior renovations to spruce things up—and the sacrifice of a couple of seminar rooms to office space as the department grew—the building remains as it was in Bundgaard's day. Each floor has several small spaces equipped with blackboards, tables, and chairs, where people can gather and chat. The "mathematics canteen" on the first floor attracts students and faculty from within and outside the department. During a two-week CTQM workshop in 2008, fifty mathematicians from all over the world, including a large contingent from Japan, attended talks in one of the building's larger lecture halls, milled around the corridor during coffee breaks, and mixed with students in the canteen for lunch. The proof of the genius that went into the building's design can be seen in the use to which the building is put: many different kinds of activity comfortably coexist.

Bundgaard knew that a high-quality mathematics library was needed to support research in the department, and for this he secured funds from the Carlsberg Foundation, which was created by the Carlsberg beer brewery in part to support scientific research. Today the library has about 100,000 books as well as subscriptions to more than 400 journals. Some of the journals come in exchange for *Mathematica Scandinavica*, which is another initiative of Bundgaard's and which is



(Photo courtesy of Masaaki Suzuki, Akita University.)

**The entrance to the mathematics building at the University of Aarhus.**

still produced in the Aarhus department. Because of these long-standing exchange arrangements, the library has some rare journals that one typically does not find in a standard mathematics library. Aarhus mathematics faculty member Johan Dupont recalled that in 1969, when he was a graduate student at Aarhus, he attended a conference in Bucharest and was put up in a fancy hotel room after telling the conference organizers where he was from. Thinking of their journal exchange arrangement with *Mathematica Scandinavica*, "they mistook me for an Aarhus bigwig," Dupont said with a laugh. Three years later, Dupont became a coordinating editor of *Mathematica Scandinavica* and served in that capacity until 1988.

For those who have become accustomed to libraries outfitted like airport security checkpoints, the Aarhus library evokes amazement. Anyone can walk in, browse around, find books and journals on the shelves, and photocopy materials. It is not a quiet place: the first floor is the math lab, filled with students sitting at tables discussing math problems. The one rule is that books must not be removed from the math building. Inevitably, some material is lost. But according to Hansen, so far it has proved less expensive to replace the missing material than to hire a gatekeeper.

Thanks in large part to Bundgaard, the Aarhus mathematics department has all the facilities needed to function as a small mathematics research institute. What it does not have is the money to support such an enterprise—in fact, the university provides little funding to support research. For this reason, Aarhus mathematicians have long pursued outside funding from the Danish government and other sources in order to host institute-like activities within the mathematics department. One of the best known of these enterprises was MaPhySto, which stands for Mathematical Physics and Stochastics. In its initial incarnation, MaPhySto ran from 1998 until 2003, with a five-year grant

**This portrait of Svend Bundgaard is one of several interesting paintings in the Aarhus mathematics building.**

of about 50 million kroner (around US$6 million at the current exchange rate) from the Danish National Research Foundation. The founder and scientific director was Ole E. Barndorff-Nielsen, a member of the Aarhus mathematics department and a key figure in building the department's strength in stochastics. When Barndorff-Nielsen retired in 2003, he had to give up the position of director of MaPhySto. Arne Jensen of Aalborg University became his successor, and the structure of MaPhySto changed from being a center located at Aarhus to being a network stretching across several universities in Denmark.

Over its lifetime, MaPhySto spurred interdisciplinary collaborations between areas of mathematical physics—such as quantum mechanics, statistical mechanics, and quantum field theory—and areas of stochastics—such as stochastic analysis, interacting particle systems, stochastic matrices, and free probability. By the time MaPhySto ceased operations, it had drawn hundreds of long- and short-term visitors, held an ongoing seminar series, and organized many conferences and workshops. It also had an active program for postdoctoral researchers and supported many Ph.D. students.

