CHAPTER IV: FUNDAMENTAL RESEARCH

> Le milieu en quelque sorte naturel pour la recherche fondamentale est évidemment l'Université. De tous temps, et jusqu'au dernier quart du XIX° siècle, il en fut ainsi: l'ensemble de nos connaissances fondamentales n'a pas eu d'autre source.
> —Léon Motchane.[1]

1. INTRODUCTION: THE PUZZLE PLACE

In January 1973, mathematician Alexander Grothendieck, who had, three years earlier, angrily resigned from the Institut des hautes études scientifiques (IHÉS), applied for a professorship at the prestigious Collège de France. To support his candidacy, he wished the *Publications mathématiques de l'IHÉS* to print a "sketch" of his mathematical work together with a two-page biography. To this request, Jean Dieudonné, general editor of this journal, replied that while he was glad to accept Grothendieck's mathematical sketch, he saw

> no reason to publish a 'curriculum vitae'; . . . the scientific interest of such texts is null and void, and the biographical information they offer can only interest

[1] "The so-to-speak natural milieu for fundamental research obviously is the University. At all times, up until the last quarter of the 19th century, this has been so: all our fundamental knowledge has had no other source." L. Motchane, Rapport Euratom, 2. Arch. IHÉS. Is it necessary to underscore that recent historical studies of science has provided ample evidence that this statement was grossly mistaken? See, e.g., the special issue of *La Recherche,* devoted to the locales of science, ed. Dominique Pestre, 300 (1997).

> historians of science. In my opinion, [their] interest is for that matter entirely minor; if, as I believe, the history of science is first and foremost that of *ideas,* these biographical facts are mere anecdotes [*ne relèvent que de la 'petite histoire'*].[2]

Only ideas mattered for the history of science, he thought; the rest was accessory. Yet, how could Jean Dieudonné—a permanent professor of the IHÉS from its foundation in 1958 until 1964, and general editor of its *Publications mathématiques* until 1979—not have been aware of the extraordinary role that the Institute itself had played in the history of mathematics? Clearly, he was aware, for at the end of the same year he wrote to Léon Motchane, first director of the IHÉS:

> From the point of view of mathematical research, the record of the IHÉS since its foundation has more than justified the *idea* you had to create it. . . . I think future historians of mathematics will speak of the IHÉS in the years 1960-70 as one speaks of the great periods of Göttingen, in 1850-60, with Gauss, Dirichlet and Riemann, and in 1895-1910 with Hilbert, Klein and Minkowski.[3]

It is not my purpose here to dispute these comparisons, but I do want to question the reasons Dieudonné gave to explain the success of the IHÉS, or at least, to add nuances to these reasons. As the quote above shows, even the IHÉS was seen as an *idea* by Dieudonné, rather than a social institution endowed with its own culture. It is this very focus on the history of ideas that I shall question in the following. In this chapter, I describe the conditions in which this Institute was founded in 1958 and the way it functioned during the few years before René Thom and David Ruelle were hired by

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[2] Lettres de Jean Dieudonné à Nicolaas Kuiper (3/2/73); de Alexander Grothendieck aux professeurs du Collège de France, et à Jacques Tits et Jacques-Louis Lions (20/1/73); de Alexander Grothendieck à Nicolaas Kuiper (25/1/73). Arch. IHÉS. Original emphasis. Unless explicitly stated, all quotations are my translation from the orginal French. See Dieudonné's biography, Pierre Dugac, *Jean Dieudonné, mathématicien complet* (Paris: Jacques Gabay, 1995).

Motchane in 1963. By doing this, I mean to draw attention to the *social, cultural,* and *ideological* resources that the IHÉS would offer to its professors.

> It is true that you [Motchane] have had the chance to have as permanent members of the IHÉS three of the mathematicians of our time whose genius is the most powerful and most original, Grothendieck, Thom, and Deligne. Yet it was necessary to have know[n] how to attract them to IHÉS and *to give them favorable working conditions* so they could radiate their influence.[4]

According to Dieudonné, this capacity of attracting and retaining the right men, above anything else, accounted for the success of the Institute. The question I want to raise is whether it would not be more profitable and perharps more accurate to consider the Institute as an active player in the history of catastrophe and chaos theories. Clearly, the IHÉS indeed provided conditions for the development of algebraic topology, catastrophe theory, dynamical systems theory, and deterministic chaos by attracting and retaining Alexander Grothendieck, René Thom, and David Ruelle. But, going further, we may explore its active role in bringing about the emergence of a set of original modeling practices at the heart of catastrophe and chaos theories. I am therefore concerned with the ways in which the IHÉS can be considered as a full actor of the history I am writing, just like Grothendieck, Thom, or Ruelle. My final aim is to interpret, as we historians would do for any other actor, its role in this history of chaos.

The task outlined above is too important to be done in a single chapter. In what follows, I first present a historical study of the Institut des hautes études scientifiques. Focusing on the IHÉS as an institution that shaped emerging modeling practices, this chapter examines the conditions for this institute to achieve and retain a certain stability,

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[3] Lettre de Jean Dieudonné à Léon Motchane (16/12/73). Arch. IHÉS. Translation done at the IHÉS. My emphasis.

thereby creating an atmosphere conducive to theoretical research. I focus on the ideology that animated its founders, allowing this peculiar institution, sponsored by industry and yet solely devoted to fundamental research in the most abstract sense, to exist. I also describe the efforts deployed in order to set up first-rank mathematics, physics, and humanities sections, and to promote communication among them. This gives a picture of the institution that hired René Thom and David Ruelle in 1962-63. This chapter forms the background for my discussion of the formation of Thom's research school, which I delay until Chapter VI below, and Ruelle's adaptation of the modeling practices promoted by its visiting topologists, which I discuss in Chapter VII.

2. A BRIEF HISTORY OF THE INSTITUT DES HAUTES ÉTUDES SCIENTIFIQUES (BURES-SUR-YVETTE)

On Friday, June 27, 1958, at 4 o'clock in the afternoon, a dozen men and women, most of whom were industrialists, met at the Sorbonne in the office of Joseph Pérès, Dean of the *Faculté des sciences de Paris.*[5] Boldly, they decided to go ahead and create the *Institut des hautes études scientifiques* (IHÉS), a non-profit association whose aim was "*to promote and sponsor theoretical scientific research* in the domains of pure mathematics, theoretical physics and the methodology of the sciences of man."[6] They explicitly stated

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[4] *Ibid.* My emphasis.

[5] The persons present at the first meeting were Joseph Pérès, Léon Motchane, Gabrielle Reinach, Fernand Picard (Renault), Jacques Ballet (Esso Standard), Louis Devaux (Shell Française), Pierre Besse (Société des Pétroles B.P.), Pierre Braillard (Compagnie Générale de T.S.F.), Mr. Seitz (Tréfileries et Laminoirs du Hâvre), Mr. Fernique Nadau des Îlets (Gaz de France), Jean Wegbecher (representing Edmond de Rotschild), and a legal advisor Me Jean Robert. *Procès-verbal de la séance de fondation du vendredi 27 juin 1958,* 1. Arch. IHÉS.

[6] *Journal officiel de la République française,* 90, no. 165 (16 July, 1958): 6652. My emphasis. The original name proposed for the Institute was "*Institut de Recherches*

their hope to put together an institute that would form a European counterpart to the Institute for Advanced Study (IAS) at Princeton. They moreover expected that their undertaking, with the help of its director, Robert Oppenheimer, whom they named an honorary member for life, would be modeled closely on Princeton's institute.

This enterprise exhibited many peculiarities. In the land of planned capitalism, in a country where the State occupied so much of the economic space, monopolized higher education, and was the major sponsor of scientific research, a fiercely independent organization was born.[7] An entirely private initiative, "for the first time since the Pasteur Institute, ended up creating a center of international renown," devoted to "fundamental research."[8] At the same time, the industrialists who would sponsor the new institute agreed that no research subject be imposed on its scientists, that no planning at all be set

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Fondamentales" [cf. *Note,* portant la mention "strictement confidentiel," jointe à une lettre de Léon Motchane à Pierre Ailleret (7/5/58). Arch. IHÉS. Comp. to Chapter IV]. On June 4, 1958, Léon Motchane mentions the Institut des hautes études *théoriques* in a letter to Victor Weisskopf. Apparently, the definitive name was proposed by Paul Montel in June 1958 [*Hommage de André Grandpierre à Joseph Pérès* à l'Assemblée générale du 14/3/62. Arch. IHÉS]. It is mentioned for the first time on a *Note pour Francis Perrin,* dated June 10, 1958.

[7] On science policy in France around 1958, see Dominique Pestre and François Jacq, "Une recomposition de la recherche académique et industrielle en France dans l'après-guerre, 1945-1970. Nouvelles pratiques, formes d'organisation et conceptions politiques," *Sociologie du travail,* 3 (1996), 263-277; Robert Gilpin, *La Science et l'État en France* (Paris: Gallimard, 1970); and Jean-François Picard, *La République des savants. La recherche française et le CNRS* (Paris: Flammarion, 1990).

[8] *Lettre* de Léon Motchane à André Maréchal (22/11/61). Arch. IHÉS. I do not know for sure if such a statement is accurate. In any case, few academic institutions had been founded in France with private money during the last century. The precedents of the Institut Henri Poincaré, the Institut de Sciences Politiques, and the Sixth Section of the École Pratique des Hautes Études were sometimes invoked, but, all founded with the help of private foundations, they differed significantly in intent and in their realization from the IHÉS, which remained a rather unique institution in the French system.

Figure 7: Robert Oppenheimer and Léon Motchane at the IHÉS in 1963. Copyright © Arch. IHÉS.

for them. In brief, the sponsors were asked to write a blank check, and gladly handed it to Léon Motchane, who was named director of the IHÉS.

a) Léon Motchane and the Mobilization for Fundamental Research

"It is Motchane who took the initiative [in creating the IHÉS] and devoted himself to the quest for its means of existence."[9] It was he who wrote its bylaws "from A to Z."[10] In this light, the creation of the IHÉS naturally appears as the single-handed accomplishment of a resolute man with a vision. Léon Motchane was born in Saint-Petersburg in 1900 of Swiss parents. While in Russia, he studied mathematics and physics, but was interrupted

[9] Lettre de Paul Montel à Léon Motchane (n.d., mais reçue le 23/6/58). Arch. IHÉS.

by the 1917 Revolution. He soon left Russia, and went on with his physics studies in Lausanne, Switzerland. For a while, he then worked there as a physics *assistant*. But, in the mid-twenties, he had to find a better-paid position, and entered banking and industry, serving as consultant and administrator for various firms. He was naturalized as a French citizen in 1938, and at the start of World War II volunteered for the Army. After the 1940 defeat, he went on several missions of information for the Resistance.[11] Around 1948 that Motchane went to Paul Montel to present to him some of his mathematical ideas. Montel advised him to write up a short notice for the Academy of Sciences, and make it into a doctoral thesis. Only in 1958, after a more than thirty-year hiatus, did he obtain full-time employment in a scientific position again, as director of the Institut des hautes études scientifiques.[12]

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[10] Lettre de Léon Motchane à Victor Weisskopf (5/2/70). Arch. IHÉS.

[11] Resistance networks certainly played a role in the history of the postwar French University. "Cette préhistoire [de la VIe section de l'EPHE] donne aussi un coup de projecteur sur l'importance de la résistance universitaire souterraine – trop généralement minimisée aujourd'hui – qui apportait un prélude aux réformes d'après la Libération. [...] Cela met aussi en relief l'importance des relations personnelles, forgées dans cette période difficile." Pierre Daix, *Braudel,* (Paris: Flammarion, 1995), 249. I have very few indications that the same kind of network played any role for Motchane's enterprise, but this might be interesting to investigate.

[12] Various versions of Léon Motchane's *Curriculum vita; Mémoire de proposition pour Médaille Militaire et pour la Légion d'Honneur* (14/4/65); lettre de François Le Lionnais à Léon Motchane (12/4/65); de Paul Montel à Léon Motchane (23/4/63). Arch. IHÉS. See M. Berger, "Hommage à Léon Motchane," *Le Monde* (7 February 1990) [actually written by Louis Michel], and a more detailed manuscript in Arch. IHÉS. From 1934 to 1958, Léon Motchane published 11 notes on mathematics and theoretical physics in the *Comptes-rendus de l'Académie des sciences.* On December 17, 1954, he defended his thesis, in front of Montel, Arnaud Denjoy, Jean Favard, and Gustave Choquet; it was published as *Propriétés invariantes par convergence simple* (Paris: Gauthier-Villars, 1954). Under the pseudonym of Thimerais, he also clandestinely published, during World War II, two booklets of sociological reflections about the task ahead of rebuilding a socialist France: *La pensée patiente* (July 1943), and *Éléments de doctrine* (February 1944), both at the Éditions de Minuit.

As Dominique Pestre has shown in his history of Leprince-Ringuet's laboratory at the École polytechnique, there is a danger in telling a story that insists on the role of an institution, like the IHÉS, which is to succumb to the temptation of repeating the standard epic that belongs to the collective memory of mathematicians and physicists, as well as that of the Institute itself.[13] But, as Pestre has also insisted, neither is everything false in this memory. Although originally the idea of a single man, the IHÉS required special circumstances to come to life. It is only through a careful investigation of the social and cultural resources deployed by Motchane to promote his idea, and the constraints imposed on it, which may have affected its final shape, that we can fully comprehend the meaning of the foundation of such an institute in Paris in 1958. To go too far in this direction would however lead us away from the main topic of this chapter, which is to examine the way in which the Institute helped the emergence of a specific modeling practice. Here I examine only the social networks mobilized by Motchane in support of his project.

First, Léon Motchane convinced a part of the mathematical establishment that something had to be done in order to stop the "French hemorrhage to the USA," the "brain drain" in mathematics.[14] From France, Jean Dieudonné, Schützenberger, Benoît Mandelbrot, among others, had just left for the US in the previous decade. After spending some years in the US, Claude Chevalley had trouble getting appointed to Paris; albeit "one of the two or three greatest mathematician alive," André Weil failed to get

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[13] See Dominique Pestre, "Le renouveau de la recherche à l'École polytechnique et le laboratoire de Louis Leprince-Ringuet, 1936-1965," in *La Formation polytechnicienne, 1794-1994,* ed. Bruno Belhoste, Amy Dahan Dalmedico and Antoine Picon (Paris: Dunod, 1994): 333-356.

nominated to the Collège de France.[15] The feeling was that the French mathematical school, one of the world's best, was losing some of its most prominent representatives for lack of attractive positions to offer.[16] Something had to be done. Thus, Motchane was able to get his mentor Paul Montel (1876-1975) to head the Consultative Scientific Committee of the IHÉS, who would alone take all the major scientific decisions.[17] As dean of the Faculté des sciences de Paris until 1946 and president of the Academy of Sciences, Montel was a prestigious patron, but a rather old man, who did not participate much in the establishment of the IHÉS.[18]

For that purpose, Motchane enrolled Joseph Pérès (1890-1962), who presided over the Institute and chaired its Administrative Board until his death. Dean of the Faculté des

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[14] *Notes de séances* manuscrites, par Annie Rolland, de la séance de foundation de l'IHÉS (27/6/58). Arch. IHÉS. Cf. E. C. Zeeman, "How to Reverse the Brain Drain in Maths," *New Scientist* (4 May 1967): 263-264.

[15] About Chevalley's difficulties, see J. Dieudonné, "Claude Chevalley, 11 février 1909 - 28 juin 1984," *Annuaire des Anciens élèves de l'Ecole Normale Supéieure* (1986). The quote about Weil is from Jean-Pierre Serre, lettre à Léon Motchane (18/12/58). Arch. IHÉS. About Weil's failed candidacy at the Collège de France, where Jean Leray was preferred to him by a vote of 32 to 1, see Chapter VII below. *Assemblée générale des professeurs* (16/2/47). Arch. CdF. G-iv-1 28U.

[16] See, *e.g.*, Pierre Lelong, "Questions d'actualité et de prospective," *Gazette des mathématiciens,* 1st ser., 2, no. 3 (November 1963): 1-3. Motchane himself "criticize[d] the stinginess with which we pay intellectuals in France." Lettre de Jean Dieudonné à Léon Motchane (25/2/59).

[17] Later, known simply as the Scientific Committee. The *Statuts de l'Institut des hautes études scientifiques,* art. 11, states: "The Administrative Board [of the IHÉS] has the power to take all decisions, . . . except those of a scientific nature which come under the authority of the Scientific Committee." See art. 5, 13-16 about the roles and powers of the Scientific Committee. Arch. IHÉS. See also *Journal officiel de la République française* (22 April 1974).

