

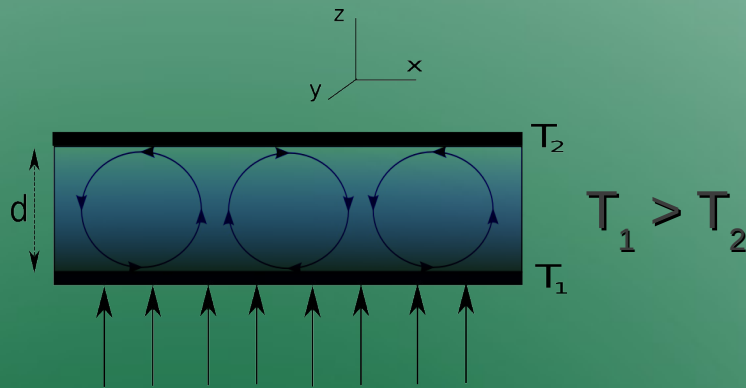
Scalings of field correlations and heat transport in turbulent convection

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- Rayleigh-Bénard convection



- Control Parameters:

Rayleigh number, $Ra = \alpha g(T_1 - T_2)d^3/(\nu\kappa)$

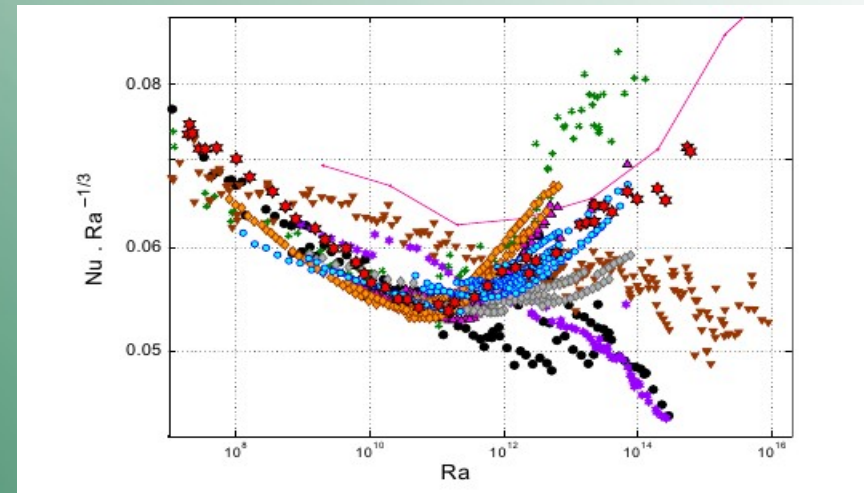
Prandtl Number, $Pr = \nu/\kappa$

- Response Parameters:

Nusselt number, $Nu =$ Ratio of convective to conductive heat flux.

$$Nu = \frac{\kappa \Delta / d + \langle u_z T \rangle}{\kappa \Delta / d}$$

- Scaling of Nusselt number :



P. E. Roche et al., New J. Physics (2010)

$$Nu \approx Ra^\beta$$

- $\beta \approx 0.3$ (for moderate Ra)
- $\beta \approx 0.5$ (for very high Ra , also called **ultimate regime ...**)

How to reconcile the scalings observed in the two regimes.

How the correlation between the velocity and temperature change in these regimes .

Numerical calculation of velocity and temperature correlations

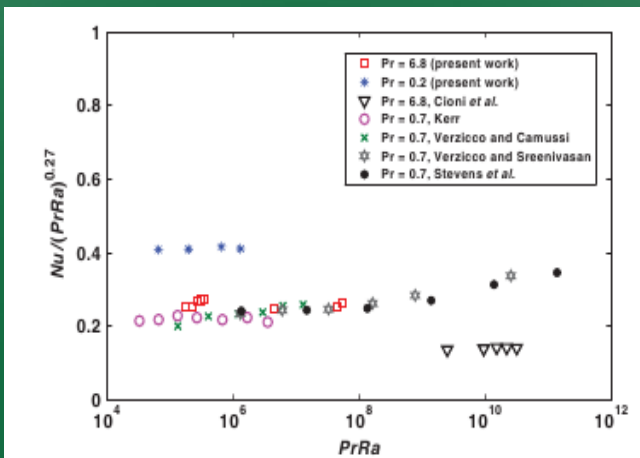
Nusselt number in terms of field correlations

$$Nu - 1 = \langle u'_z \theta' \rangle_V = C^{u\theta} (PrRa) \langle u_z'^2 \rangle_V^{1/2} \langle \theta'^2 \rangle_V^{1/2}$$

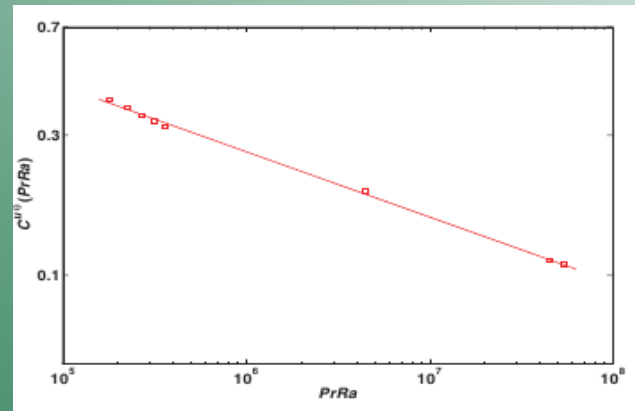
Where correlation function

$$C^{u\theta} (PrRa) = \left\langle \frac{\langle u'_z \theta' \rangle_V}{\langle u_z'^2 \rangle_V^{1/2} \langle \theta'^2 \rangle_V^{1/2}} \right\rangle_t$$

Numerical simulation:



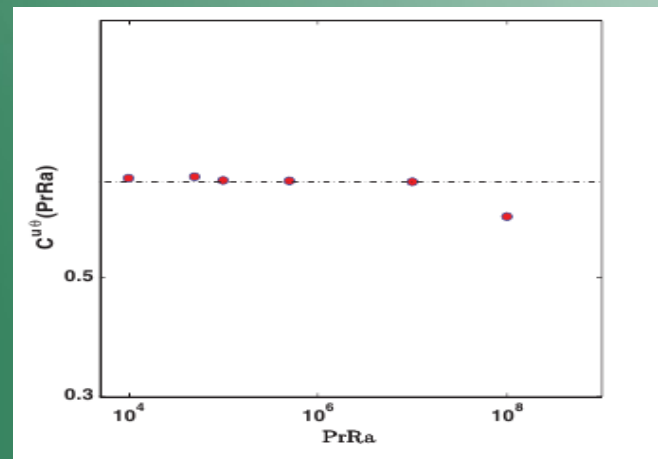
1. Correlation function for box with free-slip:



- Correlation for very large Ra ??

Will it keep on decreasing or saturate beyond certain range of Ra ...

2. Correlation function for box with Periodic condition:



- Correlation in the ultimate range may be similar to the correlation of periodic box !!

[Verma et al. PRE \(2012\)](#)