When MaPhySto ended, members of the Aarhus department were ready with a proposal for a new initiative, the Thiele Centre for Applied Mathematics in Natural Science. The center focuses on basic research in stochastics and its interplay with other disciplines of natural science. The main areas of emphasis are stochastic geometry and statistical image analysis, Lévy theory and applied probability, stochastic processes and spatio-temporal modeling, and computational stochastics and bioinformatics. The center has about twenty-five members, including permanent faculty in various departments of the university, as well as postdoctoral researchers and Ph.D. students who are supported through the center's funding from the Danish Natural Science Research Council and the Danish Council for Strategic Research. The center runs a weekly seminar and intensive courses for Ph.D. students, and organizes about four workshops and conferences each year.

The latest addition to the Aarhus department is the Center for the Topology and Quantization of Moduli Spaces (CTQM), which began in 2006 with a grant from the Danish Natural Science Research Council. The center focuses on the investigation of the topology and quantization of moduli spaces associated to two-dimensional surfaces and their mapping class groups. If this sounds rather narrow, CTQM director Jørgen Ellegaard Andersen explained that "it was an interesting move to make it very focused, because it emphasizes very much the kind of things we study, and it gives us a clear profile." At the same time, the area connects to other subjects. "Quantization of moduli spaces includes all of quantum topology, it includes many aspects of gauge theory, and so on," he remarked. "In order to study the topology of moduli spaces, you need to study various other things. The focus we have interacts with many different areas of mathematics."

Part of the reason this area was chosen is that it meshed well with the research interests of various people in the department, including Andersen and Dupont, as well as Ib Madsen, a longtime faculty member who was largely responsible for building the department's strength in topology. Madsen's profile rose in recent years after his 2005 proof, with Michael Weiss, of a conjecture of David Mumford on the stable cohomology of the moduli space of curves. Madsen is no longer at Aarhus; in 2008 he took a position at the University of Copenhagen.

The research focus of CTQM also connects to that of Nikolai Reshetikhin of the University of California at Berkeley, for whom the center secured a Niels Bohr grant from the Danish National Research Foundation. The large-scale Niels Bohr grants provide five years of support for a distinguished visiting professor, along with funding for two additional temporary positions, some postdoctoral researchers, other visitors, conferences, and workshops. In addition to bringing Reshetikhin to Aarhus for a period every year, along with some of his students, the Niels Bohr grant has greatly boosted overall funding for CTQM. The center has over 100 senior visitors a year, hosts between six and eight postdocs, and has a handful of distinguished long-term visitors each year.

In 2009 Andersen received a "center of excellence" grant from the Danish National Research Foundation for a total of 50 million kroner. This grant provides a significant boost to CTQM, securing its funding for the coming five years. The grant will help to further strengthen the ties between CTQM and UC Berkeley and to support new links to the geometry group at the University of Oxford, led by Nigel Hitchin, and to the Institut des Hautes Études Scientifiques in Paris, through the involvement of Maxim Kontsevich. The cooperation with the latter two institutions will include a component for joint predoctoral and postdoctoral appointments. "This is a great opportunity

for us here at CTQM in Aarhus to be able to co-operate with these world-renowned mathematical research institutions in this very manifest way," said Andersen.

Enterprises like CTQM and the Thiele Center have strengthened the international dimension of mathematics research at Aarhus. But such large-scale efforts exact a cost: The funding is always temporary, and there is a constant struggle to make sure new grants are lined up when the old ones run out. They also put additional pressure on the department's resources and infrastructure. Another consideration is how well these centers serve home-grown Danish doctoral students. Dupont, who is a member of CTQM and recognizes the value it brings to the department, nevertheless noted that only a few of the department's doctoral students have the background to really benefit from all of the activities hosted by the center.

