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Influence of the interaction range on the thermostatics of a classical many-body system



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ROTORES PLANARES ACOPLADOS

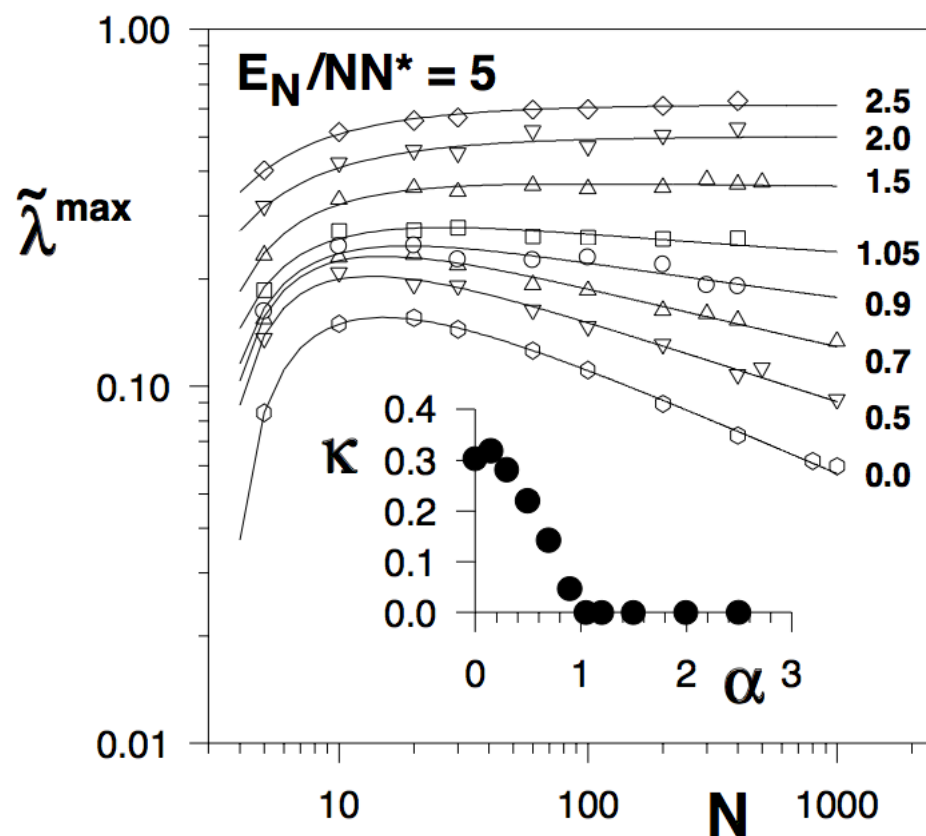
$$\mathcal{H} = \frac{1}{2} \sum_{i=1}^N p_i^2 + \frac{1}{2} \sum_{i=1}^N \sum_{\substack{j=1 \\ j \neq i}}^N \frac{1 - \cos(\theta_i - \theta_j)}{r_{ij}^\alpha} \quad (\alpha \geq 0)$$

Breakdown of Exponential Sensitivity to Initial Conditions: Role of the Range of Interactions

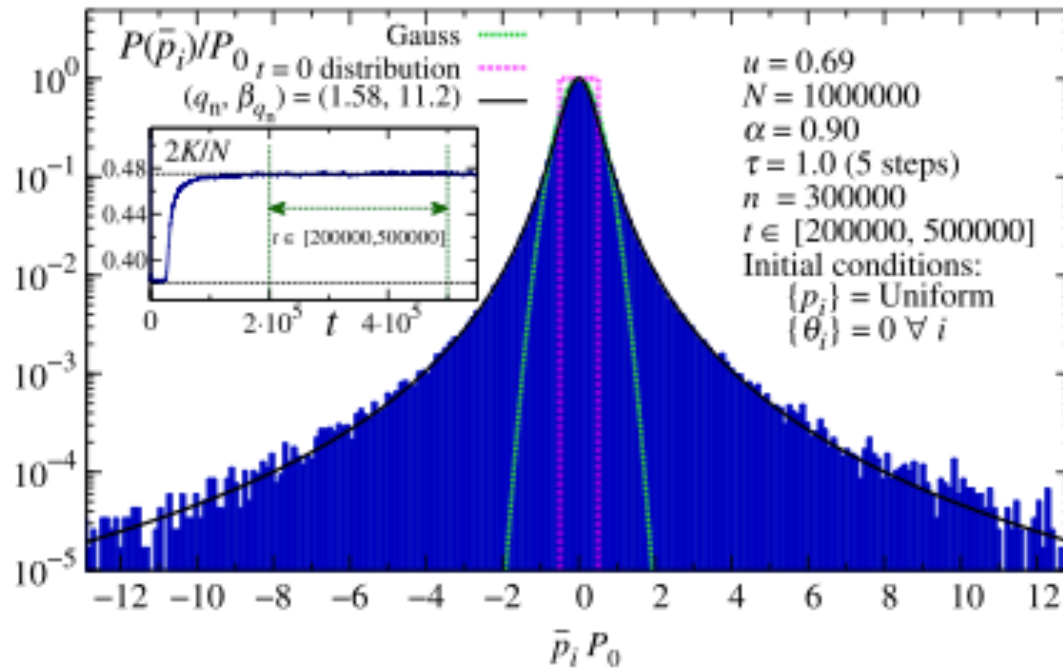
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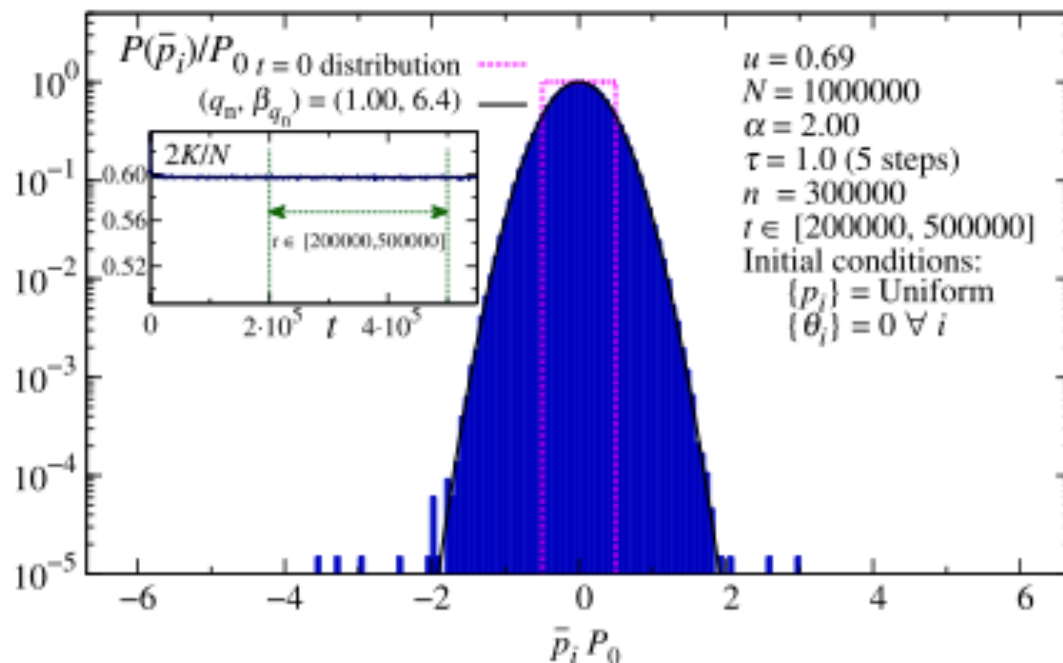
$$\lambda^{\max} \propto \frac{1}{N^{\kappa}}$$



