Elusive transition to the ultimate regime of turbulent Rayleigh-Bénard convection

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Abstract

Natural buoyancy driven turbulent convection plays a vital role in heat and mass transfer on large-scales in Nature, such as the circulation in the atmosphere or in the oceans, the flows under the surface of stars or in diverse branches of industry. Laboratory and numerical modelling of natural convection is possible on the base of a simplified physical model system - Rayleigh-Bénard convection (RBC). Such model is realized in a layer of working fluid often confined to a cylindrical experimental cell which is heated from bellow and cooled from above with a vertical temperature gradient parallel to gravity. One of the most discussed topics in the field of RBC is the existence of its ultimate regime theoretically predicted by R. Kraichnan in 1962 [1]. Confirmation of such a regime would be of great importance for understanding many natural and practical phenomena mentioned above, as the heat transport efficiency rises significantly. Observation of the transition to the ultimate regime has been claimed several times - initially in the Grenoble cryogenic helium experiments [2] and more recently also in the Gottingen room temperature SF6 experiments [3]. Our experimental work sheds new light on this issue by pointing out that the effect of temperature dependent properties of the working fluid increase the heat transfer efficiency and thus the important issue of the transition to the ultimate state of RBC remains open. Our results have been analysed and subsequently published [4, 5] within outstanding collaboration with colleagues from the Department of Low Temperature Physics at Charles University in Prague.

References

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