PhD proposal : Effect of particulate phases on a thermally convecting fluid

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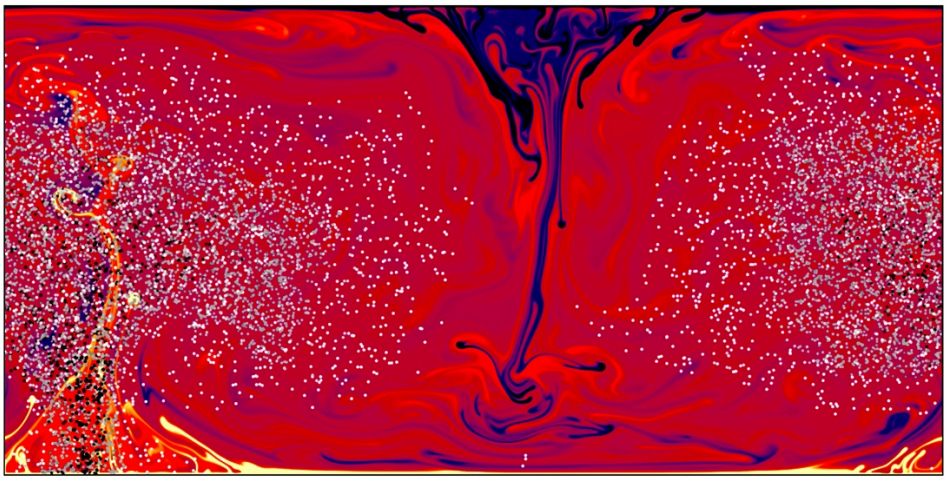

Virtually all the fluids present in nature contains particulate matter. One may think to pollen and sands transported by the wind, to rain drops advected in clouds, to planktonic organisms transported by the sea currents or to the variety rock crystals in a lava flow.
The presence of what is called a disperse phase in a fluid can have effects on its material properties (such as its viscosity and thermal conductivity) as well as on its dynamics (leading for instance to modifications of the global drag or heat transfer associated to a given flow system). A particulate phase can also affect the threshold of convective instability in a suspension, by modifying the buoyancy force or the fluid stresses. Such a phenomenon, beyond its theoretically challenging aspects, is of relevance for many environmental and climate related problems.
In this PhD project we aim at studying the effect of a disperse phase on thermally convecting fluid system. We have here in mind either geophysical applications involving drops or solid crystals [1,2] or ecological applications comprising aquatic organisms, such as algaes [3,4].
The problem will be studied theoretically by means of the approach of hydrodynamics stability analysis and numerically, through state-of-the art direct numerical simulations.

The interested candidate should have a background in mechanics, physics o applied mathematics, he/she should love computer programming, reading/writing in English, and have good communication skills.

References:

1. Settling of inertial particles in turbulent Rayleigh-Bénard convection, V. Patocka, E. Calzavarini, N. Tosi *Phys. Rev. Fluids* 5, 114304 (2020).
2. Residence time of inertial particles in 3D thermal convection: implications for magma reservoirs, V.Patočka, N. Tosi, E. Calzavarini, https://arxiv.org/abs/2202.12633
3. Advances in Bioconvection, M. A. Bees, Annu. Rev. Fluid Mech. 52:449–76 (2020)
4. The onset of bioconvection in a suspension of gyrotactic microorganisms in a fluid layer of finite depth heated from below, A.V. Kuznetsov, Int. Comm. Heat and Mass Trans. 32 (2005) 574–582
5. Linear theory of particulate Rayleigh-Bénard instability, S. Prakhar and A. Prosperetti, Phys. Rev. Fluids 6, 083901 (2021)