$$\alpha = 0.9$$

yields

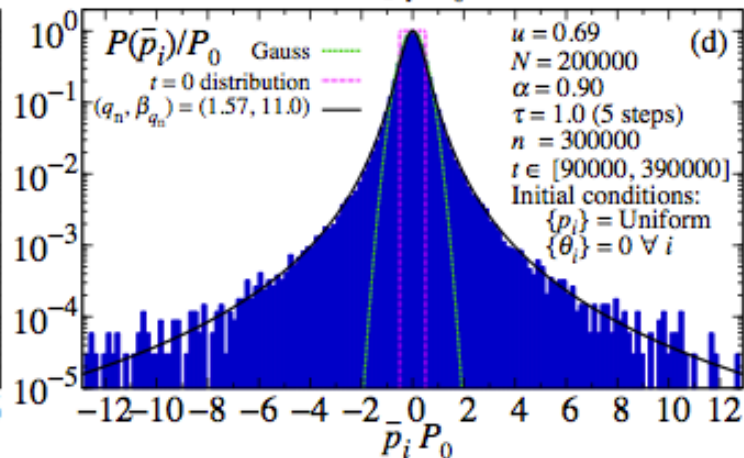
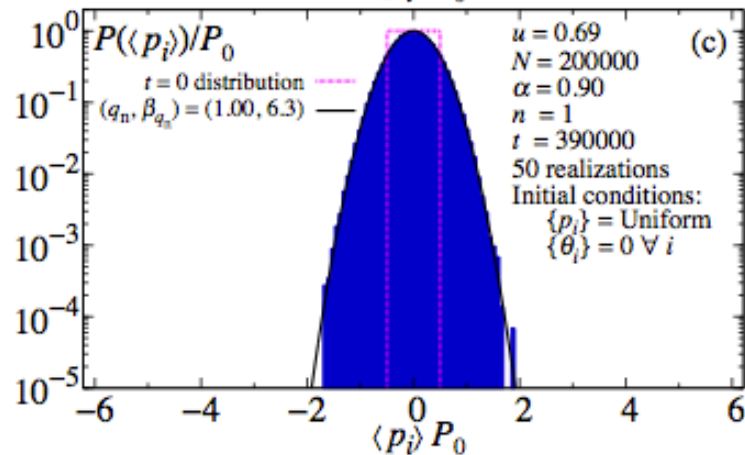
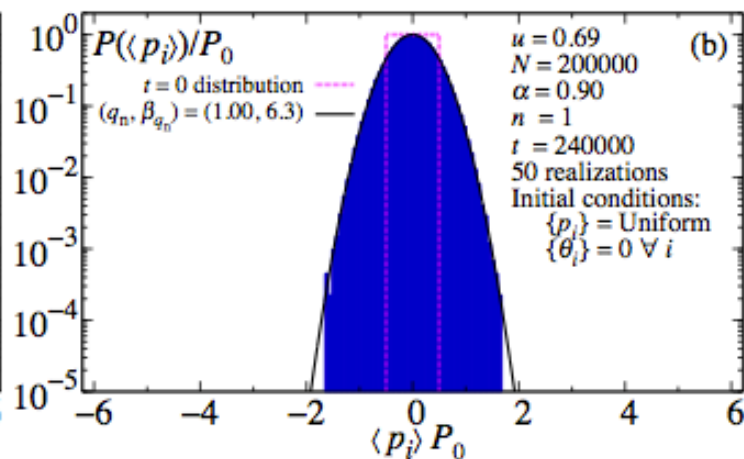
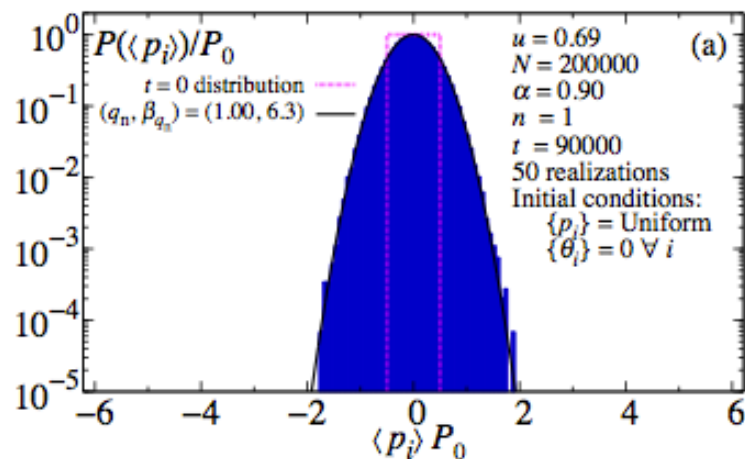
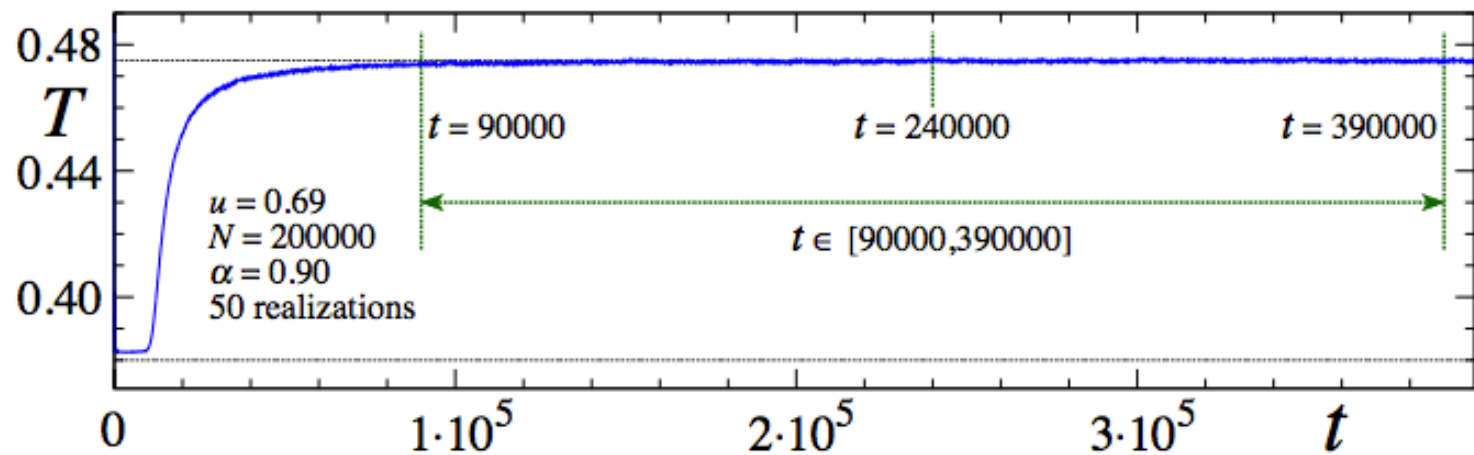
$$q = 1.58$$