[18] See Pierre Lelong, "In memoriam. Paul Montel (1876-1975)," *Gazette des mathématiciens,* no. 3 (February, 1975), 14-19. Montel presented to the Academy two notes concerning the IHÉS: "Note sur l'activité et la composition de l'Institut des hautes études scientifiques," *Comptes-rendus de l'Académie des sciences,* 254 (1962), 2257-

sciences of Paris from 1954 to 1961, Pérès also lent his prestige to the enterprise, but more importantly "ease[d] the relations between the newly created Institute and the University," which could have regarded (and sometimes did) the IHÉS as a threat to its activities. Pérès "was able to show to his colleagues that the Institut des hautes études scientifiques, far from hindering the development of the University, brought new means facilitating the progress of research."[19] Pérès also helped with establishing crucial contacts with the government, at the highest level.[20]

The Institute for Advanced Study at Princeton—"in its spirit and its structure"—always provided Léon Motchane with a model *par excellence* to which the IHÉS should aspire.[21] His brother, Alexandre Motchane, an engineer living in New Jersey, had introduced him to Robert Oppenheimer, director of the IAS. Apparently Motchane was

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2258; "Historique de l'Institut des hautes études scientifiques," *Ibid. (Vie académique),* 269 (1969), 95.

[19] *Hommage de André Grandpierre à Joseph Pérès,* Assemblée générale (14/3/62). Cf. *Éloge du Doyen Pérès par Marc Zamansky* (22/2/62). Arch. IHÉS. Also: "Cependant, dès notre fondation, une certaine méfiance s'est manifestée en France de la part de quelques institutions universitaires. La crainte d'une concurrence, la possibilité de débauchage des professeurs de la part d'un centre riche et ayant une plus grande liberté de manoeuvres que l'Université, furent probablement à l'origine de cette réserve. La présence à la présidence de notre conseil d'administration du Doyen de la Faculté des Sciences de Paris et aussi la politique rigoureusement suivie par l'Institut ont rassuré les esprits. Il est rapidement apparu que les 'emprunts' de l'Institut au personnel universitaire français se réduiraient à peu de chose." *Rapport scientifique 1958-1959* (9/2/59).

[20] *E.g.* lettre de Joseph Pérès au Général de Gaulle (27/6/58); de Joseph Pérès à André Maréchal (28/8/61), etc. Arch. IHÉS.

[21] *Note communiquée à la presse* (11/7/58). Arch. IHÉS. In fact, the bylaws of the IHÉS (art. 11, quoted above) were "more liberal" than Princeton's. Lettre de André Weil à Léon Motchane (29/9/62); de Léon Motchane à André Weil (9/10/62): "clause disant que toutes les décisions scientifiques sont du ressort du Comité Scientifique et ne peuvent pas . . . être infirmées par le Conseil d'Administration." Arch. IHÉS. About the IAS and Princeton University, see W. Aspray, "The Emergence of Princeton as a World Center for Mathematical Research, 1896-1939," *History and Philosophy of Mathematics,* ed. W. Aspray and Philip Kitcher (Minneapolis: University of Minnesota Press, 1988): 346-366.

able to convince Oppenheimer to play an important role in the founding of a "Parisian Princeton."[22] From the earliest plans remaining in the archives of the IHÉS (probably dating from the end of March 1958, but no later than June), we learn that Pérès talked with Oppenheimer in the spring of 1958 and that Motchane was already counting him among the potential members for the Consultative Scientific Committee.[23] Until his death in 1967, Oppenheimer offered unconditional support to the IHÉS, and his advice on scientific, financial, and organizational matters. Motchane adopted many a tradition from the IAS, including such English rites as serving tea and cakes at 5 o'clock![24] More importantly, Oppenheimer became something of a mentor for him in his new job as the director of a research institution. On the occasion of a trip to the US, Motchane confessed to Oppenheimer:

> There is no doubt that I come principally to see you, and, like every year, have two or three good conversations with you. By discussing with you the problems that we share, by talking in all friendliness of things and men—because the Institute is a human affair—by listening to you, I succeed in finding my course.[25]

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[22] In the years that followed its foundation, the IHÉS was widely known as the French Princeton or the Parisian Princeton. For its fundraising campaigns in the US, from 1963 to 1969, it used, with Oppenheimer's blessing, the name of "Institute of Advanced Study—Europe." Lettre de Arnaud Denjoy à Léon Motchane (20/7/58), *Séance de fondation du Comité américain [American Committee]* (11/3/64). Cf. R. P. Dubarle, "Un Princeton français: un cloître voués à la recherche," *Le Monde* (16 May 1963), 13; L. A. Zbinden, "Le Princeton de l'Europe," *Gazette de Lausanne* (4/5 May 1963).

[23] *Notice* de Léon Motchane pour Fernand Picard, directeur des Études et recherches de la Régie Renault (n.d., portant la mention manuscrite "fin mars [1958]?"). Besides Pérès and Montel, Louis de Broglie was also mentioned. He was indeed approached, but declined because of his "too heavy duties." Lettre de Louis Motchane à Louis de Broglie (7/7/58).

[24] Robert Oppenheimer said of tea: "It is where we explain to each other what we don't understand." Quoted in *Batelle Rencontres: 1967 Lectures in Mathematics and Physics*, ed. C. M. DeWitt and J. A. Wheeler (New York: Benjamin, 1968), x.

[25] Lettre de Léon Motchane à Robert Oppenheimer (24/10/62). Arch. IHÉS.

Under such patronage, Léon Motchane gathered the nominal support of many internationally renowned scientists, most of whom, however, did not directly contribute to the founding of the Institute.[26] At the International Congress of Mathematicians, held in Edinburgh in August 1958, and probably before, Jean Dieudonné and Alexander Grothendieck, eminent figures of two particularly successful generations of French Bourbakist mathematicians, accepted offers to become the first permanent professors of the Institut des hautes études scientifiques.[27] But, however successful at enrolling scientists and university administrators in supporting the Institut des hautes études scientifiques, Motchane could not set it up alone. He needed money.

b) What is Fundamental Research and Why Should Industry Sponsor It?

Before the foundation, a Committee was set up which comprised, besides Motchane, Montel, Pérès and Oppenheimer, two more members: Fernand Picard and Maurice Ponte.[28] Both occupied high-level executive positions in large French corporations. Both were seriously involved in the process of the foundation of the IHÉS from the very

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[26] A *Note communiquée à la presse* (11/7/58) lists Profs. Amaldi, Niels Bohr, Max Born, Louis de Broglie, Jean Dieudonné, P.A.M. Dirac, Alexander Grothendieck, Louis Néel, and Victor Weisskopf. To which we can add Jean Leray and W. Heisenberg. Lettre de Werner Heisenberg à Léon Motchane (3/10/58); de Louis de Broglie à Léon Motchane (9/7/58); de Jean Leray à Joseph Pérès (15/7/58); de Léon Motchane à Robert Oppenheimer (24/6/58), in which Motchane asks Oppenheimer to approach Dirac, as he did Bohr. Arch. IHÉS.

[27] In the files of the IHÉS, their official agreement to become professors is lacking. The first letter from Jean Dieudonné to Léon Motchane was dated 23/6/58, in which he remarked: "Vous pouvez assurer CARTAN que nous ne dépeuplerons pas la Sorbonne!", thereby indicating that his coming to the IHÉS was already secured. On October 8, Motchane wrote to Oppenheimer about the two permanent professors. It was understood that they would start in February, 1959. Motchane's first letter to Grothendieck that is preserved is from 8/12/58. Arch. IHÉS.

beginning.[29] A physicist, *normalien* and *agrégé,* who had invented the first French radar, Maurice Ponte was vice-president of the *Compagnie générale de télégraphie sans fil* (CSF). Later in 1958, he would be drafted in de Gaulle's efforts for developing a coherent science policy at the inter-ministerial level. From the beginning a member of the *Conseil consultatif de la recherche scientifique et technique* (CCRST), also known as "les 12 sages,", he even briefly headed it in 1959.[30] "Clearly [a] positive element," Motchane noted, but understandably, with "no time to devote to the Institute."[31] While Ponte did participate in some of the early meetings and secure the financial participation of his enterprise, he seems not to have been involved so much with the actual work of organization and fundraising. At one of the last meetings prior to the foundation agreement, Ponte declared to Motchane: "I'm in, provided you take care of everything!"[32]

On the other hand, Fernand Picard, director of the research department of the nationalized automobile manufacturer Renault, actively worked at securing a financial basis for the IHÉS. Trained as an *Arts et Métiers* engineer, his general culture was only

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[28] Lettre de Léon Motchane à Francis Perrin (2/6/58). Arch. IHÉS.

[29] Lettre de Léon Motchane à Maurice Ponte (n.d., mais portant la mention manuscrite "fin mars [1958]?"), in which Motchane talked of Ponte as the "leader of our organizing committee;" notice de Léon Motchane à Fernand Picard (n.d., mais portant la mention manuscrite "fin mars [1958]?"); lettre de Léon Motchane à Fernand Picard (16/4/58). Arch. IHÉS.

[30] Presided by Maurice Letort, the first meeting of the 12 sages was held on December 13, 1958. Maurice Ponte became president of the CCRST on December 24, 1959, and was replaced by Pierre Aigrain on November 29, 1961. Arch. IHÉS. See also Antoine Prost, "Les origines de la politique de la recherche en France (1939-1958)," *Cahiers pour l'histoire du CNRS,* 1 (1988): 41-62.

[31] *Note pour le Dr OPPENHEIMER,* par Léon Motchane (septembre 1959), 2. Arch. IHÉS.

[32] Lettre de Léon Motchane à Joseph Pérès (2/2/59). Arch. IHÉS. On Maurice Ponte and CSF, see F. Jacq, *Pratiques scientifiques, formes d'organisation et conceptions politiques*

"average," according to Motchane, but he unfailingly remained "idealistic and enthusiastic about the Institute."[33] Picard enrolled his boss Pierre Dreyfus, president of the Régie Renault, in the project. A precious supporter with useful connections, Dreyfus was, Motchane wrote in September 1959, "a remarkable man with a high conscience of useful things in all areas [*dans tous les métiers*]. Thanks to him, the Institute exists: he drew all the others in."[34] Together, Picard and Dreyfus approached several corporations linked with the automobile industry, and helped obtain the support of large oil companies, such as Esso and Shell.[35]

(i) Looking for Patrons

It may not be obvious just how bold and peculiar was Motchane's gamble. Instead of trying to enroll the traditional sponsors of pure research in France, i.e. mainly the State, together with private donors, he turned to the private and nationalized industries. And to these industrialists, Léon Motchane, from the very beginning, persistently underscored the "essential" condition for the realization of the IHÉS, *i.e.* "the scientific direction of our Institute will be *entirely free and independent* from any financial influence."[36]

In the French political context especially, this was far from an obvious gamble. For the many scientists who had strong Leftist inclinations, the support of big industry for

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de la science dans la France d'après-guerre, thèse (École nationale supérieur des Mines de Paris, 1996).

[33] *Note pour le Dr OPPENHEIMER,* par Léon Motchane (septembre 1959), 2. Arch. IHÉS.

[34] *Note pour le Dr OPPENHEIMER,* par Léon Motchane (septembre 1959), 2. Arch. IHÉS.

[35] Motchane met with MM. Ballet (Esso), Kaplan (Shell), and Besse (B.P.) on 20/5/58. Note de Léon Motchane à Fernand Picard (17/6/58). Arch. IHÉS.

fundamental research was bound to be seen as a form of capitalistic control over it. Understandably, however, this objection hardly surfaces from the IHÉS archives. The only exception is a note indicating that in 1965 Grothendieck reported that Bourbaki mathematician Roger "Godement holds like Schwartz that the Institut represents the beginning of the takeover of the University by French capitalism and is decided not to have any contact with us."[37]

Actually, Motchane also looked at more traditional sources of financing, and this might well be where the feasibility of the institute project first became apparent. In a letter to Pérès, Mlle Gabrielle Reinach (1889-1970) explained that, being without direct heir, she had intended bequeathing her fortune to the Collège de France, where her father, Théodore Reinach, had taught.[38] She moreover wished to endow immediately a new chair in one the disciplines "of what we today call 'fundamental research', to the exclusion of any concern for applications." Without much of a scientific background, she confidently asserted that "since Henri Poincaré's writings, even non-mathematicians know that the progress [of the exact sciences] is possible or fruitful only when very general and disinterested abstract research is restlessly pursued." This activity, without a doubt, not only demanded great intellectual abilities, but also "much courage and character, and quite a lot of abnegation." Consequently, Mlle Reinach asked that the Collège choose not

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[36] Lettre de Léon Motchane à Maurice Ponte (n.d., mais portant la mention manuscrite "fin mars [1958]?"). Arch. IHÉS. My emphasis.
[37] Note taken by Annie Rolland (15/11/65). Arch. IHÉS.
[38] Notice that the lawyer who, at the origin, helped Motchane with the legal status of the IHÉS, Me Jean Robert, previously was Gabrielle Reinach's lawyer. Procès-verbal, Assemblée des professeurs (30/6/57). Archives du Collège de France (thereafter Arch. CdF), G-iv-m 28G*. I thank Christine Delangle and Marie-Ange Aucherie for their kind help in looking through these archives.

only professors of a sufficient scientific level, but also those that would have "the value of a moral example and would lead the young towards disinterested scientific research that our country greatly needs."[39]

Given her requirements, the faculty of the Collège de France found that there were "grave administrative difficulties" in accepting her generous offer.[40] Upon learning of the IHÉS from Motchane, Reinach decided to give the Institute an immediate gift of 15 millions *ancien francs,* and named the IHÉS her sole legatee. She became a member of the first Administrative Board, but not of the Institute after the minimum annual contribution was raised in 1959.[41]

Remembering "the generous gesture of his grandfather who founded, more than thirty years ago, the Institut Henri Poincaré, of international renown," Léon Motchane also approached "the young baron [Edmond] de Rothschild" in order to have him finance the Institute's land investment.[42] Contrary to the above precedent—or to that of the VIth Section of the *École pratique des hautes études* being set up by Fernand Braudel at about

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[39] Lettre de Gabrielle Reinach à Joseph Pérès (23/6/58), reprenant les termes d'une lettre de Gabrielle Reinach à Marcel Bataillon, administrateur du Collège de France (31/5/57). Arch. IHÉS.

[40] Procès-verbal, Assemblée des professeurs (30/6/57). Arch. CdF, G-iv-m 28G*.

[41] From 5,000F to 50,000F! *Procès-verbal de l'Asssemblée générale* (10/2/59). Mlle Reinach gave the IHÉS 50 kF in 1958, and then bequeathed her fortune to the Institute.

[42] Lettre de Léon Motchane à Albert Roncey, pour Edmond de Rotschild (6/6/58); note de Léon Motchane à Fernand Picard (n.d., "fin mars [1958]?"). Arch. IHÉS. About the foundation of the IHP, I refer the reader to Dominique Pestre, *Physique et physiciens en France 1918-1940* (Paris, Montreux: Éditions des Archives contemporaines, 1984); and L. Beaulieu, *Bourbaki,* 45-49.

the same moment—Motchane does not seem in 1958 to have solicited the Rockefeller Foundation or any other such organization.[43]

(ii) The Nationalized Sector

Léon Motchane himself felt more comfortable in asking for support from the nationalized industries producing electricity and natural gas. He also insistently solicited Francis Perrin, head of the *Commissariat à l'énergie atomique* (CEA), whose support soon became essential to allow the participation of the nationalized sector.[44] On June 2, 1958, Motchane wrote to Perrin:

> It is however extremely important that all principal industries be represented in our Institute, notably the industries of the atom, of electricity, natural gas and coal. Given the particular status of nationalized corporations exploiting these domains, it appears that the participation of the CEA as a subscriber of our Institute will make it easier, for the authorities on which the nationalized industries depend, to accept the fact that these industries largely partake in the financing of our organization.[45]

Indeed, Léon Motchane had lured Pierre Ailleret, director of research at *Électricité de France* (EDF), with the prospect of solving "the crucial problem of theoretical physics . . . namely, the structure of matter and particle theory . . . [with] a delay of a few years." Such progress entailed, as a first practical application "the direct transformation of nuclear energy into electrical energy – a transformation that would avoid any

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[43] As late as 1967, Motchane writes: "nous n'avons pas l'habitude des Fondations en général." Lettre de Léon Motchane à Victor Weisskopf (7/12/67). Arch. IHÉS. On the foundation of the VIth Section, see Brigitte Mazon, *Aux origines de l'EHESS, le rôle du mécénat américain* (Paris: Éditions du Cerf, 1988).

