Mathematics   Cédric Villani was awarded the prestigious Fields Medal in 2010. Since 2009, he has been director of the Institut Henri Poincaré,[1] where he continues his exceptional, high-flying scientific career.

Cédric Villani

A Man who Counts

BY STEPHANIE ARC

Resembling a 19th century poet, with his long straight hair, lavalliere cravat, white shirt, and elegant suit adorned with a gleaming spider-shaped brooch, Cédric Villani is one of France's most brilliant mathematicians—he has recently received the highest international distinction in the discipline, along with three other laureates, including the French-Vietnamese researcher Ngô Bao Châu. "Since winning the Fields Medal, I've been in such demand that I haven't had time for any research," admits the 37-year old researcher. But far from complaining, he says it has been a "rather extraordinary" experience, allowing him to "meet people from all walks of life, including politicians, journalists, students, and all those who have expressed an interest in his work—a wide and heterogeneous fan base, to say the least.

For Villani, winning the Fields Medal is "an honor and a tremendous encouragement." His devotion to mathematics dates back to his high-school days. "I was immediately drawn by the playful aspect of math," he remembers. He was also fortunate enough to have imaginative teachers who ventured off the beaten path. "I was fascinated by what I discovered," he adds.

AS LUCK WOULD HAVE IT
Nonetheless, the young Villani did not think of mathematics as a career and hoped he would become a paleontologist. Yet after a preparatory class at Lycée Louis le Grand in Paris, he enrolled at the prestigious École Normale Supérieure (ENS). As he puts it, "in the French education system, it's as though the path is all mapped out." ENS proved to be a major phase in his development, the place where he found himself. "I had always been quite reserved, but my time there made me very sociable," says Villani.

"And I discovered the arts, especially music, which remains one of my passions." It was at ENS that he chose to specialize in analysis as part of his math course. "It was more by luck than by choice," he adds, "because when the algebra classes started, I needed to unwind." Guided by his tutor Yann Brenier, and working under the supervision of Pierre-Louis Lions, himself a Fields Medal laureate in 1994, Villani dedicated his thesis to the Boltzmann equation. "No doubt the best-known equation in kinetic theory, it describes the behavior of particles in a low-density gas," Villani explains. With this early work, he was already interested in entropy,[2] an essential concept in physics and the theme running through his research.

FOCUS ON PHYSICS
After completing and brilliantly defending his thesis in 1998, Villani published with his colleague Felix Otto an article on optimal transport, another recurrent theme in his research. Eager to help his interviewer understand the concept, the mathematician grabs a piece of chalk and begins drawing curves on the blackboard. "Optimal transport? Imagine you have a mound of earth to move at an excavation site. Moving each grain of soil entails transport costs. How can you spend the least money possible?" After this publication, Villani was invited to teach at Georgia Tech in Atlanta (US) for six months. "Optimal transport wasn't my main field," he admits, "but teaching something is a great way to learn more about it." He retrieves two prodigiously thick treatises from a nearby shelf and continues "there were hardly any reference works on the subject back then, so my books filled a void."[3]