$$\alpha = 2$$

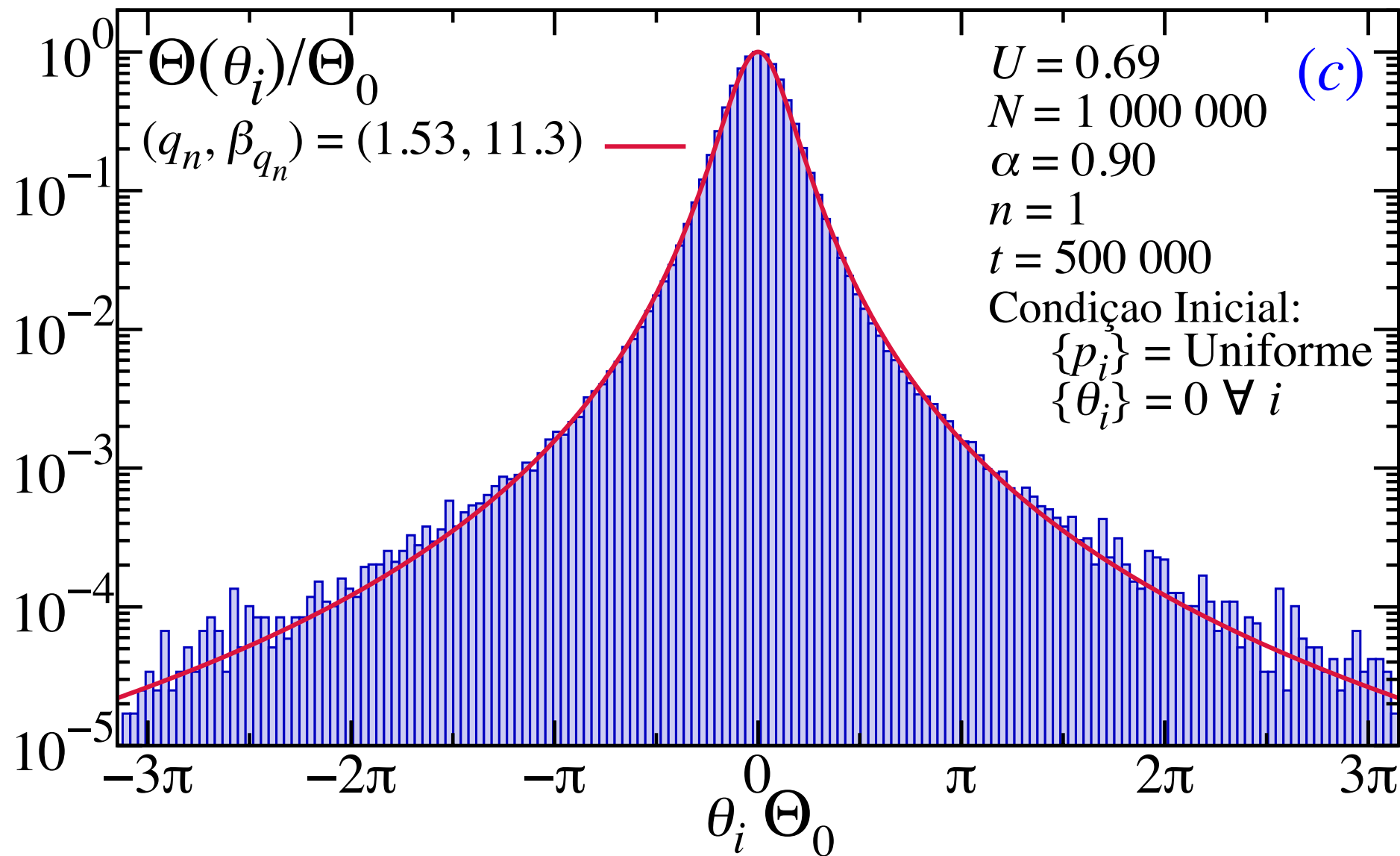
yields

$$q = 1$$

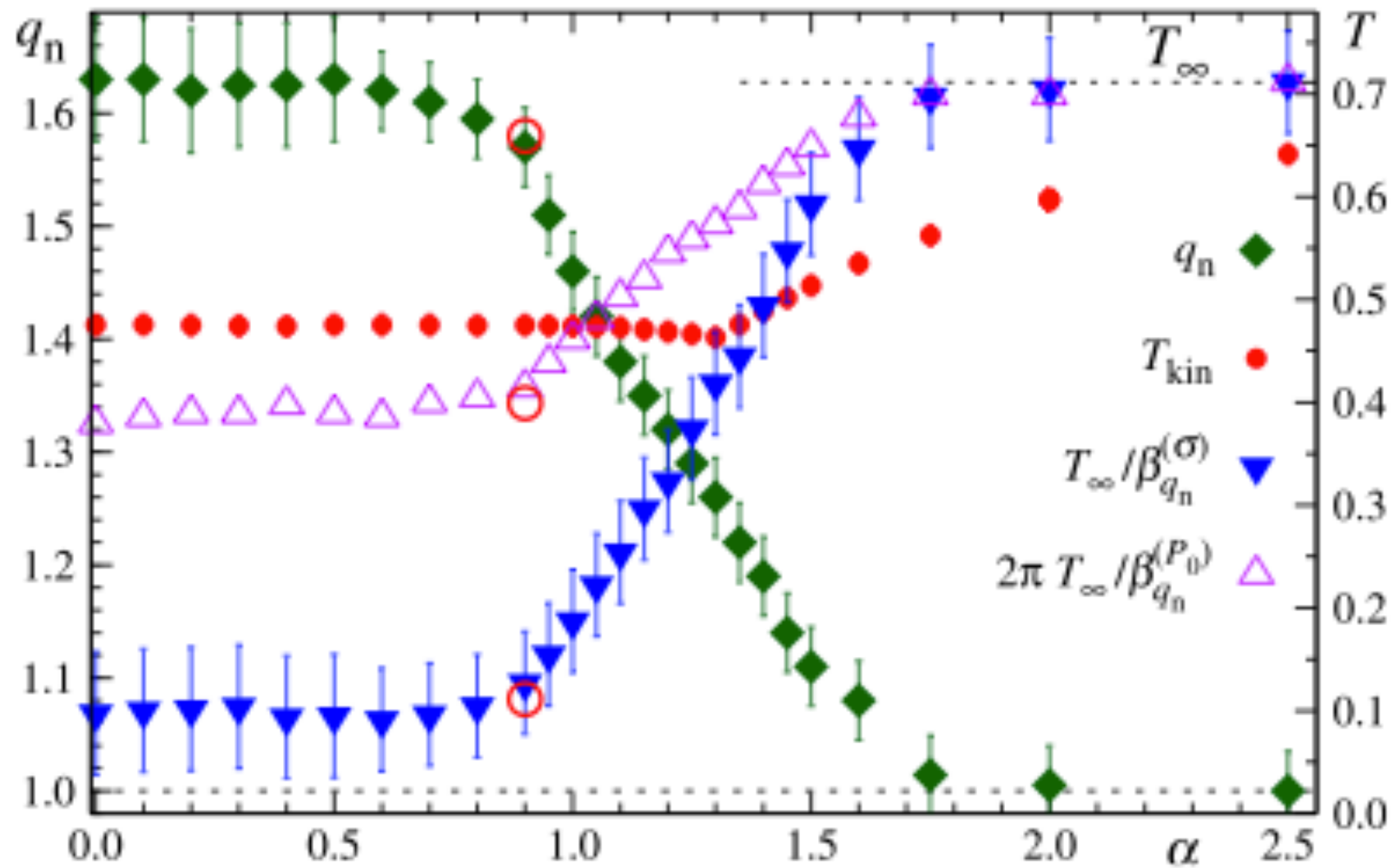


$$\alpha = 0.9$$

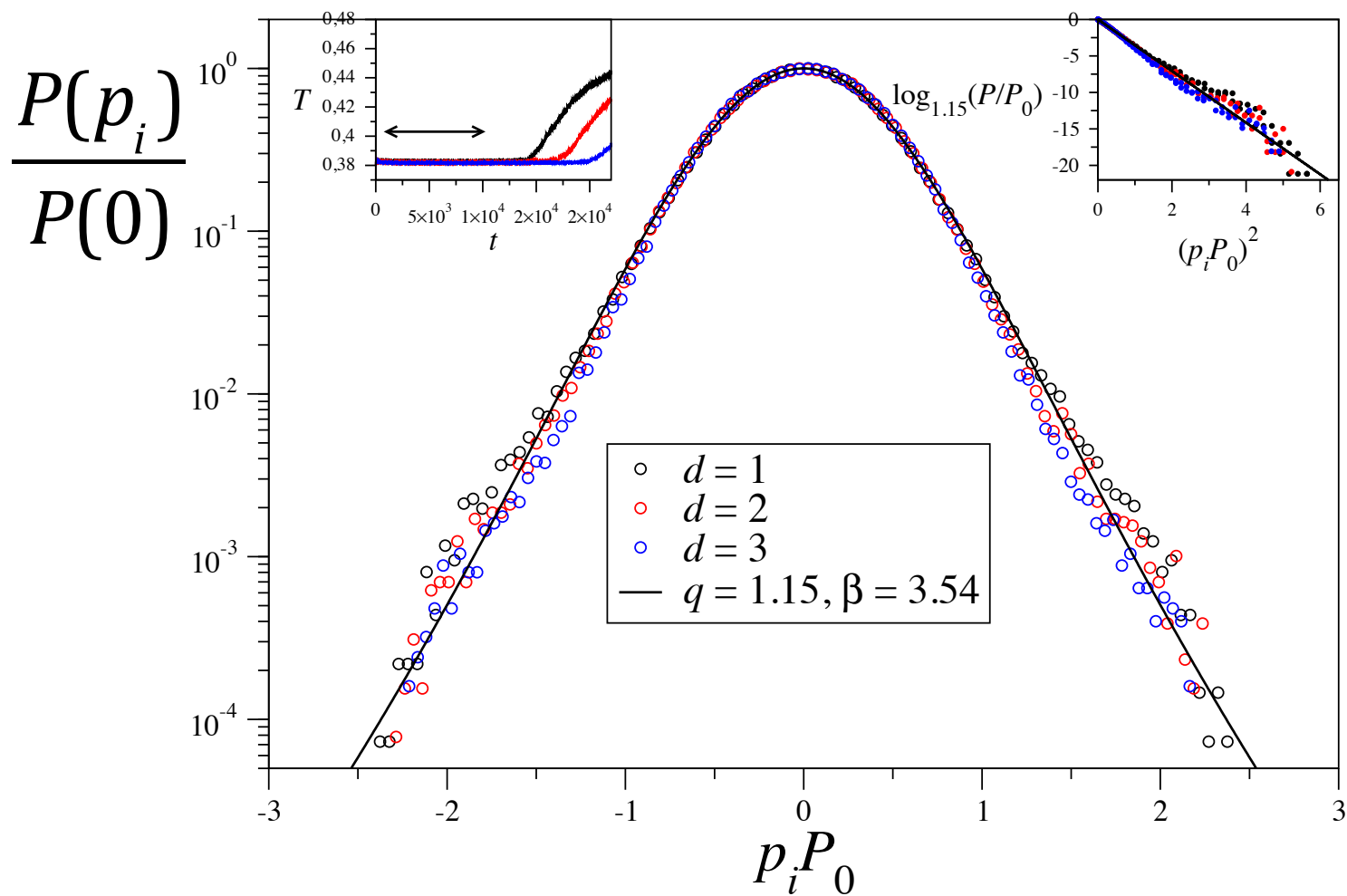
$$q = 1.53$$



(d=1)

