The ultimate state of turbulent convection : myths, facts and open questions

Philippe Roche*[1]

[1]Institut Néel (NEEL) – Centre National de la Recherche Scientifique : UPR2940 – 25 rue des Martyrs - BP 166 38042 GRENOBLE CEDEX 9, France

Abstract

In 1997, a convection experiment in Grenoble delivered a surprise: inside a Rayleigh-Bénard cell, heat transfer abruptly improved beyond Ra≈2e11, a behavior that held up to the highest measured Ra=1e14. Yet just two years later, a separate team in Eugene, Oregon, pushed measurements to Ra=1e17 ... and saw no such transition. How could two meticulously conducted experiments arrive at such starkly different conclusions?
This apparent contradiction has driven a quarter-century of research, experimental, numerical, and theoretical and a bit of controversa. Some findings seemed to validate each study over the other, and the debate has never been settled. Instead, it has deepened, revealing overlooked consistencies, persistent misunderstandings, and new questions that challenge our understanding of turbulent convection at extreme Rayleigh numbers.
In this talk, I will summarize experimental evidence and share my own perspective on what these experiments really tell us, highlighting the hidden patterns, confronting several misconceptions that have kept this debate alive, and pinpointing open questions that still demand answers.

*Speaker