

Elevator Talk: Cédric Villani

Cédric Villani is a world-renowned mathematician, awarded the Fields Medal in 2010 for his major contributions to kinetic theory and optimal transport. His work has not only made fundamental advances in pure mathematical fields but also has practical applications in areas such as physics, economics, and artificial intelligence.

Major Contributions:

Kinetic Theory and the Boltzmann Equation

Villani has devoted much of his career to studying the Boltzmann equation, which models interacting gases in the context of statistical physics.

- With Giuseppe Toscani, he proved the **Cercignani conjecture** on entropy production, a key question that connects thermodynamic equilibrium and the statistical properties of particle systems.
- He also worked with Laurent Desvillettes to establish convergence estimates toward equilibrium in the non-perturbative framework of this equation, a complex problem that few researchers had successfully solved. They proved that systems evolving according to the Boltzmann equation tend toward an equilibrium state under certain conditions of uniform regularity, which strengthened the understanding of relaxation processes in gases and plasmas.

Landau Damping

With Clément Mouhot, Villani extended the study of the **Landau damping** phenomenon, which describes energy dissipation in plasmas, by proving that it also applies in a nonlinear perturbative context, a major breakthrough for plasma physics.

Optimal Transport

One of Villani's most remarkable contributions is his research on **optimal transport**, a field that studies how to transport resources as efficiently as possible, minimizing costs such as energy or time.

- His work has connected this theory to diverse fields such as economics, logistics, and the modeling of particle movement in fluids or social networks.
- In particular, his books *Topics in Optimal Transportation* and *Optimal Transport: Old and New* have provided new perspectives and methods for solving complex problems in geometry and analysis.

Beyond Research

Cédric Villani does not limit himself to pure mathematics contributions. He is also a passionate **science communicator** and a bestselling author, with books like *The Vivant Theorem*, where he shares his journey and the impact of mathematics in everyday life. He has also played an important role as a public figure, particularly through his engagement in the **French National Assembly**, where he served as a deputy. He advocates an ambitious vision for science: using mathematics to solve real-world problems and improve society while inspiring the next generation of researchers.

In summary, Cédric Villani embodies a modern approach to mathematics, where intellectual rigor meets creativity, social engagement, and outreach. Through his work, he has succeeded in making complex mathematical concepts accessible while opening the door to many practical applications that shape our world today.