The department will face a wave of retirements in the next few years, and having the Thiele Center and CTQM will certainly make Aarhus more attractive to job seekers from other countries who might not otherwise consider making the leap to a small Scandinavian country with a difficult language. And these foreigners will likely be needed. During a recent stint as director of the graduate program, Dupont did a survey of Aarhus Ph.D.s in mathematics over a period of ten years and found that only one-quarter of them ended up with academic jobs in Denmark. "We might get into difficulties if we want to have enough Danish mathematicians," he noted. Although he recognizes the value of cultivating a strong international research environment in the department through ventures like CTQM and the Thiele Center, Dupont cannot help but wish that funding were also available to address more local problems, such as improving the academic career path for young Danish mathematicians. The goal, as Dupont put it, should be to create something with "a long life in mathematics". No doubt Svend Bundgaard would agree.

## Centre de Recerca Matemàtica Barcelona

The student unrest that gripped the world during the 1960s led to a university building boom across Europe. In Catalonia, the historic Universitat de Barcelona, founded in 1450, was joined by two modern campuses, the Universitat Politècnica de Catalunya and the Universitat Autònoma de Barcelona, both of which were established in 1968. Located in the suburb of Bellaterra, the sprawling campus of the Autònoma abounds with the boxy concrete buildings characteristic of its era. Though the mathematics building is just as unprepossessing as the rest, in one wing it houses an oasis of elegance called the Centre de Recerca Matemàtica (CRM). The judicious use of space, the refined lighting, and the fluid, undulating corridors could
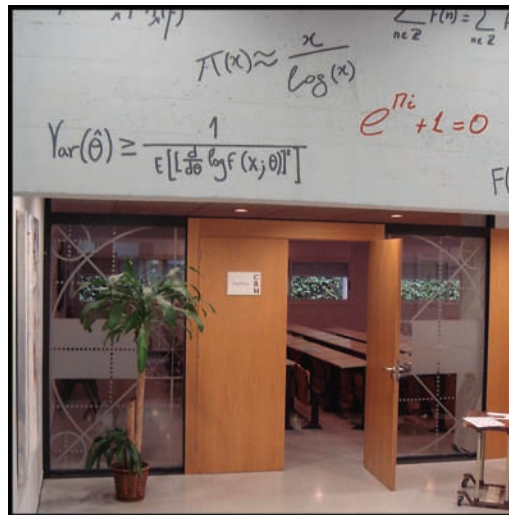


(Photo courtesy of D. Kotschick, Ludwig-Maximilians-Universität München.)

**The entrance to the main lecture room of the CRM Barcelona.**

all be the work of a good architectural firm. But when one notices the way the classic motif of the CRM logo is carried throughout the space on the etched glass that adorns the doorways, and when one notices the eclectic, often arresting works of art, one discerns a personality behind the CRM.

That personality is Manuel Castellet, the founder of the CRM and a professor of mathematics at the Autònoma. He started the center in 1984, a time when the mathematical culture in Spain was just starting to recover from the isolation imposed by the dictatorship of Francisco Franco, which lasted from 1936 until Franco's death in 1975. During the Franco era, Spanish universities emphasized personal and political connections rather than excellence and merit, and in this atmosphere mathematical culture languished. This was no less true in Catalonia, a center of resistance against Franco, than in the rest of Spain. "If you look at *Mathematical Reviews* from the end of the 1960s and beginning of the 1970s, there are no papers by Spanish mathematicians," remarked Castellet. "During the 1960s and 1970s at the University of Barcelona, only one Ph.D. in mathematics was given. And this was not much different from the rest of Spain."

At that time, a small number of Spaniards went abroad to get Ph.D.s in mathematics, with the idea of returning to their native land and building mathematics research there. Castellet was one of them. He went to the ETH (Eidgenossische Technische Hochschule) in Zürich, where he received a Ph.D. in 1973 under the direction of Beno Eckmann. About a decade before, Eckmann had founded the Forschungsinstitut für Mathematik (FIM), a research institute in the ETH mathematics department that to this day remains a well-known international center. Castellet stayed on for two years as a postdoc at the FIM, where, he said, the

**A corridor in the CRM Barcelona.**

atmosphere was "fantastic": it was the meeting point for mathematicians in Zürich and attracted others from all over the world. Upon his return to Spain, Castellet took a position at the newly established Autònoma. He realized that the international contacts he had found so stimulating at the FIM were exactly what Barcelona needed for mathematics to thrive. The FIM became the model on which the CRM was designed—though on a smaller scale. Said Castellet, "We are not as rich as the Swiss."

