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NATURAL CONVECTION IN A POROUS CAVITY: THE ROADS TO CHAOS

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FINAL ABSTRACT

In this work we have studied numerically the two-dimensional unstationary natural convection in a square enclosure totally porous. The horizontal walls are adiabatic; the vertical walls are raised to a hot temperature on the half-height lower and a cold temperature on the upper half-height. The model of DARCY - BRINKMAN is used to represent the phenomenon whose equations are:

$$\vec{\nabla}.\vec{V} = 0 \quad (1)$$

$$\frac{\rho}{\varepsilon}\frac{\partial \vec{V}}{\partial t} + \frac{\rho}{\varepsilon^2}\left(\vec{V}.\vec{\nabla}\right)\vec{V} = -\vec{\nabla}p + \mu_{eff}\vec{\nabla}^2\vec{V} - \frac{\mu}{K}\vec{V} + \rho\vec{g} \quad (2)$$

$$\frac{\partial T}{\partial t} + \vec{V}\vec{\nabla}T = \vec{\nabla}\left(\lambda \propto \vec{\nabla}T\right) \quad (3)$$

The mathematical model that we proposed is based on many simplifying assumptions as the BOUSSINESQ approximation:

$$\rho\,(T) = \rho_\infty[1 - \beta(T - T_\infty)] \quad (4)$$

The governing equations governing the phenomenon are discretized by the finite volume method with a uniform mesh and solved with SIMPLE algorithm. we take the porosity for all the problem $\varepsilon = 0.45$, DARCY number $Da=10^{-3}$ and the Prandtl number $Pr = 0.71$.
The validation of the computer code was made with the work of LAURIAT and PRASAD (Table 1) and gave satisfactory results. The relative error obtained is a maximum of about 098 %.The exploitation of results obtained in natural convection allowed us to highlight different attractors characterizing the evolution of the system towards chaos.
We noticed that the amplitude spectra contained peaks essentially harmonic whose reports are irrational (Figure. 1), the representation of attractors (Figure. 2) in the phase space allowed to say that our system is evolving into a deterministic chaos and characterize that the resulting scenario (road to chaos) which is the scenario by quasi-periodicity.

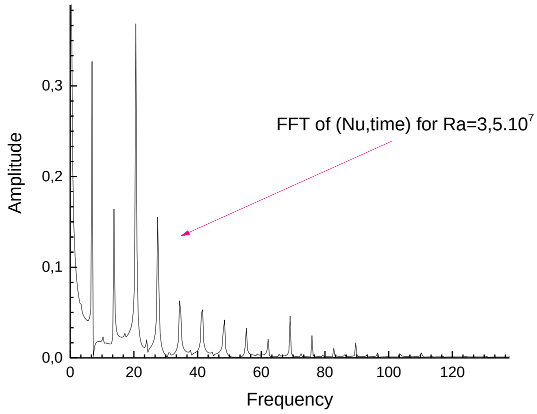

Figure 1. Amplitude spectra of temporal evolution of the hot Nusselt for (Ra = 3.5 10^7).

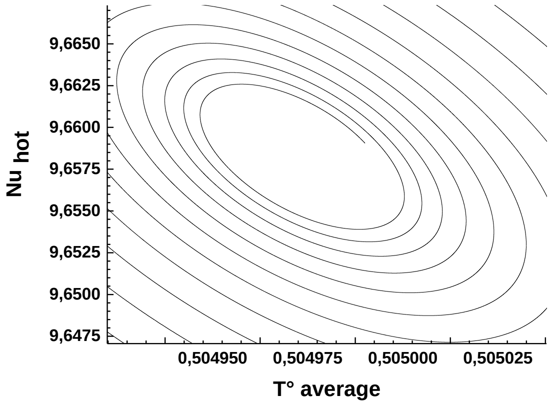

Fig 2. Hot Nusselt phase portrait in accordance with the average temperature for (Ra = 8 10^6).

Table 1

Validation the results of present work and work of Lauriat and Prasad.

Parameters	Ra=10^7; Da= 10^{-6} Pr=1 ε=0.4				
mesh	41	61	81	101	Reference
$N_{U\ Hot}$	1.05829916	1.06557066	1.06849974	1.07048052	1.07
Error %	1.09	0.413	0.149	0.044	

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KEYWORDS

Natural convection, Porous medium, Chaos, Attractors, finite volumes, Fast Fourier Transform.