

# Supplementary Materials for: Flow structures transition in thermal vibrational convection

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## Three dimensional (3D) simulation

Two 3D cases have been performed with the parameters (a)  $a = 0.1$  and  $\omega = 10^3$  and (b)  $a = 0.1$  and  $\omega = 10^4$ . Figure S1 displays two vertical cuts of the instantaneous temperature fields of both 3D cases. One can observe the columnar structure in figure S1(b).

## Thermal vibrational convection with lateral periodic boundary condition

Figure S2 shows the three 2D simulations for the TVC case with lateral periodic boundary conditions of (a)  $a = 0.1$  and  $\omega = 10^3$ , (b)  $a = 0.1$  and  $\omega = 10^5$ , and (c)  $a = 0.1$  and  $\omega = 10^7$ . We found that the columnar structure also appears in the 2D case with periodic boundary (see figure S2 (b)). At high frequency (see figure S2 (c)), the columnar structure also breaks down, corresponding to the columnar-broken regime.

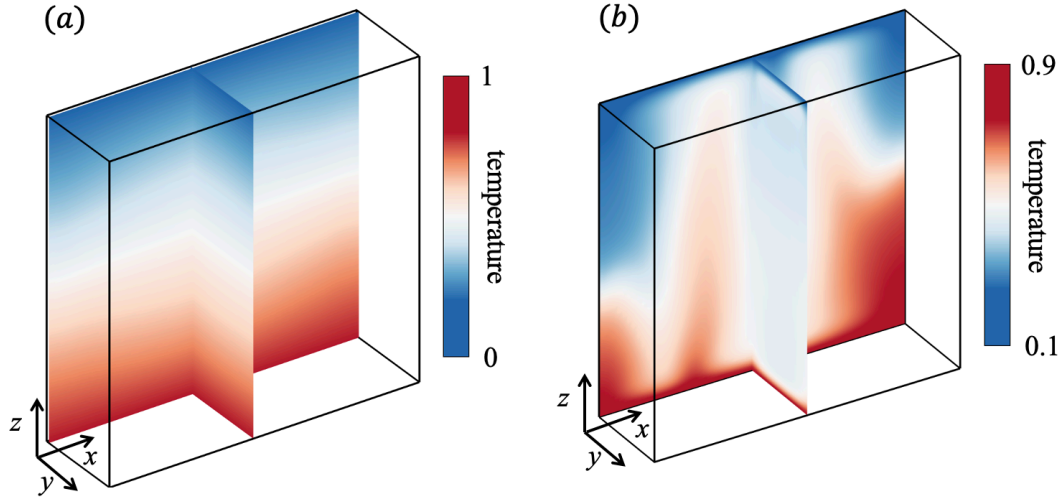


Figure S1: Instantaneous temperature fields on the two vertical cuts in the 3D cases with (a)  $a = 0.1$  and  $\omega = 10^3$  and (b)  $a = 0.1$  and  $\omega = 10^4$ .

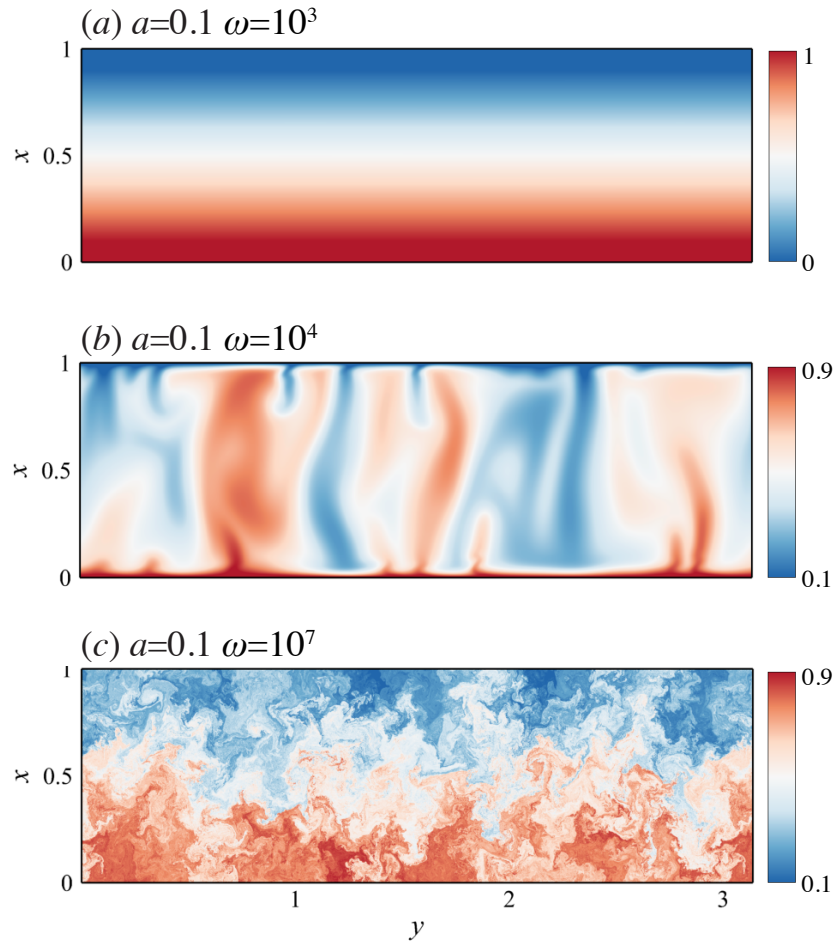


Figure S2: Instantaneous temperature fields in TVC case with lateral periodic boundary condition for (a)  $a = 0.1$  and  $\omega = 10^3$ , (b)  $a = 0.1$  and  $\omega = 10^5$  and (c)  $a = 0.1$  and  $\omega = 10^7$  at fixed aspect-ratio  $\Gamma = \pi$ .