Catalonia has its own language, distinct from Spanish, and a strong cultural identity, and many Catalans think of themselves as more Catalan than Spanish. The CRM too has had a strongly Catalan character. It was founded within the Institut d'Estudis Catalans (IEC), an organization that promotes research in areas related to Catalan language and culture. The CRM retains its ties to the IEC even though it has since the late 1980s received its core funding from the Catalan government rather than from the IEC. The CRM has emphasized, first of all, service to the local community of mathematicians in Barcelona and, secondly, service to the international community. Although it has been for many years the only international visitor's institute for mathematics in Spain, very few non-Catalan Spaniards participated in its programs. It could be argued that the influence of the CRM has been greater in Europe outside of Spain than in Spain outside of Catalonia (though this has been changing in recent years).

The role of the CRM has been to provide a forum in which mathematicians at the three local universities—the Universitat de Barcelona, the Politècnica, and the Autònoma—could bring in visitors and organize research programs, conferences, and workshops. Unlike in Aarhus, the CRM has no on-site housing for visitors. Instead they are lodged in a set of apartments the CRM rents for that purpose in nearby San Cugat del Vallès, in university housing, or in hotels in the center of Barcelona, which is about thirty-five minutes away by commuter train. The CRM does not have its own library but instead relies on the mathematics library of the Autònoma, which subscribes to about 250 journals and has good access to books through an interlibrary network in Catalonia. The CRM offices are modern and comfortable, and the center has a dedicated staff who know their jobs inside and out and keep the center running smoothly. It has become increasingly crowded in recent years, and there are now plans to build a new wing adjacent to the mathematics building, adding another 900 square meters to the existing 1,200 the center now occupies.

Over the years the CRM has emphasized areas in which there are strong local mathematicians, in particular in Castellet's own area of algebraic topology. The emphasis on the latter area can be seen in the Barcelona Conference on Algebraic Topology, a series of meetings held at the CRM every four years from 1986 to 2002. These conferences attracted some of the top experts in the area and helped put Barcelona on the map as a focal point for research in algebraic topology internationally, while also providing much stimulus for the local mathematicians working in that area. The influence of the conferences was also spread through publication of proceedings in book series of Springer and Birkhäuser (Birkhäuser also publishes a series, "Advanced Courses in Mathematics, CRM Barcelona", which was started in 2002 and comprises some ten volumes). Some mathematicians in Barcelona say that the CRM's focus on a limited range of areas, particularly its focus on algebraic topology, constituted an insufficient attention to breadth. Others argue that the CRM had to carefully husband its scarce funds to focus on areas of strength and excellence. Despite these disparate views, it seems clear that Castellet's careful cultivation of the CRM over the years has helped to develop mathematics in Catalonia. As one of the main players in establishing ERCOM (European Research Centres on Mathematics, a committee of the European Mathematical Society), Castellet has also been active in supporting mathematics institutes across Europe.

It is exactly the cultivation of the CRM into a well-run, well-established institute that has allowed it to capitalize on new opportunities that have appeared in recent years. In 2002 the CRM became a "consortium" between the IEC and the Catalan government. To do so, the center had to sign a contract with the government that specified duties and strategic objectives to be carried out; in return, the CRM received larger and more stable core funding. The contract also brought changes in the way the CRM had been run. Previously, decisions about which research programs to hold at the CRM were made mainly in discussions between local mathematicians and the center. Under the terms of the contract, the CRM began issuing

formal calls for proposals open to mathematicians all over the world and established a clear decision-making process by the CRM's Scientific Advisory Board. As a result, a broader range of areas has been represented at the CRM in recent years: Research programs have included geometric flows, enumerative combinatorics and random structures, Arakelov geometry and Shimura varieties, and control theory. In addition, through a European Union project called NEST (New and Emerging Science and Technologies), the CRM has hosted programs to foster international collaboration and training in three emerging subjects: risk assessment, mathematical neuroscience, and digital content security.