[44] Professor at the Collège de France, Francis Perrin, born in 1901, insistedly promoted the creation of theoretical professorships at the Collège. See Procès-verbal, Assemblée des professeurs (16/3/47), G-iv-l 29E; idem (27/11/49) G-iv-l 39X; idem (5/3/50) G-iv-l 40O; idem (25/11/51) G-iv-m 4Dd; etc. Arch. CdF.

[45] Lettre de Léon Motchane à Francis Perrin (2/6/58). Arch. IHÉS.

thermonuclear reaction."[46] Given that Motchane envisaged nothing less than a solution to the fusion problem, it becomes easy to understand why the participation of EDF was made contingent on that of the CEA, whose informed opinion could be trusted. As president of the Second International Conference of the United Nations on the Uses of Atomic Energy for Peaceful Ends, taking place in September of that year, Francis Perrin certainly was an authority to be counted on.[47]

Whether or not Motchane actually thought it possible to solve the fusion problem in a few years, the question was not so much that this progress would be achieved at the IHÉS—clearly, given the nature of the institute envisaged, it would not—but rather whether there would be, in Europe, and particularly in France, at the crucial moment, "a team of trained and informed scientists [*savants*]," able to serve as "interpreters" between theory and practice, between scientists and engineers.[48] In the future, nuclear energy was never mentioned again as a possible fallout from the Institute's activities, but this conception, according to which the IHÉS help train "many interpreters capable of placing abstract structures at the disposal of those who will use them for experimental applications and practical accomplishments," would often be exploited in the following

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[46] *Note,* portant la mention "strictement confidentiel," jointe à une lettre de Léon Motchane à Pierre Ailleret (7/5/58). Arch. IHÉS. See Comp. (a) to Chapter IV.
[47] Georges Guéron, "Observations à propos de la Seconde Conférence internationale des Nations-Unies sur l'utilisation de l'énergie atomique à des fins pacifiques," *Prospective,* 2 (January 1959): 13-21. This was the time when nuclear energy started to be used commercially in France, see Syndicat CFDT de l'Energie Atomique, *L'Electronucléaire en France* (Paris: Seuil, 1975).
[48] *Note,* jointe à une lettre de Léon Motchane à Pierre Ailleret (7/5/58). Arch. IHÉS. See also Comp. to Chapter IV below.

years.[49] As we shall see below, apparently a move way from the ideal of pure, fundamental research, this emphasis on "interpreters" can be seen as having shaped the evaluation by the IHÉS of the research conducted within its walls.

(iii) Big Industry

Initial approaches looking promising, in June 1958 Léon Motchane carried out an energetic offensive to gather the financial commitments allowing the foundation of the Institut des hautes études scientifiques. Already, the participation of CSF, Renault, EDF, and three oil companies seemed a sure thing. In his letter to Francis Perrin, Motchane wrote that he now had the pledges of about ten corporations for an amount of over 100 million (*anciens*) francs, half of the goal he then fixed.[50] He, and Fernand Picard approached several other companies, securing about 200 million francs in contributions. So that Motchane wrote to Montel, on June 18: "In the presence of favorable responses that materialize, with a laudable monotony, in precise pledges, . . . we took the decision, Monsieur Pérès, Monsieur Picard and I, to proceed with the Foundation of our Institute on Friday, June 27, at 4 o'clock."[51]

Let us examine the arguments used by Léon Motchane in order to persuade a sufficient number of large corporations to finance his enterprise at a level often close to 1 percent of their total research budget.[52] In a note he sent to industrialists before and after

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[49] Lettre de André Grandpierre à Pierre Messmer, Ministre des Armées (3/3/66), 2. See also les *Commentaires,* préparés pour la conférence de presse (juillet 1958). Arch. IHÉS.
[50] Lettre de Léon Motchane à Francis Perrin (2/6/58). Arch. IHÉS.
[51] Lettre de Léon Motchane à Paul Montel (18/6/58). Arch. IHÉS.
[52] The amount of 1 to 1.5% of the research budget, "much below the one commonly accepted in the United States for fundamental research," is mentioned in lettre de Léon Motchane à Pierre Ailleret (22/4/58); de Léon Motchane à Francis Perrin (2/6/58); note de

the foundation of the IHÉS, Motchane emphasized that the nature of scientific research, and of its organization, had changed in recent years.[53]

> Scientific research is not a spontaneous phenomenon of nature that flourishes in the Universities, but an activity we need to deal with, to cultivate, and which brings to a country that is abundantly equipped with [research institutions] a considerable addition of prestige and political power. . . . The true modern aspect of scientific research (which is less known to the public) consists in the fact that the work of an industrialist, of an engineer, like that of a theoretical physicist and of a mathematician, be it the most abstract, are not so far from one another, and the success of the latter becomes indispensable to the former.

Scientific research had to be cultivated, and collaborations between specialists of different fields, encouraged. With this goal in mind, modern technological applications now crucially depended on

> *Fundamental Research* in the exact sciences, by which we mean, in a restrictive fashion, the researches done, without concern for applications, in the domains of *Pure Mathematics, Theoretical Physics,* and the *Physico-Mathematical Methodology of the Sciences of Man.* . . . Alone [compared with applied science and engineering], the major problem of fundamental research, neglected for many years, has never been seriously taken up [in France], which explains for example the distressing backwardness of our country in theoretical physics.[54]

One may compare Motchane's definition of fundamental research with the one provided by a group physical and chemical experts who in 1970 concocted the VIth Plan for the French government. Noting that "a nation cannot allow to renounce to fundamental research without ineluctably vowing itself to a state of intellectual and industrial underdevelopment," they contended that the motivation of fundamental research was to "know and understand the laws of nature."

Léon Motchane pour Fernand Picard, à la suite d'une communication téléphonique entre eux deux (17/6/58).

[53] *Note pour les industriels* (Mai 1958). Arch. IHÉS. See Comp. (b) to Chapter IV.

[54] *Note pour les industriels* (Mai 1958). Arch. IHÉS. Original emphasis. Comp. (b) to Chapter IV.

> Used criteria are simplicity [and] generality. They allow to chose relatively simple problems, which will lead to the pulling out and formulation of these laws in their most profound and general form, and to the definition a simple language adapted for their analysis.[55]

In the US, and in Russia, Motchane claimed, the organization of fundamental research had been centered around institutes, like Princeton's. The solution was clear: "To gather a relatively limited number of scientists [*savants*] of great value, physicists and mathematicians, to give them all ease for work, without imposing on them teaching duties, nor any obligations."[56] While Motchane's contention about the role played by Institutes such as the IAS in Princeton may be highly contestable on historical grounds, we must note that the IAS being his model for the organization of the IHÉS, he saw the great advantages he could take away from portraying fundamental research as such.

Clearly, the mere fact that contributions to the IHÉS, up to 0.2 percent of the corporations' turnover, were tax deductible, is not enough to understand the reasons why "almost all the industrialists approached enthusiastically embraced the idea of a center for fundamental, that is, disinterested, research."[57] Motchane's arguments above hardly

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[55] DGRST, *Rapport de la Commission du 6e Plan, 1971-1974. Recherche,* tome 2 (Paris: La Documentation française, 1971), Chapitre I: "G.S. 1 - Etude de le matière et du rayonnement," 11-32. Fonds doc. CNRS. Quote on p. 11.

[56] *Note pour les industriels* (Mai 1958). Arch. IHÉS.

[57] *Commentaires,* préparés pour la conférence de presse (juillet 1958), 4. Arch. IHÉS. Corporations that joined the IHÉS in 1958-59 were: the Régie Renault, CSF, Saint-Gobain, CEA, Shell, EDF, Sovirel, Esso Standard, and Pont-à-Mousson. They were soon joined by two Italian companies: Fiat and Montecatini. See, *e.g.,* the *Résumé préparatoire* pour *Les hauts-lieux de la recherche scientifique,* un entretien de Paul Montel et Léon Motchane, avec François Le Lionnais, diffusé le 30 mars 1961 à 19h20, à RTF France III, dans le cadre de la série "La Science en Marche," 12. Arch. IHÉS. About conditions for tax deductions, cf. *Journal officiel de la République française* (28 September 1958): ordonnance no. 58-882 (25 September 1958) relative à la fiscalité en matière de Recherche scientifique et technique.

indicate a single direct return for the contributors to the Institute. He only offered their "noble and patriotic motives" as a motivation.[58]

Without questioning the patriotism of these men, I cannot help noticing that, for many who devoted a lot of time and energy to the IHÉS, a strong impression of personal gratification transpire from the records. Often with scientific training, having gone through the *Grandes Écoles,* they simply were excited by the prospect of contributing, in their own way, to the great adventure of pure science. In addition, they got to have lunch with Robert Oppenheimer himself.[59] Underscoring the personal component in the involvement of several companies was the fact that many decided to withdraw their support to the IHÉS just as they changed their administrators.

More seriously, we may underscore that these industrialists certainly also saw what a general increase on the scientific level of their country, and indeed of Europe in general, could offer in the long run in terms of pay backs for multinational corporations like theirs, who depended on high technological advances to make their profit.[60] One

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[58] *Commentaires,* préparés pour la conférence de presse (juillet 1958), 4. Arch. IHÉS.
[59] For example, Motchane writes Oppenheimer that Fernand Picard, during a trip to the US, "would be extremely flattered if you [Oppenheimer] devote a few moments to him." Lettre de Léon Motchane à Robert Oppenheimer (10/1/61). Similarly, René Grandgeorge, with Motchane, visited Oppenheimer on a trip to Princeton. Lettre de Léon Motchane à René Grandgeorge (4/3/60). When Oppenheimer came to Paris in September 1959, an busy schedule was established so that he ate with each administrator of the Board. *Note pour le Dr OPPENHEIMER,* par Léon Motchane (septembre 1959). Arch. IHÉS.
[60] I wish to thank Dominique Pestre for having explained this to me. A justification of several types of investment, depending on goals set for them, is to be found in Marcel Demonque, "Quelques réflexions prospectives sur le monde industriel de demain," *Prospective,* 1 (May 1958): 25-35 and Georges Guéron, "Synthèse des travaux," *Prospective,* 5 (May 1960): 11-77, esp. 41-43. Obviously, not all industrialists accepted to get into the boat. The vice-president of the Société d'électro-chimie d'Uginé for example argued: "According to what was recently said at the Academy, the problems of the organization of research will be taken up at a governmental level. In these conditions, it

should moreover remember that this was a period of unprecedented prosperity in the West, the height of what the French call *les Trente Glorieuses.* Some of the big industries solicited by Motchane might have felt that the necessary effort for the advancement of science demanded by him would remain a small strain on their finances. It was a small price to pay for promoting, to use Gaullist terms, a boost of France's *grandeur,* scientifically just as well as politically, which, they felt, could only help their business.

Indeed, undermining arguments in favor of narrow nationalism, the founders of the IHÉS expected from the very beginning to attract a wide European participation in its financing. Obviously, this seemed to them a natural counterpart of a participation of scientists, both as permanent and invited professors, to the IHÉS, which was supposed to overlook any kind of discrimination, including nationality, in its recruiting. The founders of the IHÉS therefore solicited industrialists from other European countries (especially Germany, Belgium, and Italy), as well as nascent European supranational structures. "It is evident that there is no room in Europe for two institutes of this kind and that, moreover, the *raison d'être* of such an organism principally resides in its universal character exceeding the framework of one nation. Consequently, as soon as it is set up, a call will be addressed to industrialists from all European countries."[61]

These European contributions would however prove extremely hard to get, especially that out of the first four permanent faculty members of the IHÉS, three would turn out to be French, but not, as we shall see below, for a lack of efforts at recruiting

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seems to me, personally, premature to take a position in one direction or another." Lettre de René Perrin à Léon Motchane (10/7/58). Arch. IHÉS.

[61] Lettre de Léon Motchane à Francis Perrin (2/6/58); and also *Commentaires,* préparés pour la conférence de presse (juillet 1958), 2. Arch. IHÉS; "Rapport Euratom."

foreigners. Only two Italian corporations (Fiat and Montecatini) would answer the IHÉS's call for a few years. On the other front, European supranational structures would prove badly designed for supporting an institution like the IHÉS, even when showing much good will (*e.g.* the case of Euratom).[62] The solution for international financing of the Institute, in the end, proved to be direct solicitation of national research councils of other European countries, but this was quite slow in the making.[63]

(iv) What Thus is Fundamental Research?

As we have seen above, Motchane's reliance on private business organizations for the funding of the IHÉS had led him to emphasize ultimate benefits that fundamental research could bring to humankind, and to the companies that sponsored it. This might seem a

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[62] In contradiction with its bylaws which forbade it from sponsoring outside research, Euratom granted the IHÉS five "research scholarships" for three years, but had to stop in 1963. On "a contourné l'obstacle . . . d'une manière peu orthodoxe" [Cf. *note de* J. C. Koechlin à l'attention de J. R. Bernard (29/3/68, CTI-N° 68/246 - JCK/JAR), Bureau du Premier Ministre]. Lettre de Léon Motchane à Jules Guéron, directeur scientifique, directeur générale des études et de l'enseignement (6/4/59); *Rencontre* de Léon Motchane et Jules Guéron à la Fondation Thiers (29/12/59). Lettre de Léon Motchane à Jules Guéron (18/2/60); de Léon Motchane à Hervé de Vitry (19/4/60); de Léon Motchane à Jules Guéron (25/6/60); de Jules Guéron à Léon Motchane (29/9/60); de Léon Motchane à Jules Guéron (3/10/60); de Léon Motchane à Jules Guéron (6/10/60); téléphone de Hervé de Vitry à Léon Motchane (25/10/60); de Jules Guéron à Léon Motchane (26/1/66). Arch. IHÉS.

[63] Britain's SRC was the first to contribute to the IHÉS, in 1970. First contacts were established through Zeeman (Lettres de E. C. Zeeman à Léon Motchane [22/6/64]; de Léon Motchane à E. C. Zeeman [30/6/64]; de E. C. Zeeman à Léon Motchane [25/8/64]). Initially, the British were more inclined to use their money in order to found a similar institute in England. Serious efforts therefore started in 1967, after the founding of the Warwick Institute, and resulted in SRC's joining the IHÉS in 1970. Lettres de Léon Motchane à E. C. Zeeman (31/8/67); de Léon Motchane à Rudolph Peierls (19/6/69); de E. C. Zeeman à Léon Motchane (14/7/69); *An Account of the Meeting between M. L. Motchane and Professor Sir Brian Flowers, Chairman of the Science Research Council (SRC):* London (27/8/69); *Proposal for the SRC to Support IHÉS,* for the meeting of the

paradoxical way to argue for fundamental research. Indeed, was not this kind of research supposed to be developed out of motives purely internal to the scientific disciplines it stemmed from? When Motchane insisted on the role the IHÉS could play in training "interpreters" between fundamental research and potential applications, was he not moving away from his ideals?

These questions are central issues for achieving a better understanding of the kind of research the IHÉS would promote. As the above shows, Motchane was always very clear about one thing: he wanted the scientists working at the IHÉS to remain totally free to study whatever they wished. But at the same time, for Motchane, as well as for the industrialists enrolled in the project, the research done at the IHÉS, no matter how "fundamental" it was, nevertheless held potential promises for future applications. Of course, nobody believed that anything readily useable by industry would come out of the IHÉS. But a premise was shared, that such fundamental research could one day prove useful.

In view of the research later conducted at the IHÉS, notably on catastrophe theory and chaos theory, I believe that this ideology of fundamental research had an effect in orienting the kind of research that would be the most highly considered by the Institute. In effect, a middle way between pure and applied science was opened. The "fundamental research" promoted by the IHÉS was to remain free from outside influences, but at the same time, highly shaped by concerns with the world. Catastrophe theory exactly was this kind of fundamental research. By opening new vistas of understanding of natural

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SRC Mathematics Committee, 11 November 1969, by E. C. Zeeman (dated october 1969); etc. Arch.IHÉS.

phenomena, it showed that pure mathematical research could shape the way people grasped structures of nature, while at the same time remaining scarcely concerned with practical uses for technology. Understanding, as opposed to prediction, computation, and action, became the IHÉS's ideal for fundamental research. This entailed that, in the eyes of Motchane and the administrators of the IHÉS, the most valued areas of research to be pursued at the Institute became mathematical research on the structures of mathematics and the development of languages of great generality, physical research on the mathematical structure of physical theories, with an emphasis put on elementary particle physics, and humanist research on methodology, i.e. the structure of social sciences theories. In the first Scientific Report he presented to the Administrative Board of the IHÉS, Motchane wrote: "Faithful to our conception of fundamental research, we solicited scientists [*savants*] who are attracted and interested by *new problems of a great generality.*"[64] The IHÉS provides us with another instance where *structure* played an important role as a cultural connector.[65]

Of course, this attitude had obvious political undertones. As they were not concerned with applications, the IHÉS scientists would not be bomb builders. But, at the same time, concerned with general theories having a bearing on the world, they would not remain in the ivory tower of academic research. At least, this was the ideal Motchane was pushing for. In view of later research conducted at the IHÉS, this attitude seems to have had some concrete effects.

