Thermoelectric convection in a cylindrical annulus under microgravity

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Thermoelectric convection is induced by dielectrophoretic (DEP) force induced in a dielectric liquid subject both to a fast varying electric field and a temperature gradient[1,2]. The non-conservative part of the DEP force plays the role of the buoyancy force $\delta\rho\theta\vec{g}_e$ if the electric gravity $\vec{g}_e$ is introduced. The magnitude of the electric gravity is proportional to the square of the effective electric tension and to the inverse of the cube of the radius in a cylindrical annulus. The electric buoyancy is suitable to generate thermal convection in microgravity environment such as the international space station (ISS) where the effective gravity is very weak (10^{-6} g) or in microfluidic devices where the size of the fluid is very small to reach the critical Rayleigh number by varying the temperature difference imposed to the walls of device.

We will present results from direct numerical simulations on thermoelectric convection in a cylindrical annulus subject to a radial temperature gradient and to an alternating electric tension. We introduce the Rayleigh-Roberts number L which accounts for the applied tension and will characterize the flow patterns with the increase of L. Figure 1 shows an example of the iso-surfaces of the radial velocity and iso-values of Q for two values of L : L= 558.9 (a,b), L= 2760 (c, d). The heat transfer coefficient (Nu) and the kinetic energy (Re^2) of the perturbations are quantified and their variations with L are analysed[3]. Numerical results are compared with available experimental data[4].

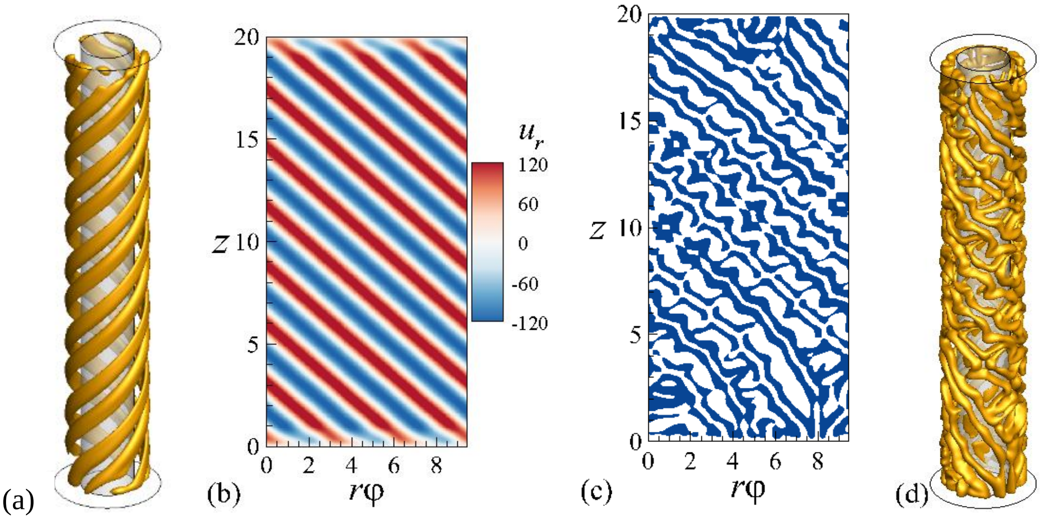

Figure 1 : Flow structures and isosurfaces of the radial velocity for : L= 558.9(a, b) and L= 2760 (c, d)

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