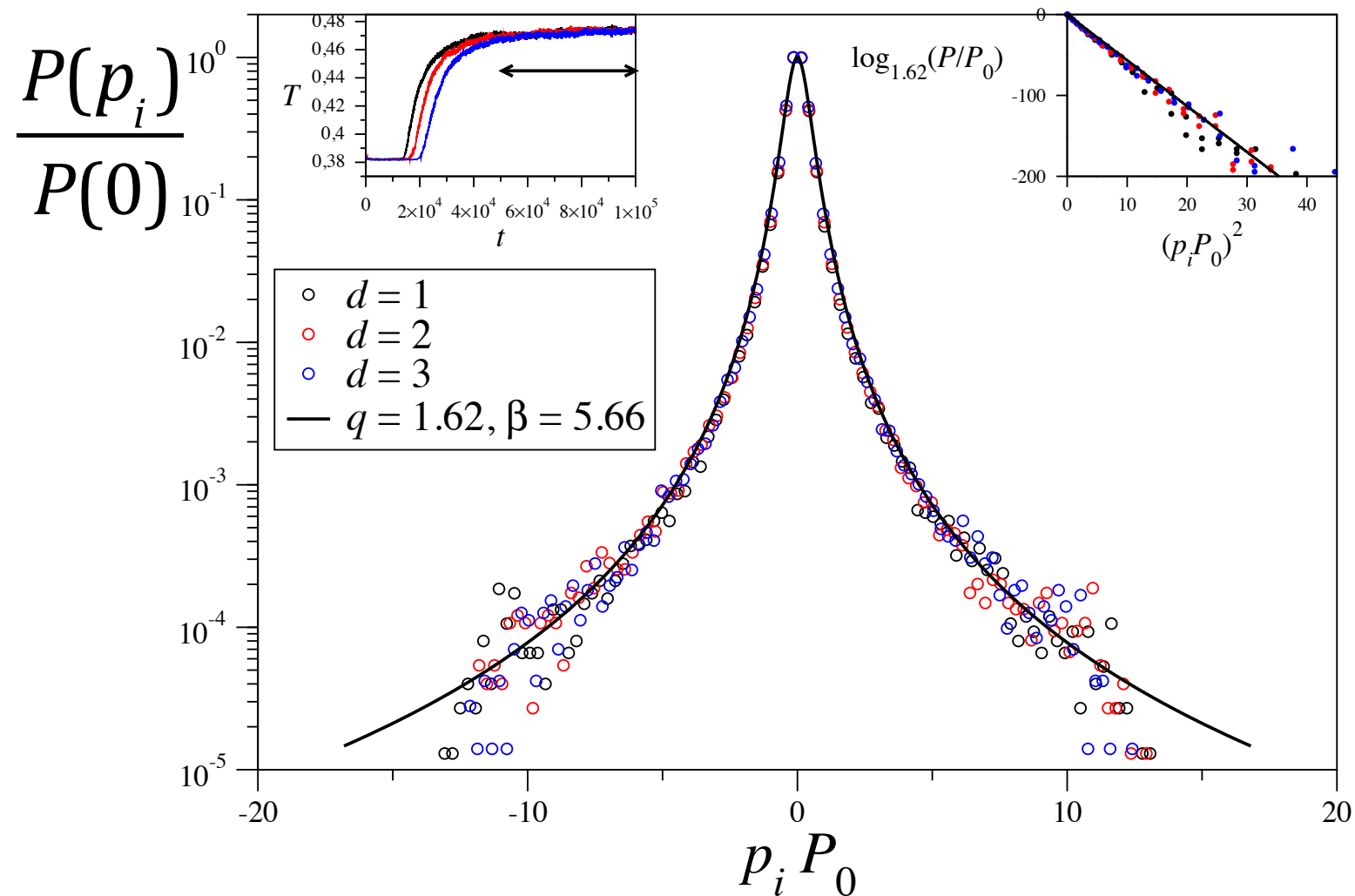


α -XY, $N = 262144$, $U = 0.69$, $\alpha/d = 0.9$

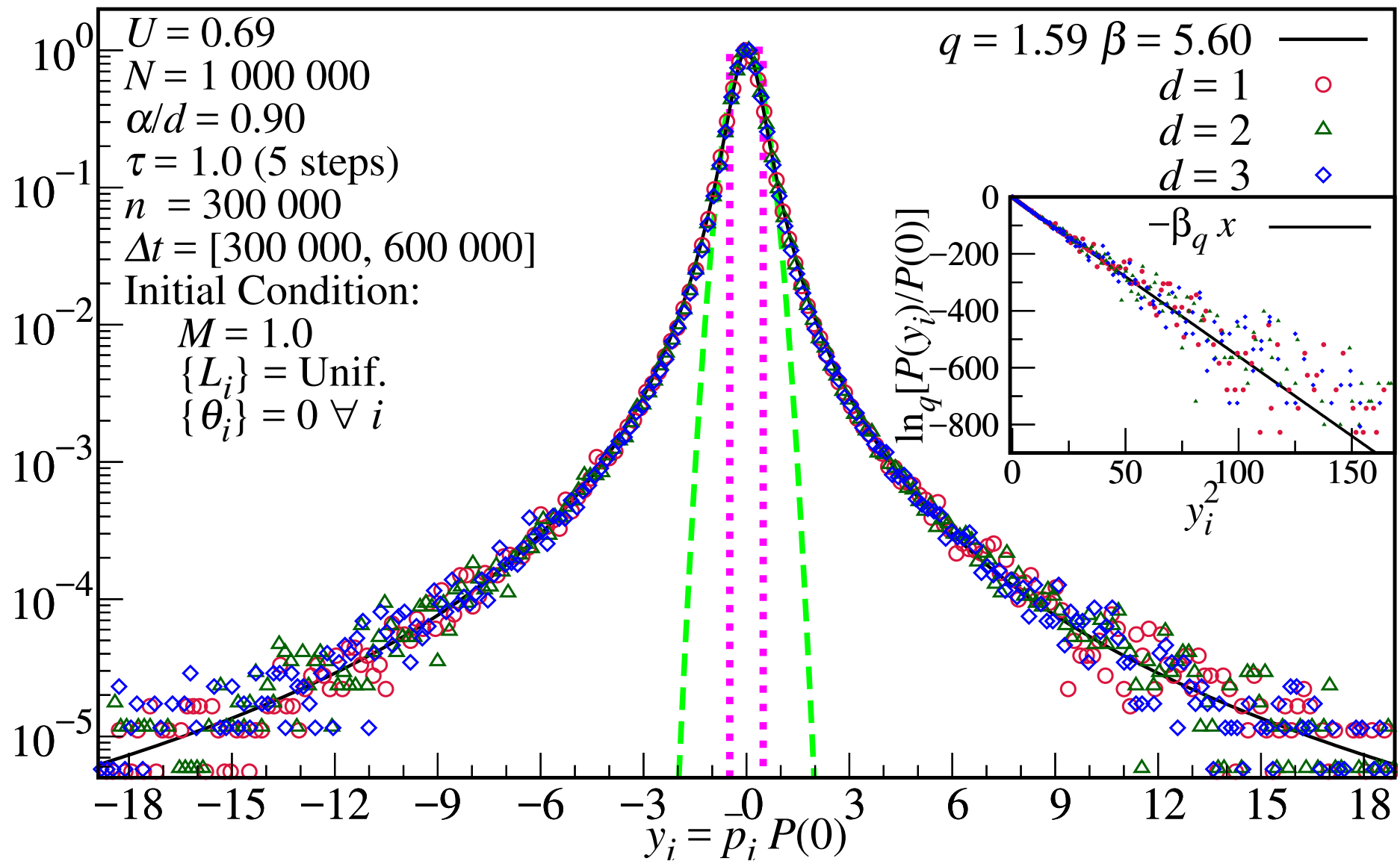


L.J.L. Cirto, A. Rodriguez, F.D. Nobre and C. T. (2017)

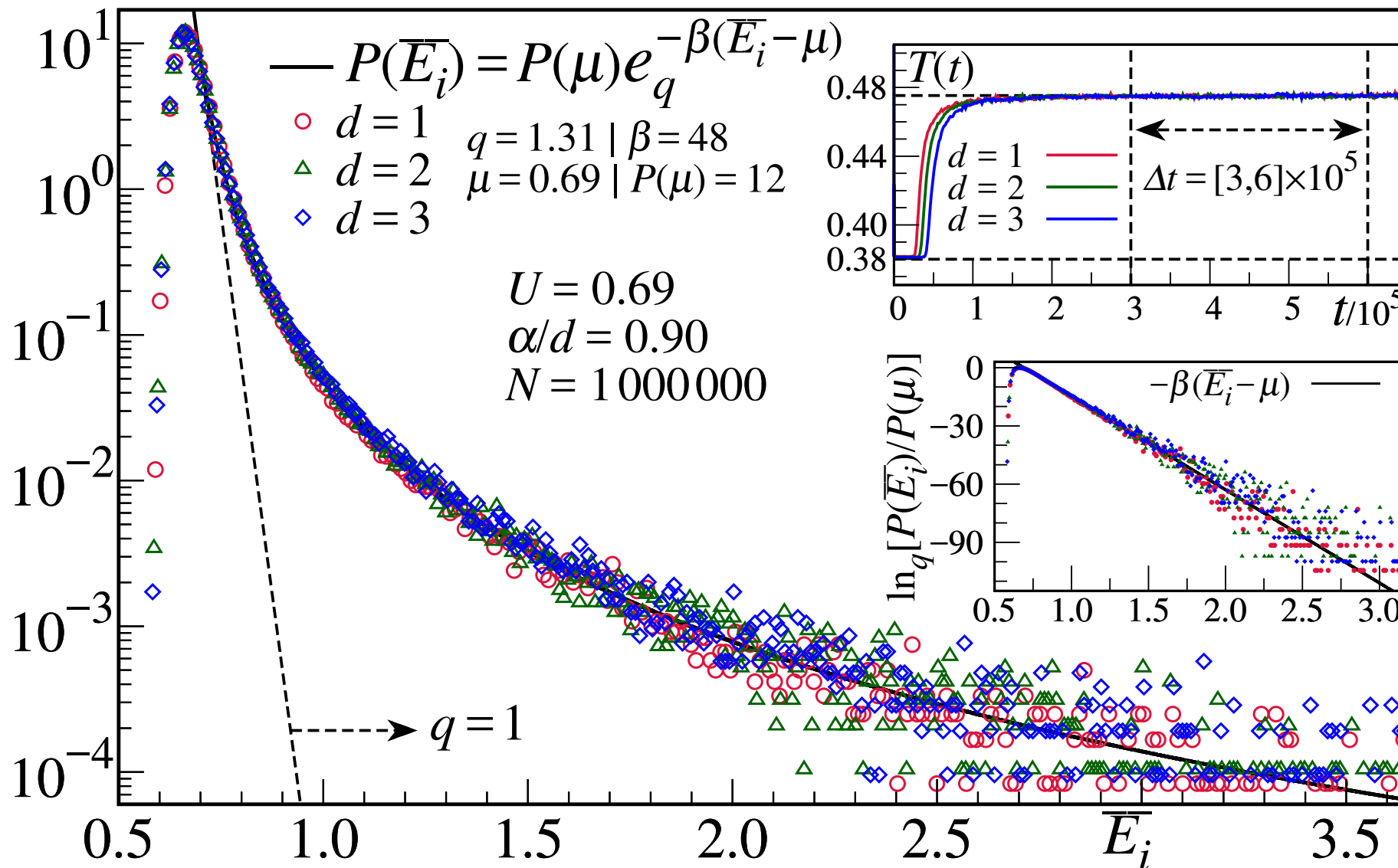
α -XY, $N = 262144$, $U = 0.69$, $\alpha/d = 0.9$