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[64] *Rapport scientifique, 4 juillet 1958 - 31 décembre 1959* (2/2/60), 10. Arch. IHÉS. My emphasis.

[65] For more on this, see Chapter VI below.

c) Searching for Financial Stability

(i) Legal Matters and Threat from Industrialists

The founders of the IHÉS discovered that the existence of such an institution, common in Anglo-American countries, posed a problem for French law, and required legal innovations that could only be obtained from the highest levels: the Government and the Parliament. Indeed, the contributing members formed a non-profit association ("Loi du 1er juillet 1901"), which clearly was not designed for research institutions. Indeed, as Motchane emphasized, this institute "markedly differed from a typical association, like 'the interprofessional association of the horse' whose goal was 'to develop, improve, and coordinate the production, use, and understanding of horses and mules"![66] In particular, this status did not allow the Institute to build up endowments; it limited its possibilities of receiving donations from foreign countries; it required contributions of all members to be equal; and it barred usual tax deductions allowed for national research institutions.[67] The problem was "to find a new legal formula that would allow scientific institutions to manage their funds, with no administrative obstacle whatsoever. Such a legal entity does not exist in French law."[68] For all these reasons, Motchane resolved, after a meeting with Minister André Malraux, to change the status of the IHÉS, by creating from scratch a new

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[66] Note préparée par Léon Motchane en vue d'une entrevue avec Gérald Antoine (23/4/60). Arch. IHÉS.
[67] *Ibid.;* "Exposé de motifs" préparé par Léon Motchane pour M. Poignant (n.d., 1959). Arch. IHÉS.
[68] Lettre de Léon Motchane à Robert Oppenheimer (8/10/58). Arch. IHÉS.

legal entity: an "international foundation."[69] Motchane spent the first summer of the Institute's existence writing these legal texts. In September, he wrote triumphantly:

> All this is quite cheering, and it leads me to some reflections of a philosophical character, namely, that if mathematicians are led to create legal texts, why would a few unsolved mathematical problems not be proposed to State councilors [*conseillers d'État*]? Who knows?[70]

However, these were tumultuous years for the French Government. Several Ministers of Education and of Scientific Research would examine the IHÉS problem one after another, until it was decided that a declaration of Public Utility (*déclaration d'utilité publique*), decreed on March 6, 1961, would suffice.[71] Ultimately, the transformation into an international foundation had to wait until 1980.

"As it often happens at a moment when we change status," Motchane reported to Oppenheimer in April 1959, "the temptation is great for some industrialists to backtrack on the generous and liberal dispositions of our original status, which allowed us to get the support of the principal scientists of the whole world."[72] Indeed, following first attempts at negotiating a new status with the Government, Pierre Besse and Léon Kaplan, both of whom had shown enthusiasm and diligence for the IHÉS, presented Joseph Pérès with suggestions that involved important modifications of its structure and spirit. By their action, Motchane wrote, "they almost put the IHÉS down."[73] In short they proposed to "envision a larger composition for the Consultative [Scientific] Committee, and to confer

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[69] *Entretien avec M. Malraux* (17/7/58) à 16h; *Notes de séance manuscriptes de l'Assemblée générale* (13/6/59) d'Annie Rolland. Arch. IHÉS.
[70] Lettre de Léon Motchane à Paul Montel (6/9/58). Arch. IHÉS.
[71] *Journal officiel de la république française,* 93, no. 56 (7 May 1961), 2382.
[72] Lettre de Léon Motchane à Robert Oppenheimer (4/4/59). Arch. IHÉS.
[73] *Note pour le Dr OPPENHEIMER,* par Léon Motchane (septembre 1959), 3. Arch. IHÉS.

on it the responsibility of defining the field of activity of permanent and temporary professors." Moreover, they suggested that

> what we could call our *'policy of work and research'* would therefore proceed from a formal agreement, achieved in conditions to be defined, between, on the one hand, the Consultative Scientific Committee [which would be] in a way 'intellectually' responsible, and [on the other hand] the financially responsible Administrative Board.[74]

This proposal infuriated Motchane who started to count his allies.[75] He accused Besse and Kaplan of "only having a vague idea of what scientific research is and of the importance of the principles of university freedom."[76] Fortunately for him, the reformers found themselves isolated.

> Basically, no doubts are possible: to accept such principles [as proposed by Besse and Kaplan] is to backtrack short of classical academic freedom, and this simply is equivalent to liquidating our Institute. Luckily, we now have new important subscribers, and even if SHELL gets out—which nobody desires—the Institute will not be in jeopardy.[77]

From all this fuss, it resulted that Besse (and his corporation, British Petroleum) never joined the association, while Kaplan finally gave his commitment to the consensus, but always remained an inside critical voice until Shell withdrew its support in the mid-

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[74] *Rapport sur l'organisation et sur les bases scientifiques et spirituelles du fonctionnement de l'IHÉS, présentée au Doyen Pérès par MM. Kaplan et Besse en décembre 1958,* 2. Arch. IHÉS. My emphasis.

[75] *Entretien* entre Léon Motchane et Maurice Ponte (22/12/58); de Léon Motchane à René Grandgeorge (20/2/59); de Léon Motchane à Fernand Picard (26/2/59); entrevue entre Léon Motchane et Pierre Dreyfus (13/5/59). Arch. IHÉS.

[76] Commentaires de la main de Léon Motchane, suite à une copie d'une lettre de Pierre Besse à Fernand Picard (17/10/58). Arch. IHÉS.

[77] Lettre de Léon Motchane à Fernand Picard (26/2/59). In his answer [lettre de Fernand Picard à Léon Motchane (11/3/59)] proposes, in a "conciliation spirit," that the president of the Board would automatically be member of the Council, and that the latter's role be "to define the orientation of the work of the Institute, in agreement with the Administrative Board." On the copy of this letter, kept in the IHÉS archives, Léon Motchane flatly wrote "non" beside this suggestion. Arch. IHÉS.

1960s.[78] For Motchane, a liberal conception of scientific freedom always remained non-negotiable.[79]

(ii) Finances and Activities

Depending on annual corporate donations, the finances of the Institut des hautes études scientifiques therefore exhibited an acute sensitivity to fluctuations in the economic situation of the sponsoring corporations, or any loss of interest on the part of their administrators. Over the years, as its investment program progressed importantly with the acquisition of a property at Bures-sur-Yvette, in the outskirts of Paris, and as its activity likewise increased, the Institute fell "victim to [its] own success," as Motchane noted.[80] The deficit for the 1964 exercise exceeded 600,000 (*nouveaux*) francs. And in 1965, after the cancellation of several subscriptions, he pulled the alarm signal: "*I am on the brink of bankruptcy!*"[81]

But, finally, the French State came to the rescue. In September, 1965, "the Government [took] a resolution in favor of regular help" to the IHÉS, which amounted to

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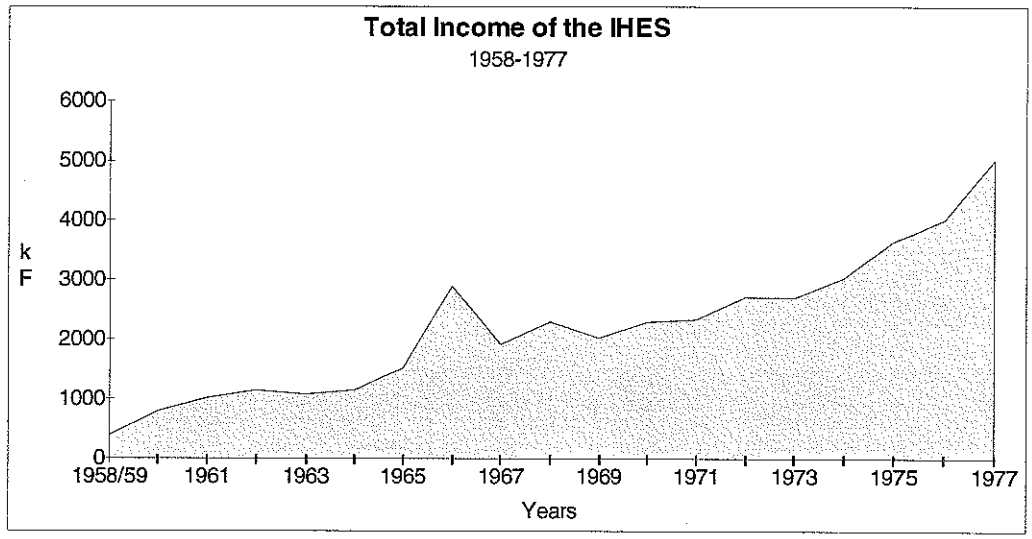
[78] According to Motchane, Kaplan's role was "constantly negative." Projet de lettre de Léon Motchane à Louis Devaux (2/11/65). "[Il] essayait d'infléchir l'activité de l'IHÉS vers des programmes tracés d'avance, sous un contrôle plus étroit d'un comité où l'influence des industriels serait importante." *"Complément"* en vue de la visite de Léon Motchane à Henri Domerg (à Matignon, 19/2/68; daté 16/2/68).

[79] Léon Motchane, on the other hand, was more than willing to accept, as members of the Scientific Committee, scientists coming from research agencies financing the IHÉS, like the CEA, Euratom, the CNRS, or foreign research councils. See e.g. "Rapport Euratom" (mars 1959), 30. Arch. IHÉS.

[80] Lettre de Léon Motchane à Shepard Stone, Director of Sloan Foundation (23/5/63). Arch. IHÉS.

[81] Lettre de Léon Motchane à Frank Bowles, Program director of the Education Division, Sloan Foundation (5/2/65). Arch. IHÉS.



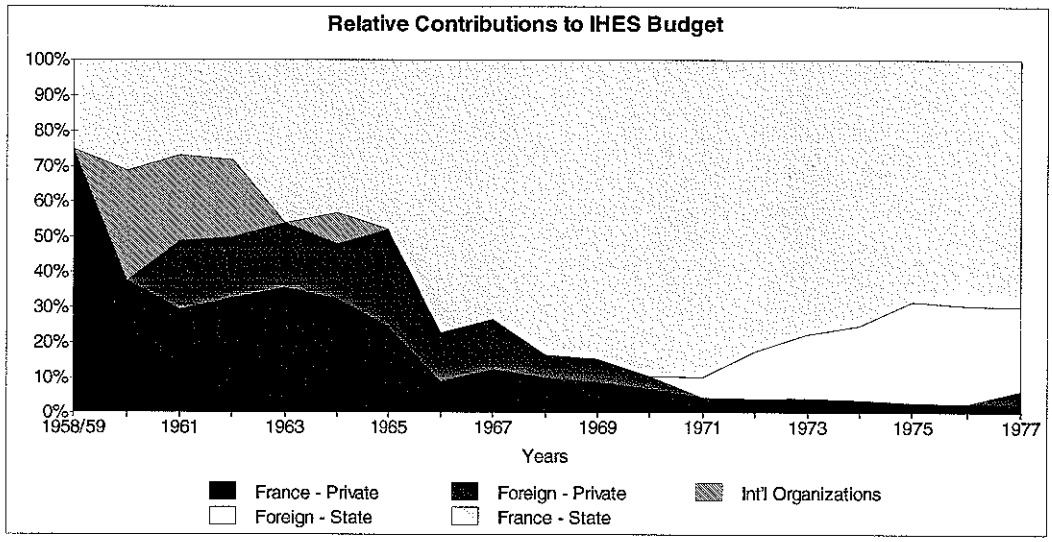
Graph 1: Evolution of the actual total income to the Institut des hautes études scientifiques (1958-1977). Arch. IHÉS.

about half of its resources for many years to come.[82] Its survival was thereby assured. In Graph 1, the peak in 1966 corresponds to an exceptional aid from the French State intended to balance earlier deficits.

Graph 1 above shows the evolution of the IHÉS budget in current francs from 1958 to 1977. This graph underscores two periods of relative stagnation: from 1962 to 1965, corresponding to the successive defection of a number of private subscribers, and then from 1967-1974, corresponding to a stagnation in the State's help, together with few infusion of money from other sources.

In order to have better view of the changing nature of the financial bases of the IHÉS, I plotted in Graph 2 the evolution of the relative contributions coming from five

[82] Lettre du Premier Ministre Georges Pompidou au Secrétaire d'État auprès du Premier Ministre, chargé de la recherche scientifique et des questions atomiques et spatiales [André Maréchal] (20/9/65). Copy in Arch. IHÉS.

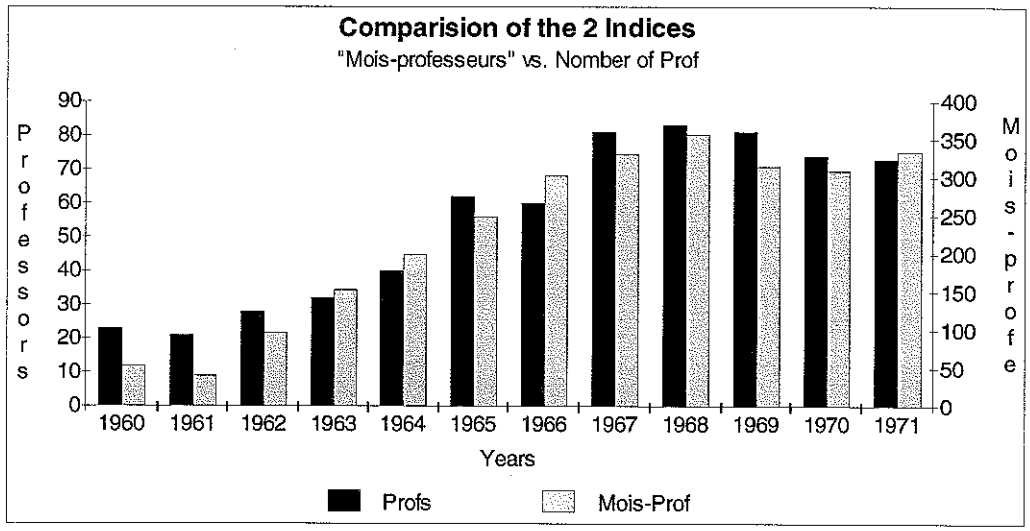


Graph 2: Relative contributions (in %) of the different types of sponsors of the Institut des hautes études scientifiques (1958-1977). Arch. IHÉS.

types of founders: the French private sector, the foreign private sector, international organizations, the foreign public sector, and finally, the French public sector.

The private sector, predominant until 1965 quickly became a lesser partner, while the French State insured the larger part of the IHÉS budget (up to 90% in 1970-1971!). Note however that nationalized industries, such as Renault, and the CEA, which were always counted as private support by the IHÉS have been here counted together with the French public sector. Support from foreign national science foundations became important starting in 1970. But clearly, the role of the French State remained predominant.

Since the level of activities at the IHÉS had not ceased to increase in 1962-1966, this situation clearly was strenuous (Graph 3). Indeed the very survival of the Institute



Graph 3: Total number of professors and total number of "mois-professeurs" at the Institut des hautes études scientifiques versus years, 1960-1971. Arch. IHÉS.

was then jeopardized. In 1965, the French State's decision to support the IHÉS directly therefore gave Motchane a little respite.

3. 'OSMOSIS' BETWEEN PHYSICISTS AND MATHEMATICIANS?

a) Statistics for Visiting Professors, 1960-1971

In Graph 3, I compared two indices that were used by the administration of the IHÉS in order to measure the evolution of the number of professors working at the Institute:[83]

(1) The absolute numbers of professors paid by the IHÉS each year, including permanent professors, invited professors, and, starting in 1965, visitors admitted without pay by the IHÉS. From the beginning, the distinction between mathematicians and

[83] The list used to compile Graph 3 below was included in Nicolaas Kuiper's *Rapport scientifique 1971* (18/5/72). Arch. IHÉS.

physicists was always clearly recorded in the IHÉS files. And (2) the number of "mois-professeurs," an index introduced by Motchane in 1963 which counted the number of months professors spent at the Institute, whose series unfortunately is incomplete.

