- Running head: Georges de Rham
- Title: Georges de Rham (Roche, 1903 - Lausanne, 1990)
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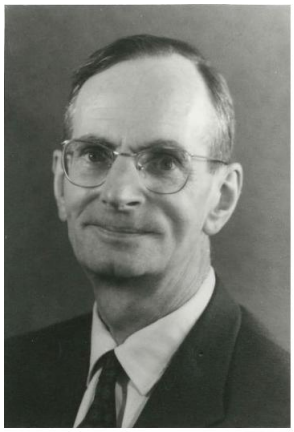
Georges de Rham (Roche, 1903 – Lausanne, 1990)
Ex Officio Member of the Executive Committee 1963-1966

Margherita Barile



1 Short Biography

Georges de Rham was born in Roche, in the district of Aigle in Canton Vaud, Switzerland, on 10 September 1903. After attending a secondary school specializing in classical studies in Lausanne, and though feeling inclined, since childhood, towards the arts (watercolour and drawing), and fascinated by philosophy and literature, in 1921 he entered the Faculty of Sciences at the University of Lausanne. Many years later, he said that ″the feeling of a gap in my knowledge, the curiosity and the charm of mystery"[1] (Burlet 2004, p. 5) had been responsible for this choice. After five semesters, he gave up chemistry, biology and physics to devote himself totally to mathematics. This subject, which he once used to consider "a closed domain, where it seemed impossible to do anything new"[2] (ibidem, and, similarly, de Rham 1980, p. 19), now appeared to him as an "immense domain" (ibidem). With the support and advice of his two good teachers (De Rham 1980, p. 19), Gustave Dumas and Dmitry Mirimanoff, he graduated in the autumn of 1925. In June 1931 he received his doctoral degree in Paris, with a dissertation on the topology (*analysis situs*) of differentiable manifolds; his interest for this topic had originated in Poincaré's memoirs, where he had run into his famous conjecture (which he had also tried to prove), and, which, in November 1926, motivated him to move to Paris to attend the lectures delivered by Henri Lebesgue at the *Collège de France.* There he would meet Élie Cartan, who was to become his thesis adviser. "The chance of my life"[3] (ibidem, p. 24): with these words de Rham described the moment when he came across

[1] The original text is: “Le sentiment d’une lacune, la curiosité et l’attrait du mystère”.
[2] The original text is: “un domaine fermé où je ne concevais pas qu’on puisse faire quelque chose de nouveau”.
[3] The original text is: “ce fut la chance de ma vie”.

the note[4] by Élie Cartan, published in 1928, which suggested a connection between the theory of multiple integrals on a closed manifold and its topological invariants, but without giving a proof. This goal was achieved by the result which is nowadays known as "De Rham's Theorem", and can be formulated in terms of isomorphisms between cohomology groups. With its many consequences it marked a milestone in contemporary mathematics. Its implications reach far into sheaf theory, complex geometry, algebraic geometry, algebraic topology and even non-commutative differential geometry. In physics, it is related to many aspects of modern field theory. It is the emblem of de Rham's unifying view - focused on general, abstract structures - which culminated in his theory of "currents", born as an intuition inspired by electromagnetism and further developed in the framework of the *distributions* introduced by Laurent Schwartz in 1945. Other important contributions of de Rham's concern Riemannian manifolds, for which he gave a beautiful reducibility theorem and studied the harmonic differential forms. His textbook *Variétés différentiables*, first published in 1955, was reprinted in 1960, in 1973, in 1982 and translated into Russian (1956) and English (1984).