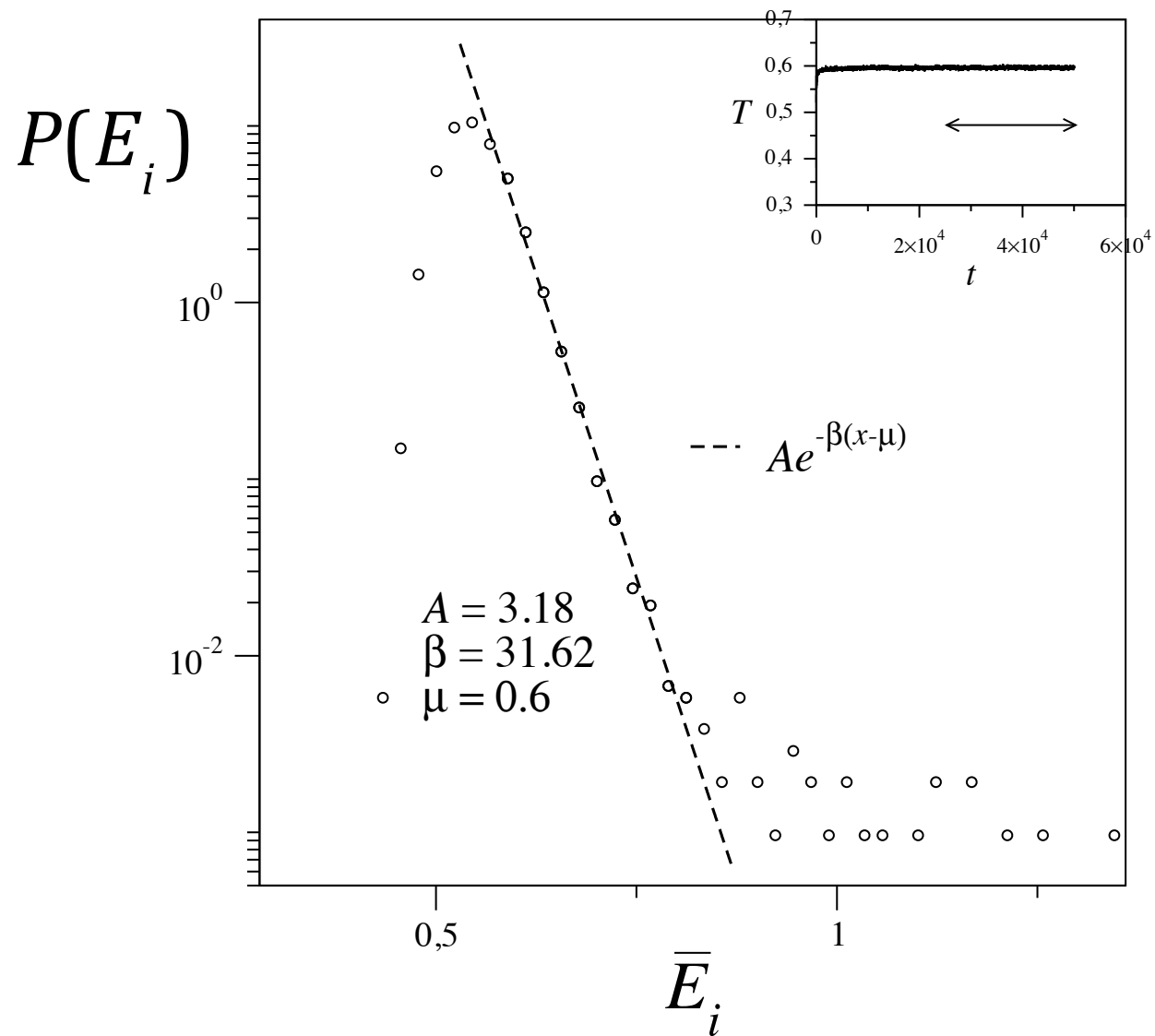
L.J.L. Cirto, A. Rodriguez, F.D. Nobre and C. T. (2017)