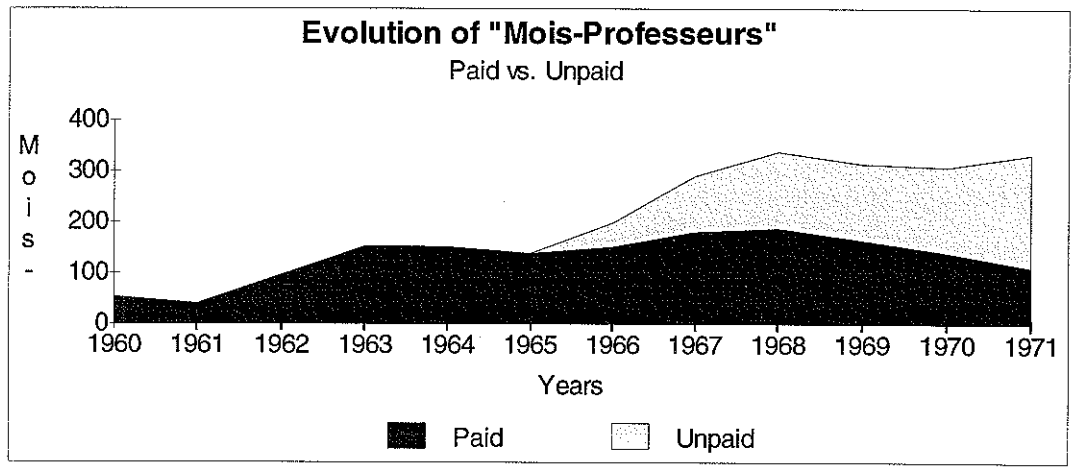
As a way to reflect the overall evolution these two indices are almost equivalent (Graph 3). The second series however underscores the low level of activity witnessed by the IHÉS in 1959-1962. The general trend is however the same for both. The activity of the IHÉS constantly increased until 1967-1968, and then witnessed a stagnation until at least 1971.

(i) Comparing Paid vs. Unpaid Professors and Visitors

To better interpret the global evolution, we may want to compare the number (or number of "mois-professeurs") of paid versus non-paid professors, as well as the number (or number of "mois-professeurs") of physicists versus mathematicians.

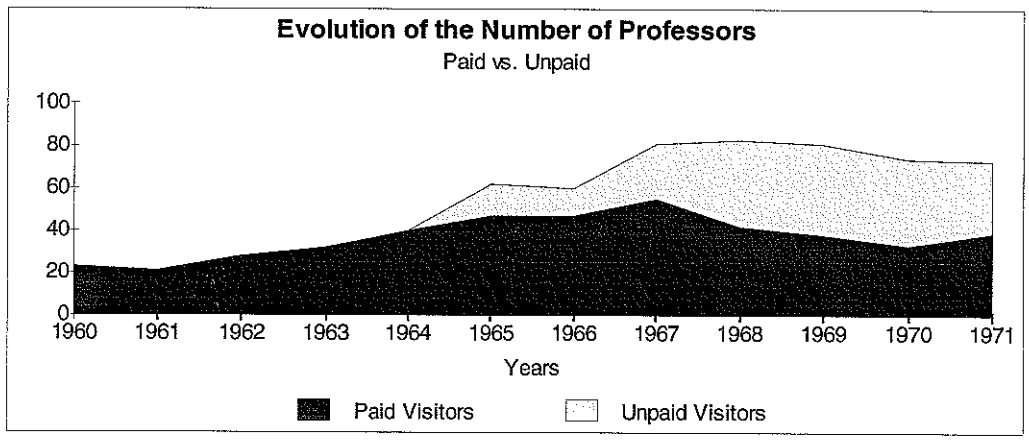
Graph 4 and 5 clearly show the increasing part played by admitted visitors (without pay from the IHÉS) as opposed to paid professors. Moreover, since admitted visitors often were graduate or postdoctoral students, whose stipend was paid by foreign universities and science foundations, they also tended to stay longer at the IHÉS.

Graph 4 gives the evolution of the number of "mois-professeurs." It graphically demonstrate the important role admitted professors were playing in 1968-1971. Considering the stagnation in the total number of collaborators working at the IHÉS, this graph underscores that the invitation budget of the IHÉS was then quickly becoming insufficient, at the same time as its repute, measured by the way it attracted unpaid researchers, was increasing.

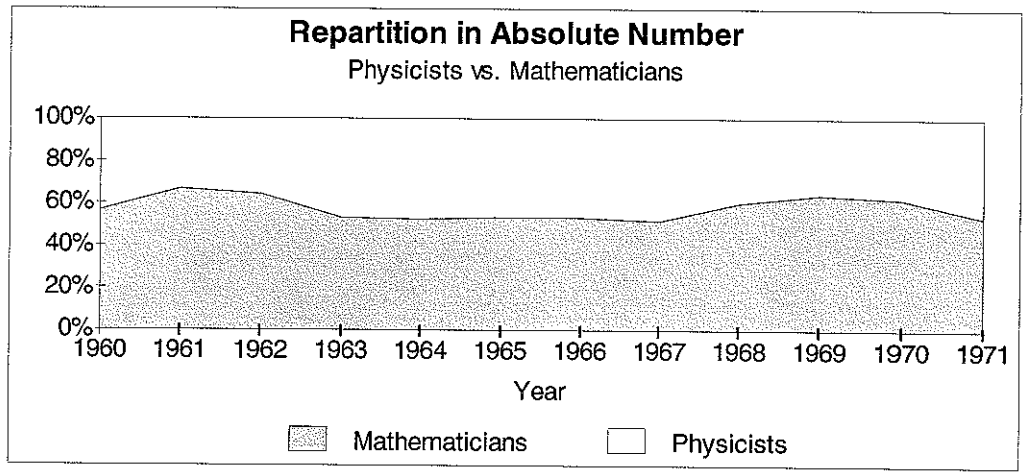


Graph 4: The number of "mois-professeurs" emphasizing the part played by unpaid admitted professors versus years, 1960-1971.

Graph 5 provides the same evolution in terms of absolute numbers of professors staying at the IHÉS. While it minimizes the importance of non-paid visitors, it however shows that these visitors started to play an important role as early as 1965.



Graph 5: The absolute number of professors emphasizing the part played by unpaid admitted professors versus years, 1960-1971.



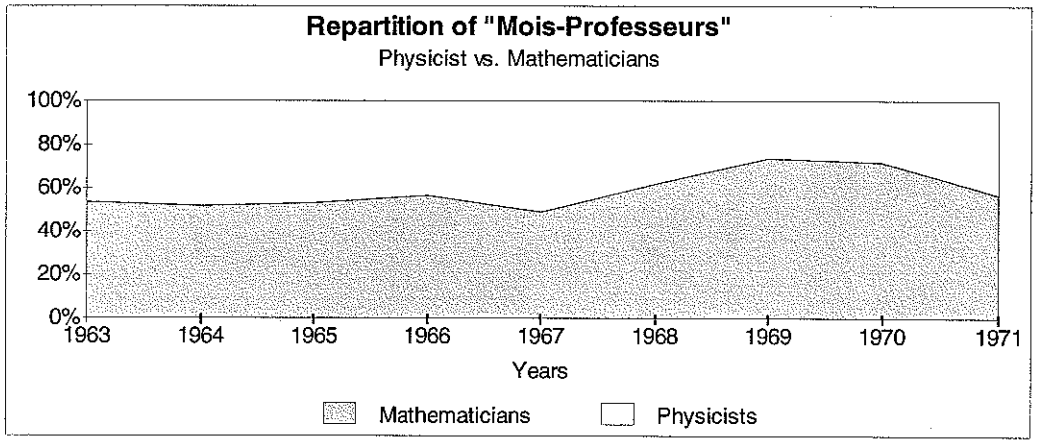
Graph 6: Percentage of mathematicians, as opposed to physicists, among the total number of professors invited at the IHÉS, 1960-1971

(ii) Comparing Physicists with Mathematicians

Graph 6 and 7 give the evolution of the percentage of mathematicians invited to work at the IHÉS. In absolute number, the proportion of mathematicians was relatively stable at around 50-60% over the whole period 1960-1971.

In terms of "mois-professeurs," however, the proportion of mathematicians, while similar to the above for 1963-1967, increased to as much as 70% in 1969-1970 (Graph 7). This graphically exhibits an important domination of mathematicians in the later part of the decade, as well as the fact that they tended to stay longer than physicist.

Let us now look more closely at the way the work was set up at the IHÉS, and at the activities that went on there during its first years, before the time when, in 1963, both René Thom and David Ruelle were hired.



Graph 7: Percentage of "mois-mathématiciens" as opposed to "mois-physiciens" spent at the IHÉS, 1963-1970. Note the scale different than in Graph 6.

b) Organizing the Work at the IHÉS

From the above, it appears that the conditions for the existence of the Institut des hautes études scientifiques hinged on an ideological premise: the success of fundamental research depended on communication between great scientists working in different disciplines of a very general character. And indeed, from the start, "a collaboration between mathematicians and physicists [was] envisaged."[84] In 1958, this hardly was a trivial statement to write; it underscored an important facet of Motchane's conception of fundamental research and foretold the kind of physics and mathematics that would be done at the IHÉS.

> The principle of establishing contacts between men whose investigation methods are . . . very different, has shown itself fruitful in the past. Today, this principle remains our only protestation against an excessive specialization, and our only

[84] Lettre de Léon Motchane à Francis Perrin (20/11/58). Arch. IHÉS.

> hope of preserving a global vision of problems, which is *precisely the key to the success of fundamental research.*[85]

The attention paid above to the problems encountered around its foundations, and to the particular nature of its legal status and sources of financing, puts us in a position to see the effects that such an organization was to have on the research conducted within its walls. I will consider two consequences of these view. The first deals with the relationship Motchane tried to foster between physicists and mathematicians at the Institute, the second with the place of the humanities at the IHÉS.

As mentioned above, the official bylaws of the IHÉS dictated that it would encourage fundamental research in "pure mathematics, theoretical physics, and the methodology of the sciences of man."[86] In practice, Motchane envisioned a division of his institute into separate sections along the lines of the "Schools" of Princeton's IAS. With Jean Dieudonné and Alexander Grothendieck starting their tenure in March 1959, the mathematical section was well under way. Hans Grauert–considered for professorship at the IHÉS, but having just been appointed to Göttingen–and André Weil, from the IAS, accepted nominations as "permanently invited professors."[87] Thus a "team" had been set up, which could "no doubt be compared to the best troops [*forces*] of the Sorbonne and of the Collège de France. But it seems difficult to find its equivalent elsewhere."[88] Indeed on

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[85] *Rapport Euratom* (March 1959), 11. Arch. IHÉS. My emphasis.
[86] *Statuts,* art. 1. Arch. IHÉS.
[87] This was an arrangement already practiced at the IAS, which involved from the part of professors a yearly short visit (1 to 2 months) at the Institute. *Rapport scientifique, 1958-1959* (9/2/59) and (2/2/60). About Weil, Jean-Pierre Serre wrote to Motchane (18/12/58): "Cher Monsieur, Vous me demandez mon opinion sur l'oeuvre de mathématique d'André WEIL. La voici: à mon avis, WEIL est l'un des deux ou trois plus grands mathématiciens vivants." Arch. IHÉS.
[88] *Rapport scientifique, 1958-1959* (9/2/59), 3.

May 19, 1959, Grothendieck began his soon-to-be-famous seminar of algebraic geometry. And scheduled (in February 1960), for the *Publications mathématiques de l'IHÉS,* was the first volume of his (and Dieudonné's) *Éléments de géométrie algébrique,* which would totally reshape the outlook of the field. Building on the prestige and strength of French mathematics—with the Bourbakis Dieudonné, Weil, Grothendieck—and securing the collaboration and sympathy of Jean Leray, André Lichnérowicz, Henri Cartan, Jean-Pierre Serre, and Claude Chevalley, the mathematical section of the IHÉS "was acquiring a personality which usually characterizes well-established scientific centers."[89]

Even in the mathematics section, however, there were few visible activities during the first years of the IHÉS. To start with, before 1963, the Institute had no seminar rooms, library, office space at its disposal, except for two offices it rented for the director and his secretary from the Fondation Thiers, in the 16th *arrondissement* in Paris. Seminars were held in a room that the Fondation made available for them every Wednesday afternoon, or at the Sorbonne or the École normale supérieure. In the spring of 1959, Wightman was expected to work in the hotel room he shared with his wife and ten year-old daughter, while, taking advantage of the nice weather, Källen decided to work under a tree.[90] In 1959, besides Grothendieck's seminar, only John Milnor did give a few conferences.

In 1959-1960, an important portion of the mathematical activity was devoted to the *Publications methématiques de l'Institut des hautes études scientifiques.* In Motchane's words, this was not to be "a periodical mathematical journal of the usual type.

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[89] *Rapport scientifique, 4 juillet 1958 - 31 décembre 1959* (2/2/60), 11. Arch. IHÉS.
[90] Interview of A. S. Wightman by the author (28 November 1997). Hearing complaints about the lack of a library, Grothendieck is said to have declared: "We don't read books, we write them!"

The goal of this journal is to allow the very rapid publication of original memoirs of a great value."[91] In February 1960, two issues had been published and three more were in press, including Grothendieck's famous *Éléments de géométrie algébrique,* already planed to occupy 1500 pages in several issues of the *Publications mathématiques.* Algebra was the main topic represented in its pages.

In 1960, according to Motchane's Scientific Report, Grothendieck continued his weekly seminar on algebraic topology, in front of an audience of about thirty persons, including Claude Chevalley, Jean-Pierre Serre, Oscar Zariski, and Jean Dieudonné, and many young mathematicians. Proudly, Motchane underscored that "Paris—and more especially the Institut des hautes études scientifiques, the very place where [algebraic geometry] is created—has become the center of this branch of mathemetics." At the IHÉS, In 1960, several other conferences, mostly on algebraic topics, were held by important mathematicians: S. S. Chern, M. Atiyah, A. Weil, J. Tits. Moreover, Claude Chevalley, in abstentia from the Faculté des Sciences de Paris, spent the year 1960-1961 as a visitor to the IHÉS, where he delivered weekly lectures on "algebraic structures in categories."[92] Twelve mathematicians thus spent part or the entirety of the year at the IHÉS, including future Fields medalist Hironaka, and Lavrentiev, the Vice-President of the Soviet Acedemy of Sciences, who came from three weeks in order to establish scientific relations between his Academy and the IHÉS.[93]

It was only in the following year, 1961, that a certain diversification in mathematical topics occurred. Algebra ceased to occupy almost all the place. With Hans

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[91] *Rapport scientifique, 4 juillet 1958 - 31 décembre 1959* (2/2/60), 3. Arch. IHÉS.
[92] *Rapport scientifique sur l'activité de l'IHÉS en 1960* (5/5/61). Arch IHÉS.

Grauert, analysis and especially the study of several variable complex functions was emphasized by Motchane in the Scientific Report for 1961. The director of the IHÉS described the accomplishments in this domain as being similar in kind to Grothendieck's in algebraic geometry,

> namely to achieve an axiomatic exposition of these new theories and some kind of codification of methods which would allow young mathematicians to go ahead in this direction and exploit it sucessfully.