Castellet retired as director in 2007, and, after an international search, his Autònoma colleague Joaquim Bruna was named as successor. When Bruna began as director, everything was in place to run a successful international mathematics institute. "That's terrific," said Bruna. "That's something that has a lot of merit." Today Castellet holds the title of honorary director, by decision of the Board of Governors in recognition of his achievement in founding and building the CRM. Bruna has begun to put his own stamp on how the CRM is run and has set up a team of three codirectors from the other Barcelona universities: Marta Sanz-Solé and Carles Casacuberta of the Universitat de Barcelona and Joan Solà-Morales of the Politècnica. A group of dynamic and experienced academics like this one is not going to agree on everything. But all are committed to preserving the traditions that have made the CRM successful in the past while continuing to expand its international presence and the mathematical areas represented in the center's activities. The CRM has also renewed its Scientific Advisory Board to make it more international and more involved in decisions about the directions the center takes.

The main purpose of the CRM is still to provide a home for activities, such as conferences and year-long research programs, that local mathematics departments cannot easily carry out. At the same time, the center is trying to promote new directions that the universities do not have a way to promote. As Bruna put it, the CRM today is "at somewhat of an inflection point." When it became a consortium center under the Catalan government, the CRM joined the CERCA network of thirty-eight research centers in Catalonia—and the CRM was the only center in the network to have no permanent research staff. The new contract that the CRM negotiated for 2008–2012 stipulates that the center must appoint permanent staff. This means a big change but also a big opportunity, Bruna noted. "We have thought a lot about this, about how to match this with the typology [of the CRM]," he said. "We want to go in this direction, but always with the idea of supporting and complementing

what is being done" in the university mathematics departments in Barcelona.

The strategy the direction team is pursuing is to have "semi-permanent" research positions: one or two long-term researchers would be hired each year in areas not currently represented in the local universities. After taking a few years to build up research groups in those areas, these CRM researchers would be expected to move on to permanent positions in academia, or, in exceptional cases, at the CRM itself. The center has now established a few such positions and has a search under way to add a researcher in industrial mathematics. The strategy the CRM has pursued for these positions is similar to that of ICREA, a widely praised program of research positions that was put in place by the mathematical economist Andreu Mas-Colell when he was Minister for Universities and Research of the Government of Catalonia from 2000 to 2003. ICREA was so successful that it has been replicated in other regions in Spain.

Another area of expansion in the CRM in the past couple of years has occurred in its postdoctoral program. Since 2000 the CRM has been a participant in the European Postdoctoral Institute (EPDI), which provides two-year grants for young mathematicians to visit at least two of nine mathematics institutes in Europe for six- to twelve-month stays. The CRM also now funds its own two-year postdoctoral positions. These have been in demand, last year attracting a total of sixty-three applicants for just four slots. Altogether, with funding from various sources, the CRM last year hosted a total of twelve postdocs; the stays were of varying length, partly due to variations in the funding of the positions and partly due to some of the postdocs having found permanent positions before their time at the CRM had ended.

Overall, support for mathematics and science in Spain seems to have a bright future, partly because of insistence by the European Union that its member states invest a certain percentage of their gross national product in research. In 2006 the Spanish government funded Ingenio Mathematica, or i-MATH, a five-year, €7.5 million (approximately US$10 million) project designed to enhance and unify mathematics research across all of Spain. The CRM is one of five nodes participating in i-MATH, and Bruna sits on the project's direction board. The establishment of i-MATH has enhanced the influence of the CRM within Spain. In the last couple of years plans have been under development for the establishment of other mathematics institutes in Spanish universities as well as a national network to connect their activities, and some of these initiatives have gotten off the ground.