ONE-BODY ENERGY DISTRIBUTION

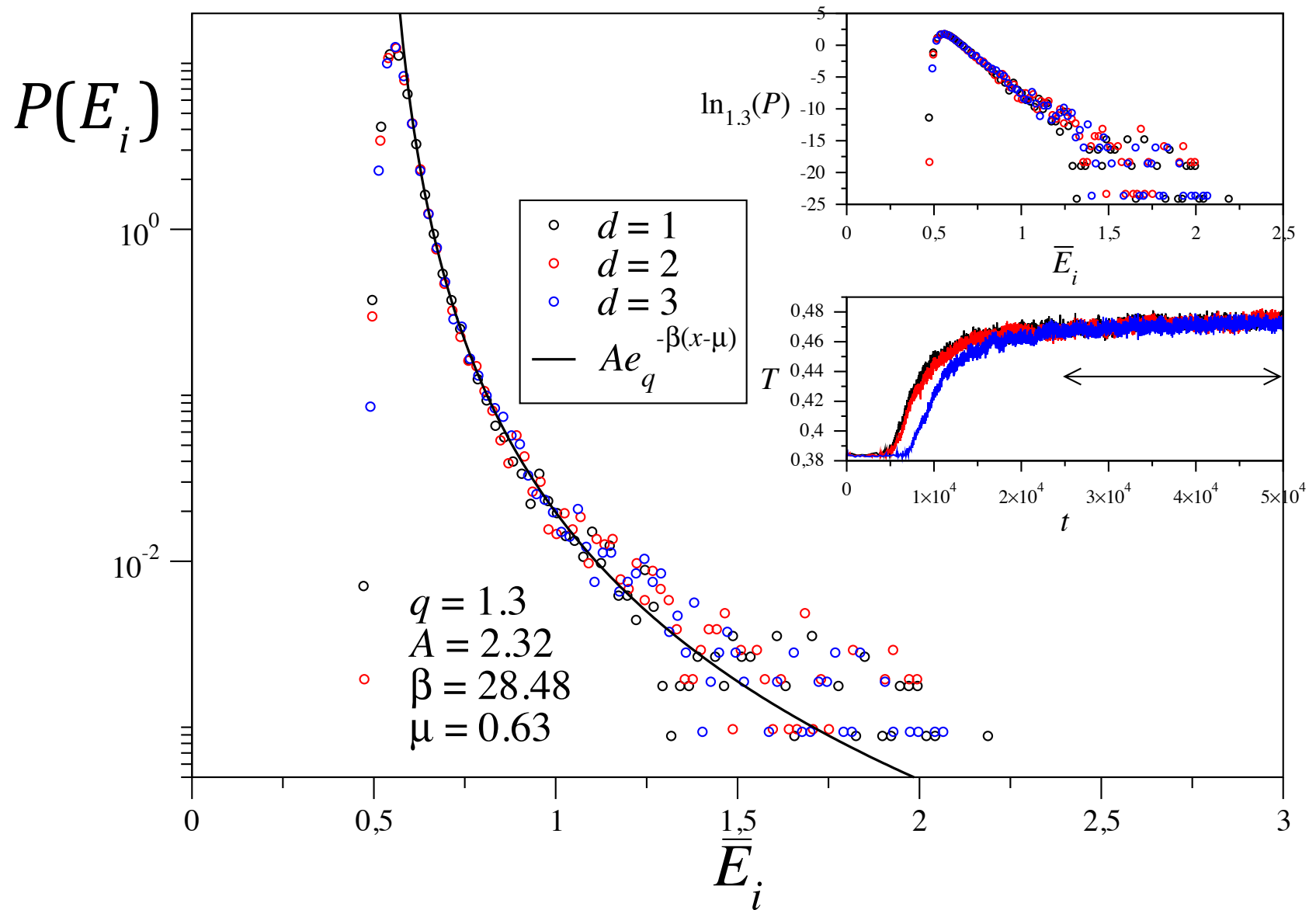


α -XY, $U = 0.69, N = 46656, \alpha = 2, d = 1$



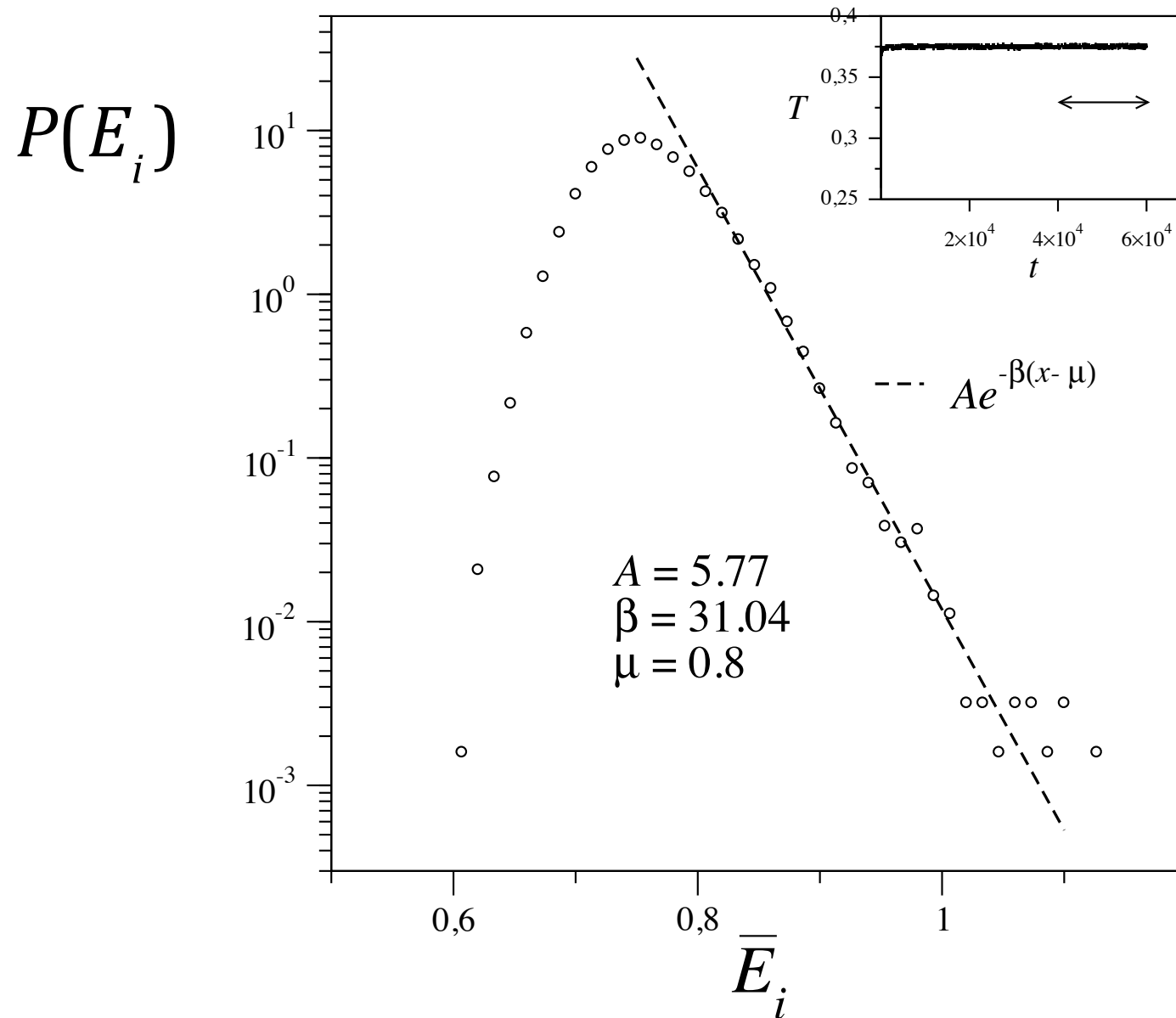
L.J.L. Cirto, A. Rodriguez, F.D. Nobre and C. T. (2017)

α -XY, $U = 0.69$, $N = 46656$, $\alpha/d = 0.9$



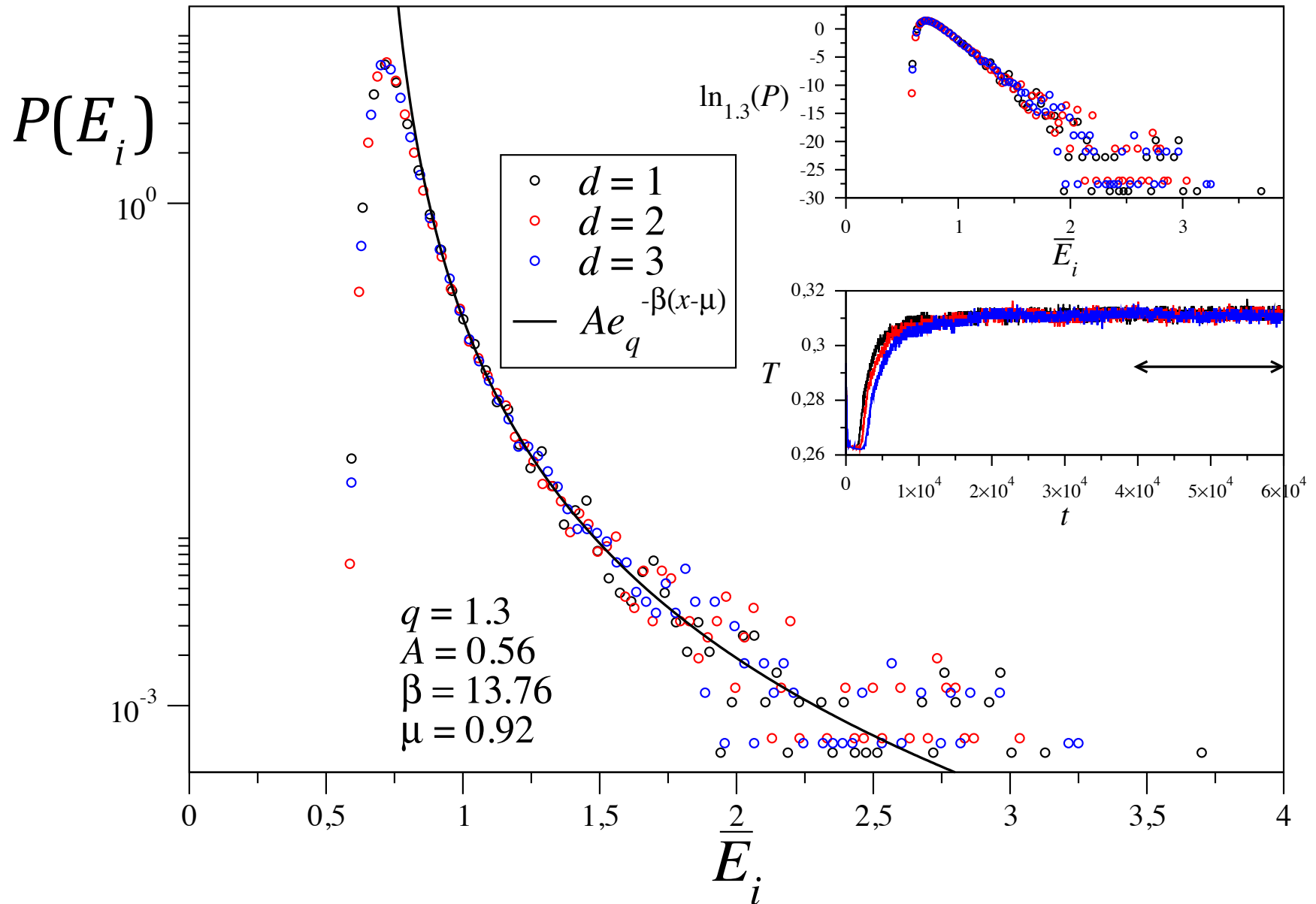
L.J.L. Cirto, A. Rodriguez, F.D. Nobre and C. T. (2017)

α -Heisenberg, $N = 46656$, $\alpha = 2$, $d = 1$



A. Rodriguez, L.J.L. Cirto, F.D. Nobre and C. T. (2017)

α -Heisenberg, $U=0.76$, $N = 46656$, $\alpha/d = 0.9$



A. Rodriguez, L.J.L. Cirto, F.D. Nobre and C. T. (2017)

Fermi-Pasta-Ulam model with long-range interactions: Dynamics and thermostatics

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² *Centro Brasileiro de Pesquisas Físicas and National Institute of Science and Technology for Complex Systems Rua Xavier Sigaud 150, 22290-180 Rio de Janeiro-RJ, Brazil*