The publication of Grauert's new exposé was envisioned as part of the *Publications mathématiques.* Thus, Motchane particularly welcomed the fact that two branches of mathematics were in great development and especially that the IHÉS was "at the same time the center of research and the focus of diffusion in these two domains."[94]

Even at the very beginning, although it certainly exhibited an elitist character, and a focus on elementary structures, the IHÉS was difficult to classify according to the Bourbakist/anti-Bourbakist fault line. Indeed both clans allied in support of the IHÉS. Although tensions were perceptible even within the Scientific Committee, this circumstantial alliance persisted for many years.[95] Apparently, Motchane himself was responsible for having imposed this conciliatory attitude in the face of divisions within the French mathematical community: "it is not at all the intention of the Scientific Committee to suggest that the activity of our Institute is devoted to a single branch of mathematics, that specialization is pushed to the extreme, and that this Section is

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[93] *Organisation et activités scientifiques* [1958-1961] (15/1/61), 5. Arch. IHÉS.
[94] *Rapport scientifique sur l'activité de l'institut des hautes études scientifiques en 1961,* 5. Arch. IHÉS.
[95] As a testimonial of tensions not often spelt out, see e.g. lettre de Léon Motchane à Jean Dieudonné (16/12/58). Arch. IHÉS.

dominated by a *chapelle*." [96] This last term, to be understood in the sense of *clique*, was then commonly used to designate different subgroups of the French mathematical community.

c) Setting up Theoretical Physics in France

The organization of the theoretical physics section of the IHÉS progressed more slowly. Besides rather vague support from prominent members of the international physics community, nothing had been set up before the foundation of the Institute. Many factors explained why the organization of this section presented greater difficulties.[97] First, Motchane himself had received his Ph. D. in mathematics, and, even though he was also trained in physics, and had published a few notes in this field, his main interests remained mathematical. Second, France's international position was much stronger in mathematics than it was in physics, especially in its theoretical branch. Motchane thought that the French situation in theoretical physics was especially poor, and, besides Francis Perrin (who also headed the CEA which was to be an important sponsor of the IHÉS), he does not seem to have pursued the collaboration of French physicists as much as that of others.[98] Finally, by the late 1950s, many career tracks, alternative to the University, were already in place for French theoretical physicists, namely at the CEA (closed to pure

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[96] *Rapport scientifique sur l'activité de l'IHÉS en 1960,* 6. Arch. IHÉS.
[97] *Rapport Euratom* (March 1959), 23. Arch. IHÉS.
[98] According to him, "on ne trouvait guère en France de physiciens théoriciens de valeur exceptionnelle, . . . ce qui ne facilite pas aujourd'hui la création à notre Institut d'un groupe de travail." *Rapport scientifique, 4 juillet 1958 - 31 décembre 1959* (2/2/60). *Commentaires,* pour la conférence de presse (11/7/58), 2. Also: "retard inquiétant de notre pays en physique théorique," *Note pour les industriels* (Mai 1958), 2. Arch. IHÉS. Comp. to Chapter IV.

mathematicians), and the CNRS (which mathematicians generally did not take full advantage of).[99]

Before October 1958, Motchane did little to set up the physics section. He then traveled to the US, the USSR, Denmark, and Italy, and took counsel with several physicists from many countries (esp. Germany, Britain, and of course France).[100] He tried, without success, to get some of them to come and work at the Institute as early as 1959 (Wigner, Weisskopf, Pauli).[101] A *Publications de physique théorique* was also envisaged, starting with review papers (of the Soviet *Uspekhi* type), with Léon Rosenfeld as the editor.[102] This never materialized.[103]

On February 21-24, 1959, this exploratory phase culminated in an international meeting of European physicists held in Paris, specifically organized by Motchane in order to help him define a general policy for setting up the physics section of the IHÉS.[104] From this meeting, three main points emerged, which seemed to go against some of the

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[99] "Les mathématiciens paient actuellement, par une place très modeste au CNRS par rapport à d'autres disciplines, le civisme dont les mathématiciens ont fait preuve lors de la crise de recrutement des années 60 en s'engageant massivement dans l'enseignement." Jean-Pierre Aubin, ed., "Rapport préliminaire du VIIe Plan. Groupe GS6: Mathématiques et méthodologies mathématiques par la DGRST," *Gazette des mathématiciens,* no. 4 (1975): 13-26, 14. As late as 1980, only 6% of mathematicians were employed by the CNRS. "Schéma directeur du CNRS - Chapitres mathématiques," *Gazette des mathématiciens,* no. 15 (1980), 93-97.

[100] The *Rapport scientifique 1958-1959* (9/2/59) lists several national "groups" of physicists with whom Motchane was discussing.

[101] Lettre de Léon Motchane à Robert Oppenheimer (8/10/58); de Léon Motchane à Francis Perrin (20/11/58); de Léon Motchane à Robert Oppenheimer (12/12/58).

[102] Lettre de Léon Motchane à Francis Perrin (20/11/58). Arch. IHÉS.

[103] *Comité scientifique* (17/9/59). Arch IHÉS.

[104] It gathered good, but not top-notch physicists: Abragam (CEA), Amaldi (Rome), Rosenfeld (Copenhagen), Källén (Lund), Kemmer (Edinburgh), and Guéron (Euratom). Cf. *Compte-rendu de la réunion consultative de physiciens* (21-24/2/59); lettre de Léon

orientations defined by Motchane for his institute. Physicists, more than mathematicians, cared about the spatial organization of the Institute, in terms of office space, library, etc., and its localization in the proximity of laboratories and particle accelerators (Orsay).[105] Already at the foundation meeting, on June 27, 1958, inspired again by Anglo-American traditions and the IAS in particular, it was stated that the permanent installation of IHÉS should be in a suburb to the southwest of Paris, close to the projected "campus" of Orsay/Gif-sur-Yvette and the CEA's laboratories at Saclay.[106] Anatole Abragam insisted:

> the proximity of the [IHÉS], devoted to abstract and theoretical research, to experimental physics centers equipped with modern materiel and directed by eminent experimental physicists, has a much deeper significance than just a topographical vicinity.[107]

The second point to emerge was that these physicists insisted on the necessity for established people to have young researchers around. They agreed with the principle that no teaching activity would be required from the professors, but thought (*dixit* Källén) that "the presence of valuable young persons, by the curiosity of their mind and their unexpected ways of tackling problems, might act as a stimulus."[108] A principle was adopted, which would remain an important policy of the Institute, to invite "not-yet-

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Motchane à Robert Oppenheimer (4/4/59); *Rapport scientifique, 4 juillet 1958 - 31 décembre 1959* (2/2/60). Arch. IHÉS.

[105] "L'importance qu'attachent les Physiciens à l'installation matérielle de l'Institut s'explique par leurs habitudes de travail. Contrairement aux Mathématiciens dont les recherches gardent traditionnellement un caractère individuel, le travail en groupe est devenu une règle courante chez les Physiciens; ceux dont les recherches portent sur un même sujet éprouvent le besoin d'être constamment en communication; ils doivent pouvoir se réunir fréquemment et dans de bonnes conditions." *Rapport scientifique sur l'activité de l'IHÉS en 1960* (5/5/61), 7. Arch. IHÉS.

[106] Another nearby site considered at the time of the foundation was close to Villacombley airport, of which no mention is made later. *Notes de séance manuscrites de Annie Rolland de la séance de Fondation de l'IHÉS* (27/6/58). Arch. IHÉS.

[107] *Compte-rendu de la réunion consultative de physiciens* (21-24/2/59). Arch. IHÉS.

established young researchers, whose first works—for example the doctorate—might foreshadow a promising future."[109] By bringing young researchers to the IHÉS, this policy had an important consequence in allowing research traditions to grow out of the IHÉS.

In his written reports, Motchane did not emphasized as much a third point he had taken away from the physicists' meeting since it confirmed his own elitist conception. A policy of "pivots," or " centers of attraction," should be adopted, the physicists thought: personalities coming for a relatively long period, around whom a group could be formed.[110] Eugene Wigner, Richard Feynman, Victor Weisskopf, Res Jost, Arthur Wightman, and Leon van Hove were mentioned as possible pivots. Aside from Feynman, all of them indeed contributed to the IHÉS, which most would often visit.

> We will note that the organization of the Physics Section at first will take a different shape from the Mathematics Section. The work will be organized on the basis of teams of temporary professors. It is likely that this method will reveal which of these researchers who will be able, in due time, of occupying the position of permanent professor.[111]

Inviting temporary "pivots" while gathering teams devoted to a specific research subject was one strategy; finding the right personalities and hiring them as permanent faculty was another; fixing some research topics to be investigated was still another. Where should the emphasis be placed in the building of the section? Motchane always

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[108] *Compte-rendu de la réunion consultative de physiciens* (21-24/2/59). Arch. IHÉS.
[109] Lettre de Léon Motchane à Robert Oppenheimer (4/4/59). Arch. IHÉS.
[110] Once this term had been introduced in the scientific literature by Thom and Ruelle, the pivots will often be designated as "attractors." For example, lettre de Nicolaas Kuiper à E. C. Zeeman (29/2/72); mémo de Nicolaas Kuiper (13/9/72). Arch. IHÉS.
[111] *Rapport Euratom* (Mars 1959), 26. Arch. IHÉS.

wavered between strategies, the most important goal remaining the establishment of a favorable international reputation.

In April 1959, particle physicist E. R. Caianiello, from Naples, initiated the work of the physics section of the Institute. In May, Motchane wrote Oppenheimer that he was collaborating with a young physicist from the École polytechnique and Orsay, Louis Michel.[112] Michel was drafted by Motchane to help him organize invitations. In September, together with Leon van Hove (Utrecht), Res Jost (ETH, Zurich), and Murray Gell-Mann (Caltech), Michel was named as a permanently invited professor.[113] He would in due time become, in the official record, the IHÉS's first permanent professor of theoretical physics. But before this happened, Motchane almost succeeded in attracting physicists who would have instantaneously put the IHÉS at the center of this discipline.

On March 1, 1960, Motchane, manifestly excited, wrote to Oppenheimer: "Important events—and favorable ones for our Institute—are about to happen."[114] The first of these events was that two physicists seemed interested in coming permanently to the IHÉS: Harry Lehmann (Hamburg), and Murray Gell-Mann.[115] These were impressive

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[112] Lettre de Léon Motchane à Robert Oppenheimer (21/5/59); de Louis Michel à Léon Motchane (12/6/59). Arch. IHÉS. Louis Michel was then teaching a course on the μ-meson at the Collège de France. Assemblée des professeurs (16/2/58), Arch. CdF G-iv-m 30D.

[113] Van Hove was later offered a permanent position at the IHÉS, which he declined. Lettre de Léon Motchane à Robert Oppenheimer (11/7/61); *Rapport scientifique sur l'activité de l'IHÉS en 1960* (5/5/61), 8. Lettre de Louis Michel à Léon Motchane (10/12/59); *Comité scientifique* (17/9/59). Arch. IHÉS.

[114] Lettre de Léon Motchane à Robert Oppenheimer (1/3/60). Arch. IHÉS.

[115] Gell-Mann's name, which was not on the agenda, first came up as a possible permanently invited member at the *Comité scientifique* (17/9/59), attended by Oppenheimer. First contact was established when he visited the Collège de France in December 1959 as a Fullbright scholar. Assemblée des professeurs (16/2/58); Arch. CdF, G-iv-m 30D. Lettre de Léon Motchane à Murray Gell-Mann (9/12/1959). Harry Lehmann

prospects. Of Gell-Mann, Oppenheimer wrote that he was "universally recognized as one of the very most brilliant theoretical physicist in the world;" of Lehmann, that he "almost single-handed[ly] was responsible for the revival of a high tradition of theoretical physics in Germany."[116] For Victor Weisskopf, both perfectly fulfilled his own requirements for permanent members: "first, a thorough knowledge in the field; second, a proof of fundamental activeness and leadership; and third, young age so that we can hope that this creativeness is not yet exhausted."[117] The Scientific Committee and the Administrative Board of the IHÉS approved their nomination in the summer of 1960.[118]

Negotiations with Gell-Mann went slowly, and stumbled on several points: the legal status of the Institute, assurance of its long-term survival, delays with the permanent location at Bures-sur-Yvette, and salary matters.[119] Still, for "moral reasons," Gell-Mann was attracted by Paris. "He knows our language well. He is fond of our culture, and what is perhaps more important, the moral climate reigning in France attracts him

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was suggested by Res Jost in 1959. Lettre de Léon Motchane à Robert Oppenheimer (2/10/59); de Léon Motchane à Rudolph Peierls (3/12/59). Arch. IHÉS

[116] Lettres de Robert Oppenheimer à Léon Motchane (17/5/60). Arch. IHÉS. Original English.

[117] Lettre de Victor Weisskopf à Léon Motchane (16/5/60). Arch. IHÉS. Original English.

[118] *Comité scientifique* (3/6/60); lettres de Robert Oppenheimer à Léon Motchane (15/5/60); télégramme de Léon Motchane à Robert Oppenheimer (21/7/60). Arch. IHÉS.

[119] A position of advisor at the CEA was arranged for Gell-Mann. Lettre de Léon Motchane à Jules Guéron, Euratom (13/6/60); de Léon Motchane à Victor Weisskopf (27/7/60); télégramme de Léon Motchane à Murray Gell-Mann (11/7/60); lettres de Léon Motchane à Robert Oppenheimer (26/7/60); de Francis Perrin à Murray Gell-Mann (28/7/60); de Léon Motchane à Murray Gell-Mann (5/10/60). Arch. IHÉS.

particularly."[120] Nevertheless, for several reasons, he was also reluctant to leave the US, and ultimately declined Motchane's offer.[121]

Harry Lehmann's case is intriguing since, although this fact is never officially mentioned in Motchane's yearly *Scientific Reports,* he was considered a permanent professor of the Institute from October 1962, when he first came to the IHÉS, until March 1963.[122] He then probably stated his intention of leaving to go back to Hamburg after 1964-65, which made him migrate into the visitor column.[123] Yet Lehmann actually was the first permanent professor of physics of the IHÉS. It is true that already in October 1962, when Lehmann arrived, a second permanent position had been offered to Louis Michel, who was already settled in at the Institute with a status similar to that of a

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[120] Lettre de Léon Motchane à Victor Weisskopf (27/7/60). Lettre de Murray Gell-Mann à Léon Motchane (21/7/60): "un offre aussi tentant [*sic*]. Il me faut réfléchir un peu." Arch. IHÉS.

[121] "It has been a most difficult decision to make; it was necessary to weigh the manifold attractions of the Institute, of Paris, and of my friends there against the ties that bind me to the United States and to Caltech." Lettre de Murray Gell-Mann à Léon Motchane (27/6/61). Original English. And lettre de Murray Gell-Mann à Léon Motchane (12/9/60); de Léon Motchane à Robert Oppenheimer (13/2/61); de Léon Motchane à Victor Weisskopf (9/3/61). It moreover seems that some difficulties came up from Motchane's part. On September 1, 1960, Oppenheimer cabled: "ALL EFFORTS IN OBTAINING PERMANENT PROFESSORS IN PHYSICS WILL SURELY FAIL UNLESS YOU PROMPTLY CARRY OUT YOUR PROGRAM OBTAINING RECONNAISSANCE DUTILITE PUBLIQUE AND ACQUIRE BOIS MARIE STOP BELIEVE FAILURE AT THIS POINT WOULD HAVE SERIOUS EFFECTS ON THE FUTURE OF PHYSICS AT THE INSTITUTE STOP WOULD MYSELF ADVICE THAT YOU WELCOME CONCURRENT APPOINTMENT AT UNIVERSITY AND SUPPLEMENTARY SALARY WHERE NEEDED STOP BEST GREETINGS ROBERT OPPENHEIMER." Arch. IHÉS. Original English.

[122] Lettre de Léon Motchane à Robert Oppenheimer (13/2/61); de Léon Motchane à Murray Gell-Mann (16/1/62); de Léon Motchane à Victor Wisskopf (24/3/1963); *Rapport scientifique sur l'activité de l'IHÉS en 1962* (30/4/63), 4-5. Arch. IHÉS.

[123] Lettre de Léon Motchane à Robert Oppenheimer (6/5/65): "Harry Lehmann après 3 ans à l'IHÉS retourne à Hambourg pour des raisons personnelles." Arch. IHÉS.

permanent member.[124] This was decided, at the suggestion of Francis Perrin, when it became clear that Gell-Mann would not come to the IHÉS.[125]

With Michel's nomination, the IHÉS's role in promoting the revival of French theoretical physics was confirmed. Together with Michel, a group of young French theoreticians with strong mathematical and philosophical interests temporarily staffed the Institute in 1961-63, before building more traditional careers: Roland Omnès, Jean Lascoux, and François Lurçat.[126] Michel's appointment however created some "tension" with Orsay. Following this, the dean Maurice Lévy "has always been a 'bitter foe' (his own word[s] in a letter to Oppenheimer who showed it to me) of the IHÉS since the creation of this Institute. For years he tried to annoy us."[127] Nevertheless, good relations were ultimately established with both the physicists and the mathematicians of the University at Orsay, and with the physicists at Saclay: "visits are constant and there is not a week when physicists [like] Froissart, Fotiadi, Stora, Messiah, etc. do not come to our table."[128]

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[124] Lettre de Léon Motchane à Robert Oppenheimer (10/1/61). Arch. IHÉS.

[125] Lettre de Léon Motchane à Robert Oppenheimer (9/3/61); de Léon Motchane à Victor Weisskopf (9/3/61); de Léon Motchane à Robert Oppenheimer (30/3/61); de Léon Motchane à Louis Michel (8/6/61); de Léon Motchane à Robert Oppenheimer (11/7/61); de Louis Michel à Léon Motchane (25/7/61); de Louis Michel à Joseph Pérès (27/7/61). Arch. IHÉS.

[126] Lettre de Raoul Omnès à Léon Motchane (25/7/61). Arch. IHÉS.

[127] Lettre de Louis Michel à Nicolaas Kuiper (10/11/76) avec post-scriptum (12/11/76). Original English. Cf. lettre de Léon Motchane à Robert Oppenheimer (11/5/60). Arch. IHÉS.

[128] Concernant les "relations qui se sont établies avec la Faculté des Sciences[,] cette collaboration . . . a eu – vous vous en souvenez certainement – des débuts difficiles qui avaient pour origine une certaine méfiance de l'Université envers un Institut privé nouvellement créé. À notre grande satisfaction, tous ces nuages se sont complètement dissipés." *Rapport scientifique sur l'activité de l'IHÉS en 1962* (30/4/63), 4-6; *Rapport scientifique sur l'activité de l'IHÉS en 1963* (14/1/64), 2. Arch. IHÉS.

d) Theoretical Physics or Mathematical Physics?