In April 2009 the CRM kicked off a celebration of its twenty-fifth anniversary, with the president

(Photo courtesy of D. Kotschick, Ludwig-Maximilians-Universität München.)

**The Palazzo Puteano, which houses the Centro de Giorgi, as seen from the steps of the Scuola Normale.**

of Catalonia in attendance and a piano concert by Alexander Melnikov (a professional pianist and son of mathematician Mark Melnikov). During its first quarter-century of existence, the CRM was the only mathematics institute of its kind in Spain. Although that singular status is now changing, the CRM will retain its special role as the best established and most experienced center in the country. What is more, the CRM has shown itself to be adaptable and able to respond to new conditions and opportunities. Today the CRM is running at full capacity, with a more intensive menu of activities than ever before. This year the focus is on analysis, and next year on arithmetic geometry. Building on its strong foundation, the ideas and energy of the new directors, and the likelihood of increased government support for research, the CRM is poised to thrive.

## Centro Ennio De Giorgi

Ennio De Giorgi, one of the best-known Italian mathematicians of the twentieth century, was a professor at the Scuola Normale Superiore in Pisa. He originally came from Lizzanello, a small village in southern Italy, where the inhabitants today number about 10,000. One day, two deputies from the town government of Lizzanello came to the office of Mariano Giaquinta, a professor at the Scuola and director of the Centro di Ricerca Matematica Ennio De Giorgi, which had been established two years before. "They told me, 'We would like to give a prize named after Professor De Giorgi. What do you think?'," Giaquinta recalled. "I told them, a prize is nice, but it would be much nicer to provide money for young people to have a chance to study. They said, 'That's good, we are willing to do that'." And so the *commune di Lizzanello*—the administrative body governing the village—agreed to provide €25,000 (about US$37,500), each year for twelve years, to fund mathematics research by

postdocs. "It is really amazing," said Giaquinta. "Every time I tell people [this story], they say 'That's not possible.' I tell them, it *is* possible. And they say, 'There must be some law that the town cannot spend money that way.' And I tell them no, the town does it." (Unfortunately, happy tales end: In 2008 Lizzanello informed Giaquinta that, due to financial difficulties, the town would be unable to continue to fund the postdocs.)

Lizzanello seems to have been a special case. Giaquinta has tried without success to get several communities that are nearby in Tuscany to support the Centro De Giorgi. Even the city government of Pisa, home to the Centro, turned him down, as did nearby Florence. But what really puzzles him is the lack of response from the Italian government. It is not that the government has decided against giving funds to the Centro. Rather, Giaquinta's inquiries are simply ignored. "If I had a letter from [the ministry of universities and research] saying, 'We have considered what you are doing and we don't think it's interesting', that would already have been a positive answer for me—just some sort of reaction, even a negative reaction," he said. The silence from the government is especially surprising considering that the Centro is the only institute of its kind in Italy and that it has from the beginning organized high-powered programs with leading mathematicians from around the world.

The Centro De Giorgi is one of Europe's newest mathematics institutes, having been launched in 2001. Despite the lack of funding from the Italian government, the Centro in some ways has had an easy time getting off the ground. For example, there was no need to build a new building, as Bundgaard did in Aarhus: the Scuola Normale provided the handsome 17th-century Palazzo Puteano, which sits on the Piazza dei Cavalieri in Pisa, directly across from the Scuola's main building. Also in contrast to Aarhus, where the university essentially provides no funds for research, the Centro receives steady funding from three universities in Pisa. And unlike the CRM, which was founded in Barcelona in 1984 with few exemplars beyond the FIM in Zurich to take as a model, the Centro De Giorgi was started at a time when there were many existing mathematics institutes with substantial track records.