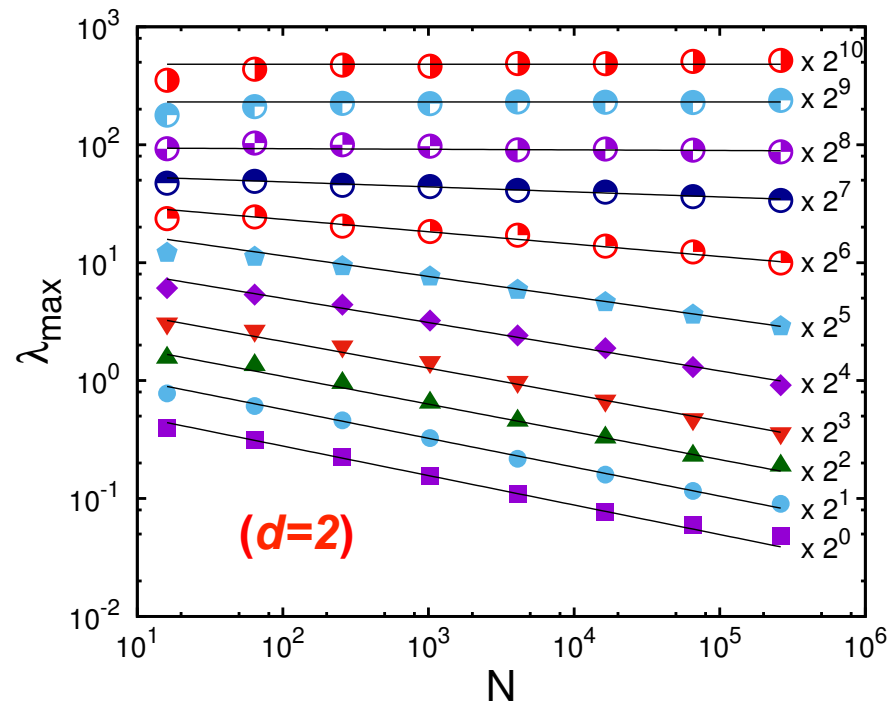
³ *Santa Fe Institute - 1399 Hyde Park Road, Santa Fe, NM 87501, USA*

$$\mathcal{H} = \frac{1}{2} \sum_{n=1}^N p_n^2 + \frac{1}{2} \sum_{n=0}^N (x_{n+1} - x_n)^2$$

$$+ \frac{b}{4\tilde{N}} \sum_{n=0}^N \sum_{m=n+1}^{N+1} \frac{(x_n - x_m)^4}{|n - m|^\alpha} \quad (b > 0; \alpha \geq 0)$$

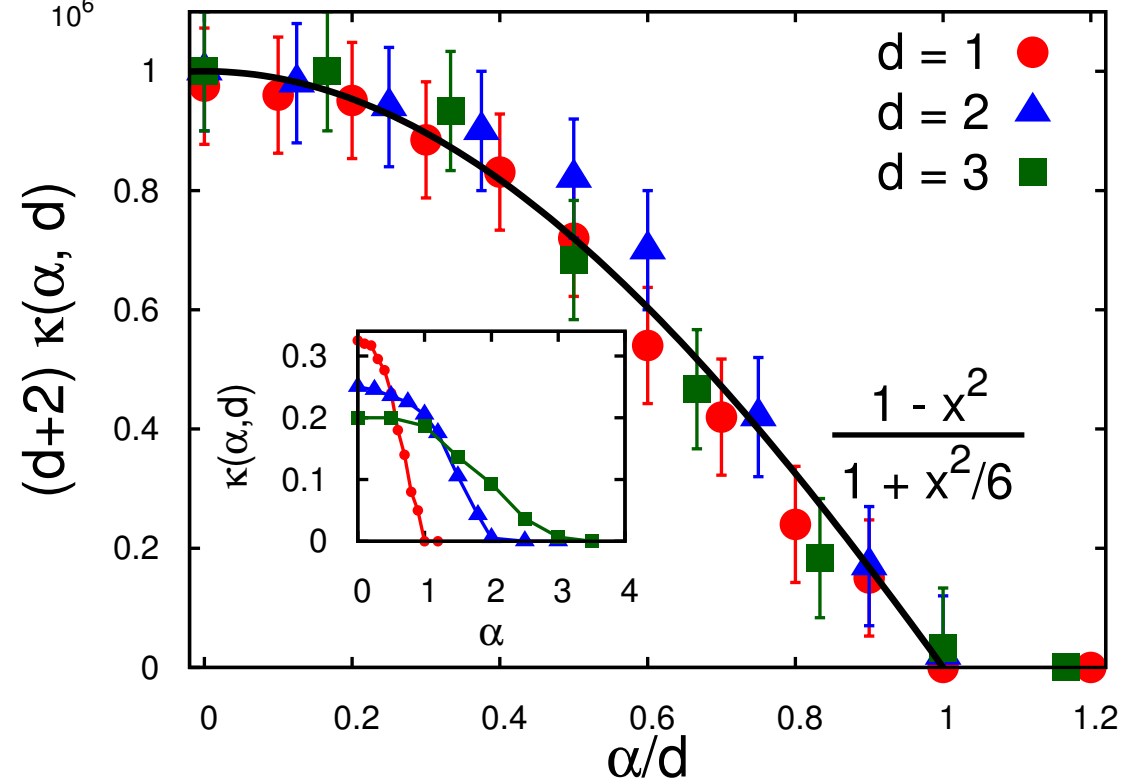
D. Bagchi and C. T.,
PRE **93**, 062213 (2016)

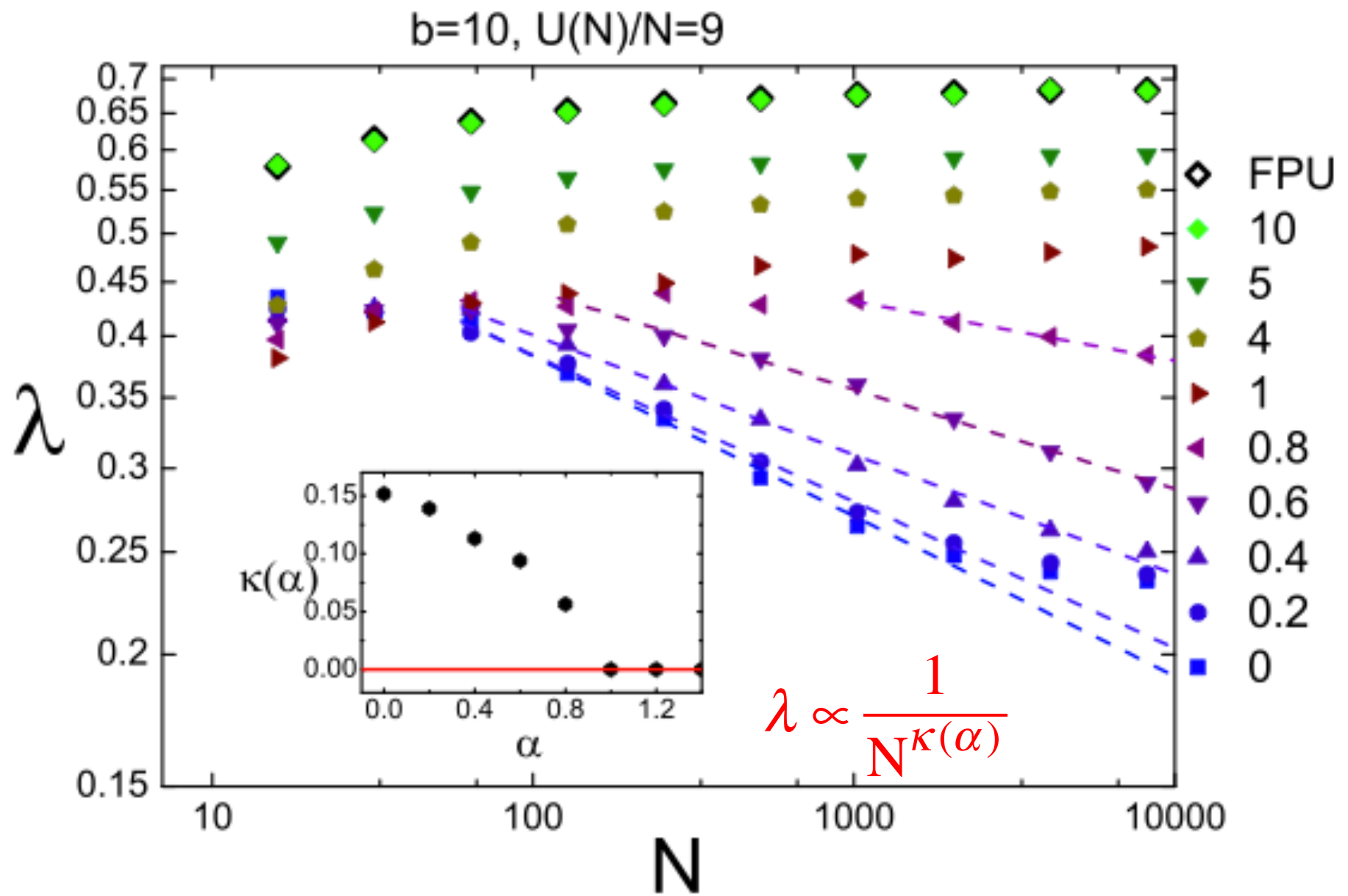
C. Anteneodo and C. T.,
PRL **80**, 5313 (1998)