De Rham spent his whole academic career at the University of Lausanne, where he had been working as Dumas' assistant since his graduation, and at the University of Geneva: at both institutions he was appointed extraordinary professor in 1936, then became full professor and, finally, the title of emeritus professor was conferred on him when he retired, in the early seventies. He visited the University of Göttingen (1930/31), Harvard (1949/1950), the *Institute for Advanced Study* at Princeton (1950, 1957/58) and the *Tata Institute of Fundamental Research* in Bombay (1966). In August 1960 he gave a course at the *Centro Internazionale Matematico Estivo* in Saltino, near Florence. These were his only long stays abroad; in fact he distinguished himself as a scientist devotedly attached to his country. While teaching a great number of university courses in analysis and geometry, he committed himself to promote mathematical culture in Switzerland. From 1932 onwards he took part in the organizing committee of the international colloquia at the *Cercle Mathématique* of the French-speaking Swiss universities. For many years he was editor of the journals *Commentarii Mathematici Helvetici* (1950-1966) and *L'Enseignement Mathématique* (1967-1978).

Furthermore, he held leading positions in several national organizations: he was member of the *Commission Fédérale pour l'Encouragement des Recherches Scientifiques* (1950/65) and of the *Conseil National de la Recherche* (1956-1969), and president of the *Swiss Mathematical Society* (1944-1945), which awarded him the status of honorary member in 1960. His efforts were constantly directed towards enhancing international exchange, especially in the aftermath of World War II. He succeeded in maintaining his relations with many prominent colleagues from all over Europe, whom he regularly invited to give seminars; he also supported the participation of Switzerland in the project of creation of the *Institut des Hautes Études Scientifiques* in Bures-sur-Yvette, France.

As a recognition of de Rham's lifelong engagement, the Swiss foundation named after Marcel Benoist awarded him its annual prize in 1965 - so far, the only case where this honour has fallen upon a "pure" mathematician[5]. Earlier he had received doctorates *honoris causa* from the universities of Strasbourg (1954), Grenoble (1955), Lyon (1959) and from the *École Polytechnique Fédérale* of Zurich (1961). De Rham was elected foreign member of the *Accademia Nazionale dei Lincei* in Rome (1962), corresponding member of the *Akademie der Naturwissenschaften* in Göttingen (1974), and foreign associate member of the *Académie des Sciences de l'Institut de France* (1978). In one of the hardest periods of the Cold War (1963-

[4] Cartan, Élie. 1928. Sur les nombres de Betti des espaces de groupes clos. *Comptes Rendus* 187: 196-198.

[5] The list of laureates also includes the mathematician Jürg Martin Fröhlich (1997), who is also a theoretical physicists.

1966) he was President of the *International Mathematical Union* and, as such, member ex officio of the executive committee of the *International Commission on Mathematical Instruction* (ICMI). In this Commission he was national delegate of Switzerland from 1955. He was one of the organizers of the Seminar on "The teaching of analysis in the secondary school and the university" (June 26-29 1961, Lausanne), jointly sponsored by ICMI and the Swiss Mathematical Society.

On the occasion of the mathematical colloquium in honour of de Rham held in Geneva in March 1969, Komaravolu Chandrasekharan wrote:

> he did as much as any one man could do to bring mathematicians together, young and old, classical and modern, from the East and West. He found a special joy in the spectacle of younger colleagues adding to the old heritage, and did as much as he could to encourage them.[6]

Georges de Rham died in Lausanne on 7 October 1990.

2 Contribution to Education

According to the testimonies of those who have known de Rham, it seems hard to separate, in his personality and his public engagement, the loyal colleague from the generous friend, the passionate researcher from the fatherly teacher, the brilliant scientist from the brave alpinist. He regarded proving a theorem, delivering a lecture or reaching the top of a mountain as a personal endeavour, requiring a full involvement of the deepest and most precious faculties of the individual, in the name of some kind of transcendental beauty. On the occasion of the centenary of de Rham's birth, his former doctoral student Oscar Burlet remembers that he once explained to him:

> For alpinism is not only a physical exercise, but it also a task for the mind, and it allows one to create a marvellous harmony between nature, soul and body. (Burlet 2004, p. 6)[7]

Climbing higher to attain a larger view could be considered as a metaphor for de Rham's constant attempt to advance in abstraction, to gain generality by looking at single problems and objects from above. The development set off by his first proof of the theorem bearing his name moved exactly in the direction of embracing specific questions in a more and more general framework. His scientific approach is based on the comparison of structures, which, unlike in the so-called "abstract nonsense", should not be treated as empty buildings, but employed as containers that enable us to grasp different particular cases at the same time. He thus described his first encounter with this method at school:

> I remember a mathematics professor who made me understand the idea of algebra, which consists in making computations with an unknown x, and produces a great simplification in solving arithmetical problems. (ibidem, p. 3)[8]

Clarity and conciseness in exposition were the most evident effects of this principle in his teaching, which, in his global vision of scientific culture, had to be closely intertwined with

[6] Letter to the editors published in: *Essays on Topology and Related Topics, Mémoires dediés à Georges de Rham*, eds. André Haefliger and Raghavan Narasimhan, viii, Berlin: Springer, 1970.

[7] The original text is: "Car l'alpinisme n'est pas seulement un exercice physique, c'est aussi un travail de l'esprit".

[8] The original text is: "Je me souviens pourtant d'un des nombreux professeurs de mathématiques qui m'avait fait comprendre l'idée de l'algèbre, qui consiste à calculer avec une inconnue x, et la grande simplification qui en résulte pour résoudre les problèmes d'arithmétique".

research. For him both activities required a concrete effort of interpretation, and nourished one another: the joy of discovering surprising connections between distant areas could not be detached from the joy of sharing these "nice things" (Unknown author 1990, p. 207) [9] with others. Essentiality, linearity of thought and calmness made up the elegance of his lectures and seminars, where, according to Henri Cartan, he was able to "suggest a lot of things in few words." (Cartan 1970, p. 1)[10] His approach to the audience was always full of benevolence and care. In de Rham's obituary in the *Notices of the American Mathematical Society*, Raoul Bott thus recalls the profound impression that de Rham left on him as a graduate student:

> De Rham had a subtle charm which drew younger people to him immediately. In those early days at Princeton he would easily mingle with the boisterous postdocs, his exquisite manners contrasting amusingly with our rude ways. (Bott 1991, p. 115)

De Rham would reply that he just intended to follow the example of Dumas, who had initiated him to mathematics in Lausanne, and whom he admired for his ability in conveying his passion to others, to make them think autonomously, by "never stopping at the purely formal aspect of a question, but always seeking the deep general idea that enlightens all things from inside, from their centre." (De Rham 1955a, p. 121)[11] This is what he writes, in 1955, in the memorial note published in *Elemente der Mathematik*. Beyond this, de Rham considered moral straightness, altruism and respect as the very reasons of Dumas' success in teaching. "Never forget that you must love your pupils" (ibidem, p. 122)[12], was his favourite advice to his assistants. And de Rham cannot refrain from mentioning that his communication talents and human qualities were certainly rooted in his devotion to philosophy and literature.

While treasuring the crucial role of teachers, at all levels, from school to university, de Rham firmly condemned the passive attitude of certain students, who only act as recipients, and are not willing to elaborate the subject by themselves (as he had been forced to do, when, at the age of fifteen, the Spanish flu epidemic had kept him away from the *collège* for several months). He once addressed this recommendation to a class of pupils:

> The courses, the books should only be suggestions and inspirations to work: a mathematician must judge on his own account, he must be critical and must not admit anything which he has not clearly recognized himself as well-founded. (Burlet 2004, p. 4)[13]

He, indeed, used to carefully verify the content of all the articles that he quoted in his papers; in his opinion, this belonged to scientific rigour and intellectual integrity, two values which he obstinately defended throughout his life.

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[9] The original text is: “de belles choses”.

[10] The original text is: “suggérer beaucoup de choses en peu de mots”.

[11] The original text is: “Ne s’arrêtant jamais à l’aspect purement formel des questions, il cherchait toujours l’idée profonde et générale qui éclaire les choses de l’intérieur, du centre.”

[12] The original text is: “n’oubliez jamais qu’il faut aimer ses élèves”.

[13] The original text is: “Les cours, les livres ne devraient en somme être que des suggestions et des excitations au travail, des invitations : le mathématicien doit tout juger par lui-même, il doit être critique et ne rien admettre qu’il n’ait clairement reconnu lui-même comme fondé.

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