The Palazzo Puteano is a lovely building but is not architecturally exceptional, so the Centro had a good deal of freedom in deciding on renovations. The result is a rustically elegant interior where exposed wooden ceiling beams and tall shuttered windows combine easily with eleven modern offices. The palazzo has nine kitchen-equipped sleeping rooms, which are, needless to say, in high demand, especially since they do not belong exclusively to the Centro but can be used by the Scuola Normale at large. (Most visitors to the Centro are put up in local hotels, which Giaquinta

said are "too few, not very good, and expensive.") The larger of the building's two seminar rooms holds only about thirty people, but bigger lecture halls are available at the Scuola Normale. Surprisingly, there is no wireless network in the building, but this might not be a disadvantage: the wired Internet connections in the offices are faster and more user-friendly than the wireless networks at Aarhus and the CRM. Keeping the place running smoothly is the friendly and efficient two-person staff, Cecilia Cappelli (who replaced Ilaria Gabbani in fall 2008) and Antonella Gregorace.

The Centro's largest source of funding is the Scuola Normale, which provides €200,000 per year (financial difficulties reduced this amount to €150,000 in 2009); the University of Pisa, just across town, contributes €100,000, and the Scuola Superiore di Studi Avanzati Sant'Anna, a newly established university for applied research, chips in €50,000. These funds come with very few restrictions, so Giaquinta has plenty of flexibility in how he can use the money. The Centro also gets smaller amounts from other sources. One is the Istituto Nazionale di Alta Matematica, which is the main funder of mathematics meetings in Italy and which the Centro can turn to for support for specific programs. A few Italian universities whose mathematics departments want to support the Centro have contributed small amounts, and a foundation connected to a bank in the Tuscan town of Lucca gives the Centro around €15,000 per year. Organizers of the programs often use money from their research grants to pay for travel and housing for students and other participants. By cobbling together these sources of support, the Centro runs fairly well on its total budget of about half a million euros per year, Giaquinta said. "But we could do much better with one million." His unsuccessful efforts to get the attention of the Italian government centered on bringing the budget up to that level.

Giaquinta said that the Centro is based loosely on the model of the Newton Institute in Cambridge, England, though the Centro is much smaller and more informal. "There are no very strict regulations concerning how the institute can be run," he noted. Indeed, since the Centro's inaugural activities began in early 2002, it has had a fluctuating mix of "intensive research periods", which last a few months, and shorter workshops, which run for up to a week. In 2003 there were four intensive research periods and one workshop; by 2007 the balance had nearly reversed, with one intensive research period and fifteen workshops. The Centro also sponsors "research nuclei", which are small groups of Italian mathematicians who are working together on a long-term basis and who use the Centro as a place to meet and collaborate. (Descriptions of past, present, and future activities of the Centro, including the annual financial and scientific reports of the director, are available on the Centro's website.)

From the start the Centro has attracted top mathematicians. The first intensive research period, organized in 2002, lasted two and a half months and had about eighty participants. It focused on dynamical systems and was organized by a scientific committee, including two Fields Medalists (John Milnor and Jean-Christoph Yoccoz; the other members were Stefano Marmi, John Mather, and Jacob Palis). Giaquinta pointed to the 2005 research program in Diophantine geometry as one of the Centro's best so far; with seventy-five participants over a four-month period, the program was organized by Yuri Bilu, Enrico Bombieri, David Masser, Lucien Szpiro, and Umberto Zannier. The intensive research program in 2007, on dynamical systems and number theory, was especially large, with a total of over 200 participants. Organized by Grigori Margulis, Stefano Marmi, Peter Sarnak, Jean-Christoph Yoccoz, and Don Zagier, it included a workshop for 100 graduate students that was funded by the Clay Mathematics Institute. The total number of mathematicians coming to the Centro per year has increased over time, hitting 800 in 2007.