With Michel, and especially Lehmann, the physics done at the IHÉS took a particular flavor. In line with Motchane's early ideas about the physical problems susceptible of being treated, the emphasis was clearly put on the structure of matter, on elementary particle physics, but with a strong mathematical bent.[129] Indeed, one of the first successes of the IHÉS in physics was the gathering, in 1963-64, of Arthur Wightman, Harry Lehmann, Res Jost, Julian Schwinger, Vladimir Glaser, assisted by the young Henri Epstein, Arthur Jaffe, and Oscar Lanford, "the strongest team in the world in quantum field theory."[130]

Thus the theoretical physics done at the Institut des hautes études scientifiques took the shape of *mathematical physics.* I use the label 'mathematical physics' here to characterize a kind of physical practice which emphasized rigorous foundations of existing physical theories rather than the elaboration of new ones on the basis of empirical results. Mathematical physics could also use their important knowledge of contemporary mathematics as a way to draw special attention to basic structures of theories.[131]

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[129] Let me note here that Michel, whose main work concerned the application of group theory to particle physics, was invited to give a half-hour talk on this topic at the Moscow International Congress of Mathematicians in 1966. Lettre de I. G. Petrovskii à Louis Michel (20/10/65). Arch. IHÉS. See L. Michel, "Théorie des groupes et particules élémentaire,." *Proceedings of International Congress of Mathematicians (Moscow - 1966)* (Moscow: Mir, 1968). More than by Bourbakist (see Chapter 2), the Moscow Congress seemed to have been dominated by the IHÉS.

[130] *Rapport scientifique sur l'activité de l'IHÉS en 1963* (14/1/64), 4; *Éléments de rapport scientifique à l'assemblée* [1964] (10/2/66). Arch. IHÉS.

[131] The distinction between theoretical physics and mathematical physics has been discussed by various authors. See, in particular, D. Pestre, *Physique et physiciens,* 111ff; J.-L. Destouches, *Qu'est-ce que la philosophie mathématique?* (Paris: Gauthier-Villars, 1967), 10-12, and G. Israel, "Vito Volterra: un fisico matematico di fronte ai problemi della fisica del Novecento," *Rivista di storia della scienza,* 1 (1984): 39-72; *La*

In particular, the regular visits of Arthur S. Wightman, leader in the study of the axiomatic foundations of quantum field theory, imprinted IHÉS physics. About Wightman, Oppenheimer already wrote in 1959, "I am fairly confident that you will see a good deal of him."[132] Indeed, in the United States, this mathematical tendency for theoretical physics had less success, much to the benefit of the IHÉS. In 1968, Michel wrote from Princeton that: "Arthur [Wightman] is a great physicist. Too bad for the United States if he is not in fashion here. We will be able to have him often at Bures."[133]

Despite some efforts to counter this mathematical specialization of IHÉS theoretical physics, it was nothing but advanced when David Ruelle joined the permanent faculty in 1964.[134] This aspect of the physics promoted at the IHÉS is dealt in more details in Chapter VII below, when the conditions of his hiring are examined. For the moment, let me only note that an emphasis on mathematical physics does not necessarily imply that contacts between mathematicians and physicists were taking place, or were encouraged by the Institute. In fact, if the relative smallness of the IHÉS might have favored contacts between mathematicians and physicists, no coherent effort seemed to have been made to invite these contacts. The physics done at the IHÉS was mathematical, but this hardly meant that it was done by mathematicians, that it was done in contact with mathematicians, or even that it had anything to do with the fact that the IHÉS also included a mathematics section. Nor did it mean that mathematicians at the IHÉS were

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Mathématisation du réel (Paris: Seuil, 1996). I deal with this again when I talk about David Ruelle's work in Chapter VII below.

[132] Lettre de Robert Oppenheimer à Léon Motchane (26/5/59). Arch. IHÉS.

[133] Lettre de Louis Michel à Léon Motchane (10/5/68). Similarly, "le fossé entre axiomatistes et les autres ne se comble pas, au contraire!" Lettre de Louis Michel, de Rochester, NY, à Léon Motchane (31/8/67). Arch. IHÉS.

more inclined to do some research in physics. With Grothendieck and Dieudonné, a Bourbakist ideology of purity surely reigned at the IHÉS.

With pains, a climate potentially conducive to a cooperation between physicists and mathematicians was nonetheless established at the IHÉS. On the basis of some of Motchane's statements in any case, the corporate members of the association were justified in believing that this cooperation was desirable for their institute. Whether it did happen was another story. Significantly, Motchane thought that the fact that mathematicians René Thom and Christopher Zeeman, a frequent visitor of the Institute, manifested some interest for physics in the early 1960s, was worth mentioning to the General Assembly. "With Thom, we see a renewal of analysts inclined for physics."[135]

At the General Assembly, on May 8, 1968, Jacques Ballet, president of Esso-Standard, remembering the original hopes for collaboration, asked Motchane: "Is there an osmosis between the two domains [physics and mathematics]?"[136] Embarrassed, Léon Motchane mumbled:

> The essential [point] for this kind of Institute is the climate that reigns. Concentration of gray matter, thanks to a climate of permanent human contacts. Everybody live together. Offices gathered in the same building, [small] Cafeteria, Tea... The whole [point] is to create a tradition. . . . It is difficult to put a number on this, but this is essential.

Overall, the concrete balance sheet that Motchane could show in response to Ballet's query was rather short: "Original work done by a mathematician in theoretical physics. A polytechnician physicist followed Thom's seminar (Math. Doctorate)." Then

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[134] *Éléments de rapport scientifique [1964] à l'Assemblée* (10/2/66), 3. Arch. IHÉS.
[135] *Notes de séance manuscrites de Annie Rolland,* Assemblée Générale (23/9/64). Arch. IHÉS.

describing the work done at the IHÉS, Motchane said that this was a "difficult period" for theoretical physics. Between mathematics and physics, "specialization forbids communication."[137]

Only three years later, the situation had changed dramatically. On June 2, 1971, delivering his last scientific report to the General Assembly before he resigned as director of the IHÉS, Motchane proudly claimed that "the IHÉS [was] one of the very scarce places where physicists and mathematicians fruitfully talk to one another."[138] This reversal was due to many factors including Ruelle's and Grothendieck's changes of interest, but mainly to the attractiveness of a school of qualitative dynamics set up by René Thom.[139]

In 1968, Motchane already perceived some of the sources for the reversal. To the Administrators, he explained that, with the recent recognition of the importance of mathematical structure, a new generation of "universal mathematicians" was emerging which offered the hope of a renewed dialogue between mathematics and other sciences. "The present period is exceptionally interesting." At the IHÉS, there were "very interesting attempts, which could bring the IIIrd section about."[140] Let us now look at the unbroken chain of failures forming the history of the humanities section of the IHÉS.

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[136] *Repartition entre physiciens et mathématiciens* (transcription des notes de séances manuscrites d'Annie Rolland, Assemblée générale [8/5/68]). Arch. IHÉS.
[137] *Ibid.*
[138] *Assemblée générale* (2/6/71)
[139] I will deal with these matters in more details in Chapter VI and VII below.
[140] *Ibid.*

4. 'PHYSICO-MATHEMATICAL' METHODOLOGY OF THE SCIENCES OF MAN?

In his report to Euratom, written in March 1959, Léon Motchane breached the subject of the Third Section of the IHÉS, purportedly devoted to the study of the methodology of the sciences of man. Again, the model was the IAS, but, here, "in the study of the human sciences, replacing Princeton's Historical and Archeological School, the emphasis is put on the methodological aspect in the European center."[141] While it may tempting to interpret this move away from history towards methodology as an early effect of the structuralist wave, Motchane's connection with the corporate and government worlds might more accurately account for the plans he drew for the Third Section.[142]

To understand Motchane's strategy with regard to the humanities, we must notice that this Section could serve to attract the support of businessmen. If fundamental research in mathematics and theoretical physics could offer the hope of solving the energy problem (or at least be presented as offering this hope), the Third Section could be seen as addressing the social challenges of the day. As Motchane wrote, it was on these issues that the industrialists' expertise might profitably complement the scientists'. As he wrote to René Grandgeorge, from the Saint-Gobain corporation:

> The idea that seduced eminent scientists, and the cultivated public opinion in general, was to found an Institute of advanced research, a very independent one, entirely sponsored by large corporations. . . . These are companies which . . . everyday must face scientific research problems and human problems of social organization. . . . [It will be] necessary that *a human contact between the corporate executives,* which will be the founders and the energizers of this

[141] *Rapport Euratom* (Mars 1959), 10. Arch. IHÉS.
[142] 1958 was the year Lévi-Strauss was elected to the Collège de France, and published *L'Anthropologie structurale;* 1959 saw the two conferences mentioned in chapter II above.

> organization on the one hand, *and the scientists*, which will lend it its scientific value and caution on the other [be established and maintained]. We thus conceive that the appearance of the section Methodology of the Sciences of Man, besides that of Mathematics and Theoretical Physics is not at random.[143]

On June 22, 1959, without having been previously introduced to him, and contrary to his usual manners, Léon Motchane wrote to Gaston Berger, who was *directeur honoraire de l'Enseignement* and a member of the Academy of Moral and Political Sciences, to talk about the Third Section of the IHÉS. Candidly, he admitted the difficulty he had with its organization:

> The humanities section, where the emphasis is put on the study and the confrontation of methods, might possibly be led to benefit from its scientific neighbors; but scientific disciplines will certainly be stimulated by problems posed in very different domains. . . . The organization of the first two sections presented no major difficulty, intellectually speaking. In the third section, I come against a great number of [difficulties]![144]

Berger's work, Motchane indicated, had given him some inspiration as to how to proceed.

> It seems to me that the methodological concerns that appear in 'Prospective' proceeds from tendencies analogous to ours. The posing of the question [of the methodology of the human sciences, an issue indirectly raised by *Prospective*] seemed new to me and capable of leading to profound research.[145]

Prospective was a journal, a think tank (like the IHÉS, a nonprofit association chartered under the 1901 law), and more generally an "attitude." On May 10, 1957, a group of men, from industry, State administration, and university, gathered in Paris and founded the *Centre international de prospective.* In their own words, this was a "group formed for the *study* of technical, scientific, economic, and social causes which accelerate the evolution of the modern world, and for the *prevision* of situations that could derive

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[143] Lettre de Léon Motchane à René Grandgeorge (15/10/58). Arch. IHÉS. My emphasis.
[144] Lettre de Léon Motchane à Gaston Berger (22/6/59). Arch. IHÉS.
[145] Lettre de Léon Motchane à Gaston Berger (22/6/59). Arch. IHÉS.

from their interconnected influences."[146] Instead of ideology, methods, or philosophy, it put forward what members called an "attitude" as a way to tackle the pressing problem of man's place in a rapidly changing society.[147]

A taste for action and efficiency permeated this attitude; this was a technocratic vision of ways to conceptualize the social problems of tomorrow, and find means to foresee and face them. Therefore, this emphasis put on action, rather than understanding, made the prospective project, albeit not explicitly so, quite an anti-structuralist one.

> Each of us has one's own different and limited view of this immense and unique world where we live our existence. To be prospective is to unite these heterogeneous visions, to project them together towards the future, . . . but by raising to the human plane the problems touched, by refusing the rigidity of a purely intellectual attitude, deprived from sensitive accents.[148]

On the social rather than scientific level, this enterprise—the *Centre international de prospective*—almost exactly corresponded to the IHÉS. As we might expect, their memberships overlapped. Among the six vice-presidents of the Centre three took special care of Motchane's institute.[149]

Strikingly, while Motchane envisaged a Third Section adapting mathematical and physical methods to the social sciences, the Prospective Centre devoted much of its attention to the issues of the social consequences of scientific and technological progress.

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[146] *Extrait des statuts du Centre international de prospective,* published page numbered separately with *Prospective,* 1 (May 1958), and 5 (May 1960), 1. My emphasis.
[147] Gaston Berger, "Préface. L'attitude prospective," *Prospective,* 1 (May 1958): 1-10. See also Marcel Demonque, "Quelques réflexions prospectives sur le monde industriel de demain," and François Bloch-Lainé, "Vue prospective sur les problèmes économiques," in *ibid.,* 25-35 and 85-97.
[148] Louis Armand (president of Euratom) to the Administrative Board of the Centre international de prospective (11/12/57); quoted in *Prospective,* 2 (January 1959), ii.

The second issue of the journal *Prospective* was devoted to "The General Consequences of the New High Technologies," the fifth to "Scientific and Technological Progress and the Condition of Man."[150] They closely followed the debates at two congresses that took place in September, 1958, on the Peaceful Uses of Atomic Energy, held in Geneva, and on cybernetics, held in Namur.[151] They invited Oppenheimer in April 1958, and published one of his texts in their journal.[152]

On September 18, 1959, Motchane, Berger, and Oppenheimer met to discuss the organization of the IHÉS's Third Section. Other such meetings apparently were held, including the economist Pierre Masse.[153] But with the death of Berger in a car accident, late in 1960, the cooperation between the Prospective group and the IHÉS seems to have ended before it really started.

As with the Physics Section Motchane adopted a two-pronged strategy for the constitution of the Third Section. While drawing attention to these meetings of experts, as well as planning new ones involving "Philosophers, Sociologists, Economists and Anthropologists," he also tried to attract one or two internationally renowned scholars

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[149] Arnaud de Vogüé (President of Saint-Gobain, treasurer of the IHÉS), François Bloch-Lainé (General director of the Caisse des Dépots), and Louis Armand (Euratom), already mentioned.

[150] *Prospective,* 2 "Conséquences générales des grandes techniques nouvelles" (January 1959); *Prospective,* 5 "Le progrès scientifique et technique et la condition de l'homme" (May 1960).

[151] Georges Guéron, "Observations à propos de la Seconde Conférence internationale des Nations Unies sur l'utilisation de l'énergie atomique à des fins pacifiques," *Prospective,* 2 (January 1959): 13-21; and G. Guéron, "Observations à propos du IIe Congrès international de cybernétique tenu à Namur, du 3 au 14 septembre 1958," *ibid.:* 59-64.

[152] See "Avant-propos," *Prospective,* 2 (January 1959): 1-9,6; and Robert Oppenheimer, " Science, culture et expansion," *Prospective,* 5 (May 1960): 79-88. The journal *Prospective* became, in 1976, *Les Futurribles.*

around whom the Section might develop. Several names were considered: biologist Roger Guillemin (suggested by Ponte), art historian Charles de Tolnay (suggested by Weil), and even Benoît Mandelbrot (suggested by Oppenheimer)![154] This list, better than any explanation, clearly shows how imprecise Motchane's ideas were.[155] The most baffling feature, however, is that these suggestions all came from scientists, and not specialists in the social sciences. As a result, De Tolnay twice visited the Institute[156]; Mandelbrot, whom Motchane had visited in the US, sent him his CV; but no one was appointed.

Another serious candidate was proposed in 1961: philosopher and historian of science Gilles Gaston Granger, who won Motchane's and Weil's support. Granger was an epistemologist, who studied the way abstract human thought was structured. He mainly planned to "define with precision the notion of *style,* justly considered as the mode of insertion of structures in concrete, individual existence."[157] But once again early contacts led nowhere.

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[153] *Organisation des sections* (n.d., 1960); *Rapport scientifique sur l'activité de l'IHÉS en 1960,* 8-9. Arch. IHÉS.

[154] Lettre de André Weil à Léon Motchane (2/3/60); de Léon Motchane à André Weil (8/3/60); de Maurice Ponte à Léon Motchane (7/3/60); *Entretien avec Maurice Ponte* (29/3/60); Lettre de Robert Oppenheimer à Léon Motchane (19/8/60); de Léon Motchane à Robert Oppenheimer (24/8/60).

[155] "Notre section des humanités n'est pas encore organisée et nous n'avons même pas une conception claire de ce qu'elle devrait être. Je pense pour ma part qu'il faudrait préférer aux sujets des personnalités." Lettre de Léon Motchane à André Weil (8/3/60). Arch. IHÉS.

[156] Charles de Tolnay gave two seminars at the IHÉS on 22 and 29 June, 1961: "Les conceptions scientifiques de Léonard de Vinci dans ses œuvres d'art;" and two more on 15 and 22 June, 1962: "Les conceptions religieuses dans la peinture de Piero della Francesca."

[157] Lettre de Léon Motchane à Robert Oppenheimer (27/11/61); de Léon Motchane à Robert Oppenheimer (24/2/62); *CV et Projets actuels* de Gilles Gaston Granger. Arch. IHÉS.

It thus appears that even if Motchane's plans remained fuzzy, a tendency emerged to envision the study of the methodology of the sciences of man as closely intertwined with other scientific concerns at the IHÉS. Social scientists were either to approach their subject with highly mathematical methods, or at least to think of their field as addressing issues of interactions between society and scientific advances.