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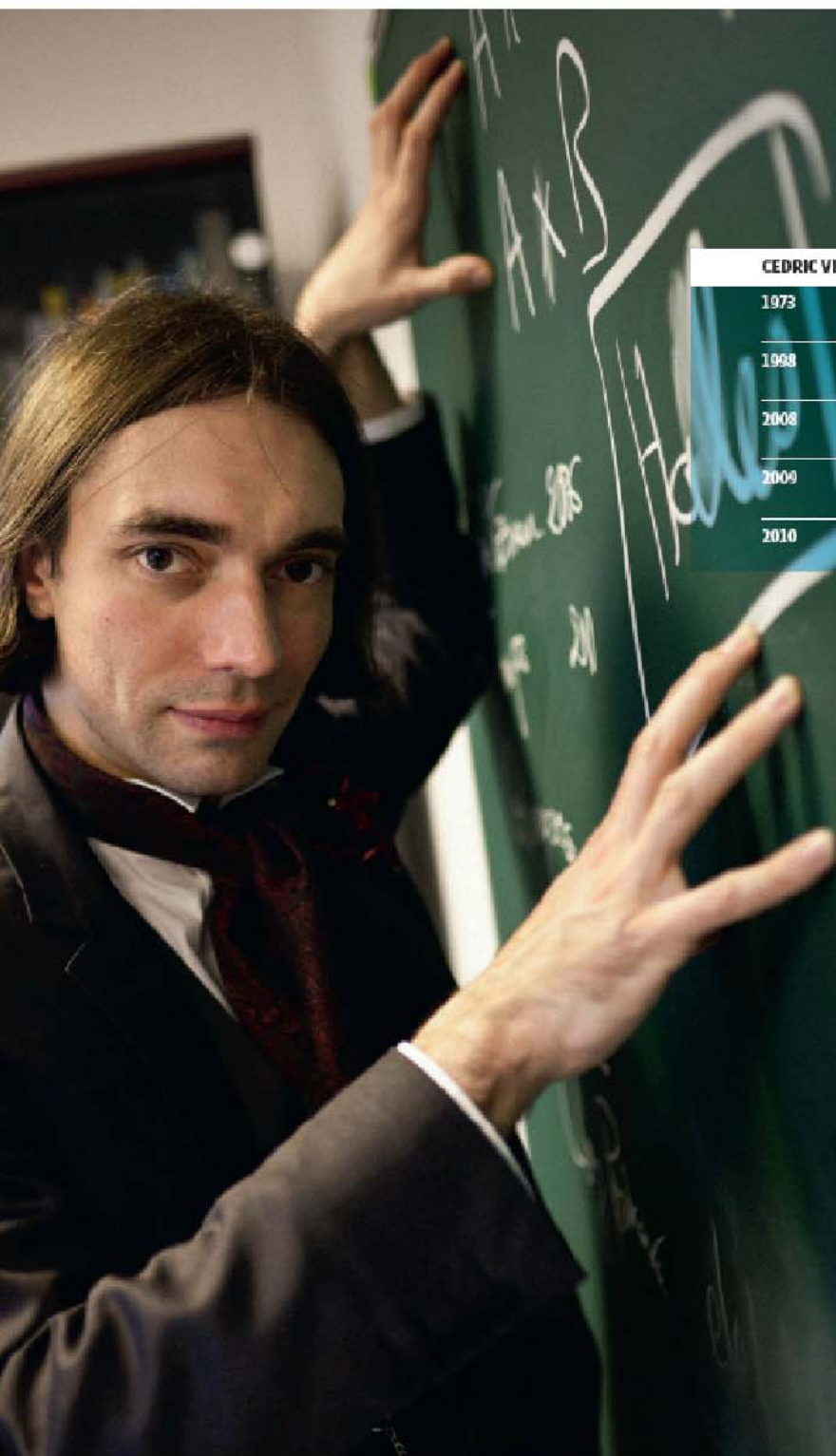
CEDRIC VILLANI IN 5 KEY DATES

Year	Event
1973	Born in Brive la Gaillarde (southwestern France)
1998	PhD in mathematics from the University of Paris-IX
2008	European Mathematical Society Prize
2009	Director of the Institut Henri Poincaré
2010	Fields Medal Recipient

that seem completely unrelated. However, he harbored no doubts about his calling: "I was no good at physics," he laughs. "Even though most of my work is inspired by physics, I can only understand it from a mathematician's point of view."

In 2000, he returned from Atlanta and became a professor at ENS Lyon. "I felt that I had to get out of Paris," he says, "and I did the right thing. ENS Lyon is based around a small but top-level versatile team." He soon took on new responsibilities, becoming chairman of the specialists' commission and forming a top-notch probability team with Alice Guionnet. Villani's new position enabled him to exchange ideas with mathematicians specialized in a wide range of fields. "In Lyon, I could talk about anything with anyone," he remembers. He would stay at ENS nine years, dividing his time between teaching, institutional activities, and, above all, research—a period during which he made great progress in his work.

ACCOLADES AND AWARDS

Villani's achievements did not go unnoticed: in 2009 he was named director of the prestigious Institut Henri Poincaré (IHP), focused on mathematics and theoretical physics, after winning the prize of the same name.[4] This was followed by the Fields Medal in 2010, in recognition of his recent research on Landau damping. With Clément Mouhot, he was able to corroborate the work of the Russian physicist Lev Davidovich Landau, who in 1946 showed, although with incomplete proof, that plasmas converge to equilibrium without increasing entropy, unlike gases. Since then, Villani has devoted himself to the supervision of the IHP, inviting researchers from across the world. He is busy thinking up future research projects, "there are still many issues I would like to solve," he muses. This problem-solver has always put his heart, passion, and intuition into his work. Much like a poet.

01. CNRS / UPMC.
02. Entropy is a physical quantity describing the state of disorder of a system. Boltzmann held that molecules proceed from an orderly state toward a less orderly state, meaning that entropy is constantly increasing.
03. Cédric Villani, *Topics in Optimal Transportation* (Providence: American Mathematical Society 2003) and Cédric Villani, *Optimal Transport. Old and New* (Berlin: Springer, 2008).
04. Bestowed by the International Association of Mathematical Physics.

Villani sees mathematical research as being largely a matter of human interaction. He recounts how, based on an idea proposed by Otto, the two worked together to explore a link between optimal transport and gas diffusion. Continuing this momentum, in collaboration with John Lott, an American specialist in the Ricci curvature, a differential geometry notion, he created a link between optimal transport and curvature study. This is Villani's forte: finding connections between fields