Local expenses are provided for all participants, including meals at the Scuola Normale cafeteria—and, this being Italy, the food in the cafeteria is quite good. Many participants are able to fund their travel through grants, and for those who cannot, the Centro can sometimes help with travel expenses. For visitors who stay for at least a month, Giaquinta said, the Centro provides "a kind of salary"—but not a full salary, as the Centro does not have enough money. In fact, Giaquinta said that one of his dreams for the future of the Centro is to have more long-term visitors who stay six to twelve months, so that there is deeper and more sustained activity. But this would require having, say, three or four long-term visitors who could interact—and that is much more than the Centro can afford right now.

As director, Giaquinta has a great deal of latitude in making decisions about the activities of the Centro. There is no committee to evaluate proposals for programs; in fact, there is no formal call for proposals. So how does one apply to organize a research program at the Centro De Giorgi? Pick up the phone and call Giaquinta. But the Centro is not a one-man show. Giaquinta consults widely with many colleagues, especially those in the Scuola Normale, about what activities would be best to host. And he does not simply sit back and wait for calls to come in; he actively pursues ideas for program topics and persuades people to serve as organizers. This highly flexible style seems to suit the small size of the Centro and allows it to put a premium on quality. Giaquinta and his colleagues at the Scuola make most of the major decisions

about directions the Centro takes, leading to some grumbling on the part of mathematicians at the University of Pisa, who see their institution contributing a tidy sum to the Centro and sometimes feeling a bit distant from its activities.
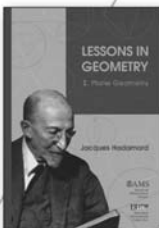
One program for which the Centro does have an organized call for applications is the program for "junior visitors" (these are essentially postdoctoral positions, but the word "junior" is used to circumvent Italian government regulations relating to positions referred to as "postdoctoral"). These positions are in high demand: In 2007 there were about 100 applications for just three or four positions. Only five of the applicants lived in Italy (applications also came from Italians living outside the country). The reason for the lack of applications in Italy could stem from the hiring traditions there, which remain extremely local. The usual method of filling positions is to pave the way for a local candidate, rather than hiring someone from outside. Such inbred hiring traditions mean that a postdoc at the Centro is not especially attractive to a young Italian mathematician whose long-term plan is to stay in Italy. The restricted hiring opportunities in Italy have caused some "brain-drain". In particular, new Ph.D.s from the Scuola Normale—which traditionally has attracted some of the most talented students from across Italy—are at a disadvantage, because the Scuola has very few positions in mathematics, and the Scuola Ph.D.s are often considered as outsiders by other departments in the country. As a result, some of the best young Italian mathematicians have ended up outside their home country.

Simon Salamon of the Politecnico di Torino was on the organizing committee for two programs at the Centro De Giorgi, including a large one in 2004 that ran for three months. He is an enthusiastic supporter of the Centro. There are several venues in Italy that have become traditional sites for mathematics conferences and short courses, but the Centro offers the possibility for longer-term activities. "There is nothing else like it in Italy," he said. Having the Centro in Pisa not only offers ease of access from most parts of Italy and from many cities abroad, but it also takes advantage of the fact that Pisa is, and long has been, a vibrant center for mathematics. "Pisa is one of the cities that has traditionally been important in mathematics," noted Salamon. "You only need to go to the *camposanto* [cemetery] and see the graves of mathematical giants."

One indication of Pisan traditions in mathematics is the statue of Ulisse Dini (1845–1918), which stands just across the plaza from the Centro. Dini was on the faculty of the University of Pisa, and late in life he became the director of the Scuola Normale. That he was also a member of the Italian Parliament might be the reason for his memorialization in a statue, yet the statue nevertheless

symbolizes the long heritage of mathematics in Italy. It is therefore surprising to find that the Italian system for supporting research and for funding enterprises like the Centro De Giorgi is weak. "You have isolated good situations, but the entire system doesn't work," Giaquinta remarked. "That is typical of everything—mathematics, physics, medicine. The system is very bad." What saves it, he said, is that "there are some very good people around."