> It is important to provide the opportunity for a collaboration between scientists and humanists, equally concerned with methodological questions and oriented towards fundamental problems," Motchane wrote, "in the hope of witnessing the emergence of new modes of research, and methods, notably in History and Sociology.[158]

How much of this remained mere rhetoric in order to entice possible sponsors is unclear.[159] Except for the year 1960, Motchane never mentioned the activity of the Third Section in any of the Scientific Reports he wrote during the 1960s.

President of the IHÉS after Pérès's death, André Grandpierre convoked two General Assemblies in 1964 to study the possibility of an American participation in the funding of the institut. On these occasions, the problem of the Third Section was raised by the members. Léon Kaplan, as always the black sheep, thought: "You will have no perenniality, no success, unless this team is set up." For Jacques Ballet, this section had to be "first rank or not at all."[160] Grandpierre suggested to "invite 1 or 2 men of a very high quality, without giving them a topic, and by seeing what they give, you may perhaps find your way." Fernand Picard, from Renault, interrupted: "No Third Section! Let us derive

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[158] Lettre de Léon Motchane à Shepard Stone, Director of Sloan Foundation (23/5/63). Arch. IHÉS.

[159] Cf. *Entrevue* André Grandpierre et Léon Motchane (20/3/63) pour préparer une entrevue [qui n'aura pas lieu] avec Hallstein, Président de la Commission de la CEE: "situer l'activité de l'IHÉS en insistant sur la IIIe section."

[160] *Notes de séance manuscrites,* Assemblée générale (14/1/64). Arch. IHÉS.

the maximum from physics and mathematics. The Third Section will be the climax" of the enterprise.[161] In face of the dire financial situation of the Institut, this probably was the only reasonable course to follow.

The pressure for creating the Third Section was off Motchane's shoulders for a few years. When he would take up the plans again, after his own retirement from directorship in 1971, the internal situation would have changed. By then, Thom's school of qualitative dynamics was in full swing. Indeed, besides de Tolnay in 1961-62, there had been only one scientist invited as part of the Third Section, and it was Conrad Hal Waddington in 1966.[162] No doubt he had been invited by Thom, who, on Monday, May 2, 1966, had given a talk, titled: "Topologie comparée de la gastrulation chez les vertébrés."[163] While Motchane's goals and the sponsors' ideals for the Institut had created a climate encouraging interdisciplinarity, it was René Thom who seized the possibilities thus offered to him. By 1971, the Third Section was not conceivable without him anymore.

5. THOM'S 'DREAMS'...

In the summer of 1958, the International Congress of Mathematicians at Edinburgh provided a convenient setting for Léon Motchane to plan out the activities of the IHÉS for the first few years. In particular, Jean Dieudonné and he agreed to invite one of the new Fields Medal winners, René Thom. Among the very first mathematicians invited to the newly founded Institut des hautes études scientifiques, Thom was asked to spend the

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[161] *Notes de séance manuscrites,* Assemblée générale (23/9/64). Arch. IHÉS.
[162] *Extrait du Rapport scientifique sur l'activité de l'IHÉS en 1966* (6/4/67), 3. Arch. IHÉS.

1959-1960 academic year in Paris.[164] "I have always had much reluctance to make a decision, whatever it is," Thom replied to Dieudonné.[165] For the time being however, mostly for personal reasons, he decided not to take advantage of this offer.

Moreover, it had not escaped Motchane and Dieudonné that, having just received his Fields Medal, but at Strasbourg without a prestigious position, Thom was a natural candidate for tenure at the Institut. His name was already suggested for such a position at a Scientific Committee in September 1959. But it was then decided that no offer should be made to him before the definitive installation of the IHÉS at its campus of Bures-sur-Yvette took place.[166]

Only two years later, when the prospect of the move seemed secure, did the professors of the IHÉS mention this possibility to Thom. At Harvard, in December 1961, Grothendieck talked to him about taking Dieudonné's place. Feeling "not mathematically active enough," Dieudonné envisioned taking the position of dean of the new *Faculté des sciences* at Nice. After making sure of Dieudonné's reasons for leaving the Institut, Thom decided to accept a permanent professorship, starting in October 1963

As soon as he got to the IHÉS, Thom seized the opportunity to invite Mauricio Peixoto, a Brazilian mathematician he had met in the United States.[167] This was Thom's way of seizing the advantages that the structure of the IHÉS offered him. Starting

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[163] *Année 1966 - Séminaire et conférences,* 2.Arch. IHÉS.
[164] Lettre de Jean Dieudonné à Léon Motchane (8/10/58); de Léon Motchane à Robert Oppenheimer (8/10/58); de Léon Motchane à Francis Perrin (20/11/58); de Léon Motchane à Jean Dieudonné (23/12/58); de Jean Dieudonné à Léon Motchane (14/1/59). Arch. IHÉS. The other mathematicians invited were Shafarevich, Bott, and Milnor.
[165] Lettre de René Thom à Jean Dieudonné (6/2/59). Arch. IHÉS.
[166] *Comité scientifique* (17/9/59). Arch. IHÉS.
[167] Lettre de Léon Motchane à Maurico Peixoto (8/11/63). Arch. IHÉS.

February 7, 1964, Peixoto gave a seminar on the "Qualitative Theory of Differential Systems and Structural Stability." Since for two years Peixoto had worked in relation with Solomon Lefschetz's school of dynamical systems, at Princeton and Baltimore, where Thom was introduced to the notion of structural stability, we might guess Thom's interest in getting him to lecture at the IHÉS.[168] Equipped with this concept of structural stability, Thom would embark on an ambitious program, first with an interest restricted to pure mathematics, but soon reaching out to the general process of using mathematical concepts and techniques in order to model natural phenomena.

6. CONCLUSION

What, in the mid-sixties, were the main characteristics of the IHÉS? An institution devoted to fundamental research and sponsored by industry, it struggled to survive. Even with massive aid from the State which the IHÉS would not attain a stable financial basis until the early years of the 1970s. As a consequence it had to remain rather small, with only four permanent faculty members.

But, with both of its mathematics professors having received a Fields Medal, it had achieved a very enviable stature in the international mathematical community. The physics section, specialized in the mathematical side of theoretical physics, had an honorable reputation, but nowhere near the one of the mathematical section. The Third Section, however, remained non-existent.

Its budget for invitations, and the quality of its permanent faculty allowed the IHÉS to get leaders in their fields as visitors. Although they often sought to diversify their

[168] *Année 1964 – Séminaires et conférences,* Rapport scientifique 1964 (10/2/66), 1.

activity, Motchane and his professors largely restricted the people to which they sent out invitations to those working on fields where the IHÉS could be among the world's best.

Scientists from all over the world started to press director Léon Motchane in order to be invited to spend a few months at Bures-sur-Yvette. In fairly large numbers, students, including those from the Ecole Normale's famously influential *Séminaire Cartan,* came to seminars given by international experts. Considering their high level and the eccentricity of the IHÉS campus, this was quite an accomplishment.

It was in this context that René Thom believed the time had come to write a book. Dealing with the implications for the mathematical modeling of natural phenomena, which, in Thom's view, derived from topology and, more specifically, the study of singularities of applications and dynamical systems, this book would launch catastrophe theory. Thom thought that the mathematical concept of *structural stability* could provide general guidance in the practice of mathematical modeling. In the following chapter on the history of structural stability, we will see that great hope had often been invested in this concept.

In chapter VI, I will then come back to the IHÉS and show how, from the mid-1960S to the early 1980s, it became one of the world's major developing grounds of new modeling practices. Introduced by topologists, these practices will bear the mark of the IHÉS.

7. COMPLEMENT TO CHAPTER IV: DOCUMENTS

a) Lettre de Léon Motchane à Pierre Ailleret, Électricité de France (7 mai 1958), accompagnée d'une "Note."

Monsieur P. Ailleret
Directeur Général des Études et Recherches
Place des États-Unis,
Paris 16e.

Cher Monsieur,

Voici quelques idées sur l'orientation des études de notre Institut. Je ne vous apprends rien de neuf, mais la récente réunion à Berlin lors de la Commémoration Planck, qui a permis à plusieurs de mes amis d'avoir de longues conversations avec Heisenberg, Bogolioubov et quelques autres, confirme l'essentiel de la note. Tout cela devient actuel et important, mais je suis mauvais juge de ce qu'il faut dire et de qu'il ne faut pas dire. Ainsi, si vous estimez qu'une certaine indication sur l'orientation probable des études doit être rendue publique et pourrait vous être utile, nous pourrions la préparer ensemble si vous le désirez, d'après les éléments réels que vous trouverez dans cette note.

Veuillez agréer, [etc.]

Motchane

Strictement confidentiel.-

NOTE

Aucun sujet de recherche ne serait imposé aux savants appartenant à l'Institut de Recherches Fondamentales (I.R.F.) dont la fondation est prévue actuellement, de même que toute recherche orientée est bien entendu hors de question, la liberté de choix étant le gage principal du succès.

Cependant, la sélection de la qualité des savants réunis au sein d'I.R.F. permet d'affirmer que le problème crucial de la physique théorique va être attaqué en collaboration par des mathématiciens et des physiciens: à savoir, la structure de la matière et la théorie des particules. Tout progrès dans ces domaines signifierait qu'on a réussi à sortir de l'impasse dans laquelle se trouve actuellement la physique théorique: C'est une supposition raisonnable si l'on se donne un délai de quelques années.

Par analogie avec ce qui s'est passé pendant la période de six années précédent la guerre à savoir la mise au point du procédé de libération de l'énergie atomique résultant des études théoriques nucléaires, on pourrait se demander quel pourrait être le premier problème pratique important auquel aboutirait les études théoriques définies plus haut. La réponse est facile à donner: il s'agit évidemment de la transformation directe de l'énergie nucléaire en énergie électrique, transformation qui éviterait toute réaction thermonucléaire. C'est le problème qui est à l'ordre du jour mais qui ne pourra être résolu avant que des progrès théoriques importants soient réalisés.

On ne voit actuellement que trois endraoit [*sic*] où de tels progrès pourraient être espérés: États-Unis (Princeton), U.R.S.S. (Moscou) et Europe (Paris, éventuellement I.R.F.). La question de priorité ne jouera pas beaucoup en ce sens que les résultats d'un centre seront rapidement connus ailleurs. Cela permettrait de travailler presque simultanément aux applications.

Mais l'absence d'un tel centre qui entraînerait le manque total d'une équipe de savants entraînés et avisés serait grave car cette absence créerait un obstacle insurmontable empêchant de franchir le seuil entre la théorie et la pratique: on mettra des années à former des interprètes capables d'instruire les techniciens.

Il semble donc impensable qu'une organisation (E.D.F.) qui a la responsabilité de la production de l'énergie électrique dans ce pays soit à l'écart d'une recherche de cette nature. Non seulement ces considérations justifient une subvention importante, mais il serait également à souhaiter que dès la formation du centre, un ou deux jeunes physiciens engagés par cette organisation bénéficient de l'enseignement d'I.R.F. qui est public et ouvert à tout le monde, afin d'être capables au moment venu de servir d'interprètes entre les savants et les ingénieurs.

b) Note pour les industriels (mai 1958), par Léon Motchane, 3pp.

Note sur la fondation d'un

"INSTITUT DES HAUTES ÉTUDES SCIENTIFIQUES"

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Il y a peu de temps encore, le terme de recherche scientifique était à peine connu du grand public. On "faisait de la science" à l'Université; l'industrie s'occupait de la technique et des applications, tandis que les inventeurs étaient des gens distraits, quelquefois fous qui mouraient méconnus, dans la misère. L'aspect moderne de la recherche scientifique est relativement récent. Il est concomitant avec l'apparition d'une nouvelle conception, aujourd'hui ancrée dans l'esprit du public, à savoir que la recherche scientifique n'est pas un phénomène spontané de la nature qui fleurit dans les Universités, mais une activité dont il faut s'occuper, qui se laisse cultiver, et qui apporte au pays qui en est pourvu abondemment [*sic*] un surcroît considérable de prestige et de puissance politique. Cette représentation sociale de la recherche contient une part de vérité dont il faut tenir compte quand on place le problème sur son véritable terrain.

I – Il est bien connu que l'économie s'industrialise de plus en plus. Cela est banal pour les pays cartésiens, mais devient vrai même pour les pays de science contemplative. À mesure que les techniques s'élèvent et deviennent plus compliquées et raffinées, elle se rapprochent, par leur niveau intellectuel, des problèmes purement scientifiques. La science pure et ses applications se voisinent davantage: dans le temps d'abord, parce qu'une découverte scientifique abstraite, telle qu'une théorie mathématique nouvelle "descend" plus rapidement à travers un symbolisme physique vers une application

pratique (quand elle en comporte une) du fait même de la grande multiplication et de l'abondance des techniques; dans leur niveau ensuite, car les techniques d'aujourd'hui sont infiniment plus élevées que jadis et utilisent des procédés qui, il y a peu d'années, relevaient d'expériences qualitatives et rares de laboratoire et de spéculations théoriques abstraites.

De telle sorte que le véritable aspect moderne de la recherche scientifique (celui-là moins connu du public) consiste dans le fait que le travail **[2]** d'un industriel, d'un ingénieur, comme celui d'un physicien théoricien et d'un mathématicien, fût-ce le plus abstrait, ne sont pas aussi éloignés les uns des autres et la réussite des derniers devient indispensable aux premiers.

2° – Cela nous amène à poser parmi tous les problèmes, celui de la Recherche Fondamentale dans les sciences exactes, par laquelle nous entendons limitativement les recherches faites sans préoccupation d'applications dans les domaines de Mathématique pure, Physique théorique, et de Méthodologie physico-mathématique des Sciences de l'Homme. Ce problème a une place à part et exige une solution de nature différente de celui de la recherche en général. En effet, la formation des cadres scientifiques d'enseignement et des cadres techniques d'industrie à l'échelle nationale incombe à l'État et se place dans le schéma général de la réforme de l'Enseignement entreprise récemment. Les recherches particulières à une branche de la physique ou de la technique, ou encore particulière à une industrie se font à l'échelon d'instituts spécialisés ou de laboratoire d'usine; son développement en France est encourageant et témoigne d'un esprit moderne chez beaucoup de chefs d'entreprise. Seul, le problème majeur des recherches

fondamentales, négligé pendant de longues années, n'a jamais été repris sérieusement, ce qui explique par exemple, le retard inquiétant de notre pays en physique théorique.

Le même problème s'est posé aux États-Unis avant la dernière guerre mondiale, et a été brillamment résolu. Il n'est pas exagéré de dire, en effet, qu'une des causes de l'avance américaine dans les domaines de la physique théorique et nucléaire avec toutes ses conséquences économiques et politiques, fut en partie la création et fonctionnement de l'"Institute for Advanced Study" à Princeton, où les plus grands physiciens et mathématiciens du monde ont eu l'occasion de vivre et de travailler ensemble. Il n'est pas sans intérêt de rappeler que sa fondation remonte aux années 1931-32, et que EINSTEIN, Von NEUMANN et OPPENHEIMER y ont cristallisé les meilleures forces scientifiques du moment e[t] qu'en 1940 déjà, on entrevoyait certaines applications pratiques, dont la source peut être tracée aux travaux abstraits de recherche pure entrepris quelques années plus tôt. Les résultats obtenus ont dépassé les prévisions les plus ambitieuses. Non seulement les progrès scientifiques peu connus du grand public furent remarquables, mais le chemin **[3]** parcouru entre les connaissances les plus abstraites et leurs applications, que tout le monde connaît, s'est avéré plus court qu'on ne l'eût cru possible auparavant.

Les Russes n'ont pas procédé autrement et avec le même succès. À côté d'un grand nombre d'Instituts scientifiques où les divers aspects des sciences exactes sont étudiés, on compte quelques centres d'études de mathématiques et de Physique théorique consacrés aux problèmes les plus avancés, et où la recherche est pratiquée avec une grande indépendance.

3° – Ainsi les faits essentiels qui dictent impérativement l'organisation de la Recherche Fondamentale ont été dégagés par l'expérience – les voici:

- Il existe effectivement un problème majeur de la recherche, limité en étendue, qui se place par son objet à un niveau exceptionnellement élevé, et qui exige pour sa réalisation la participation et la formation des élites.
- Il s'agit donc de réunir un nombre relativement restreint de savants de grande valeur, physiciens et mathématiciens, de leur donner toutes facilités de travail, sans leur imposer de charges d'enseignement ni d'obligation d'aucune sorte.
- La réalisation d'un tel projet ne présente pas de difficultés matérielles insurmontables.
- Par contre la solution est subordonnée à un certain nombre de conditions morales indispensables à la réussite.