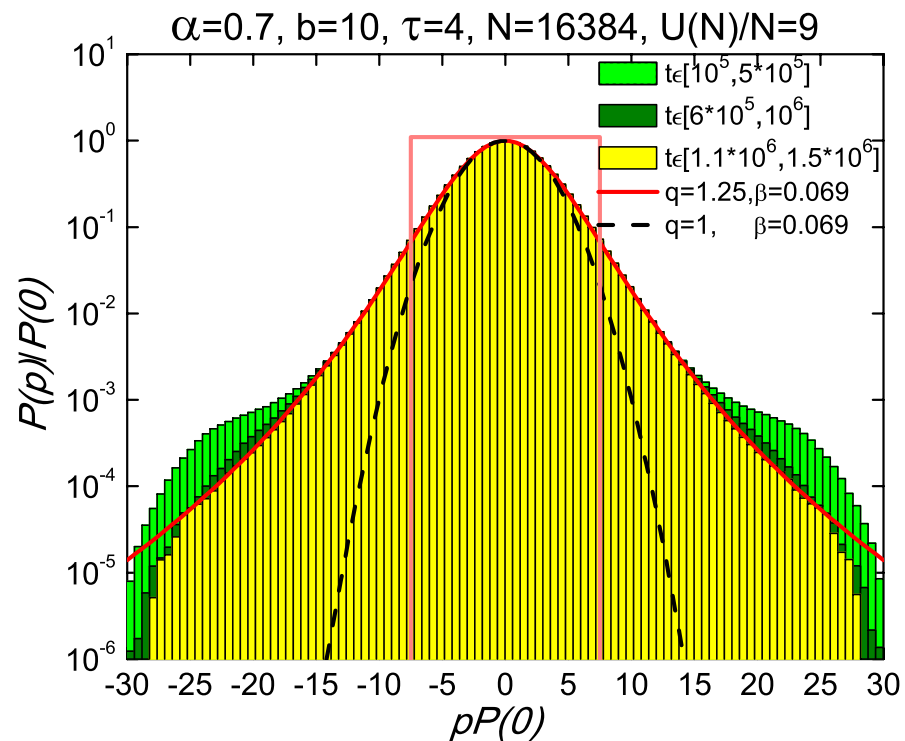


$$\lambda_{\max} \propto N^{-\kappa(\alpha, d)} \equiv L^{-d\kappa(\alpha, d)}$$

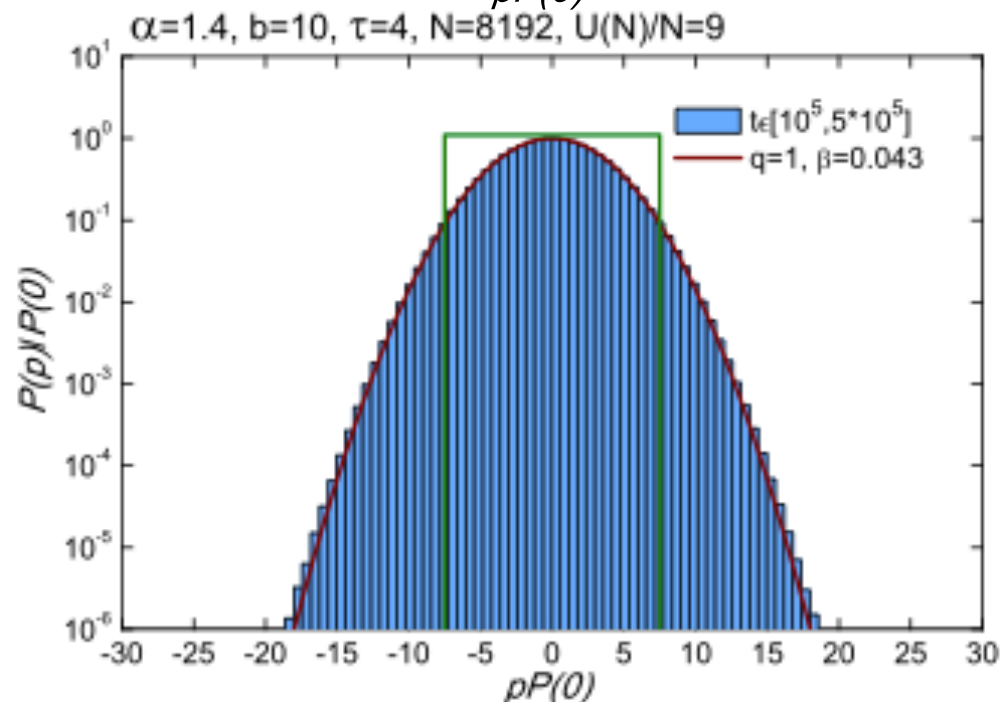
FPU model $\rightarrow 2dN$ degrees of freedom
whereas
XY model $\rightarrow 2N$ degrees of freedom



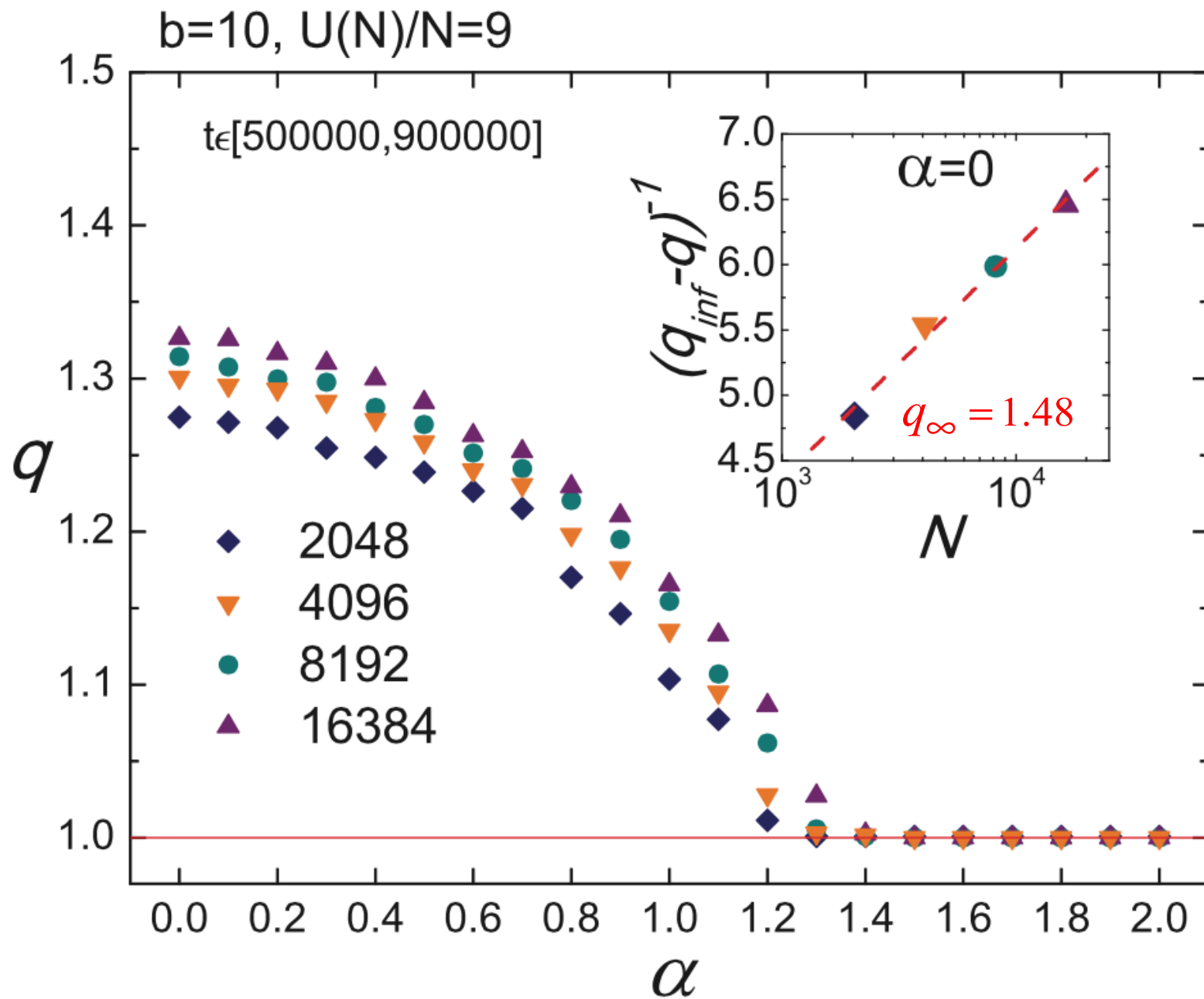




$\alpha = 0.7$
yields
 $q = 1.25$

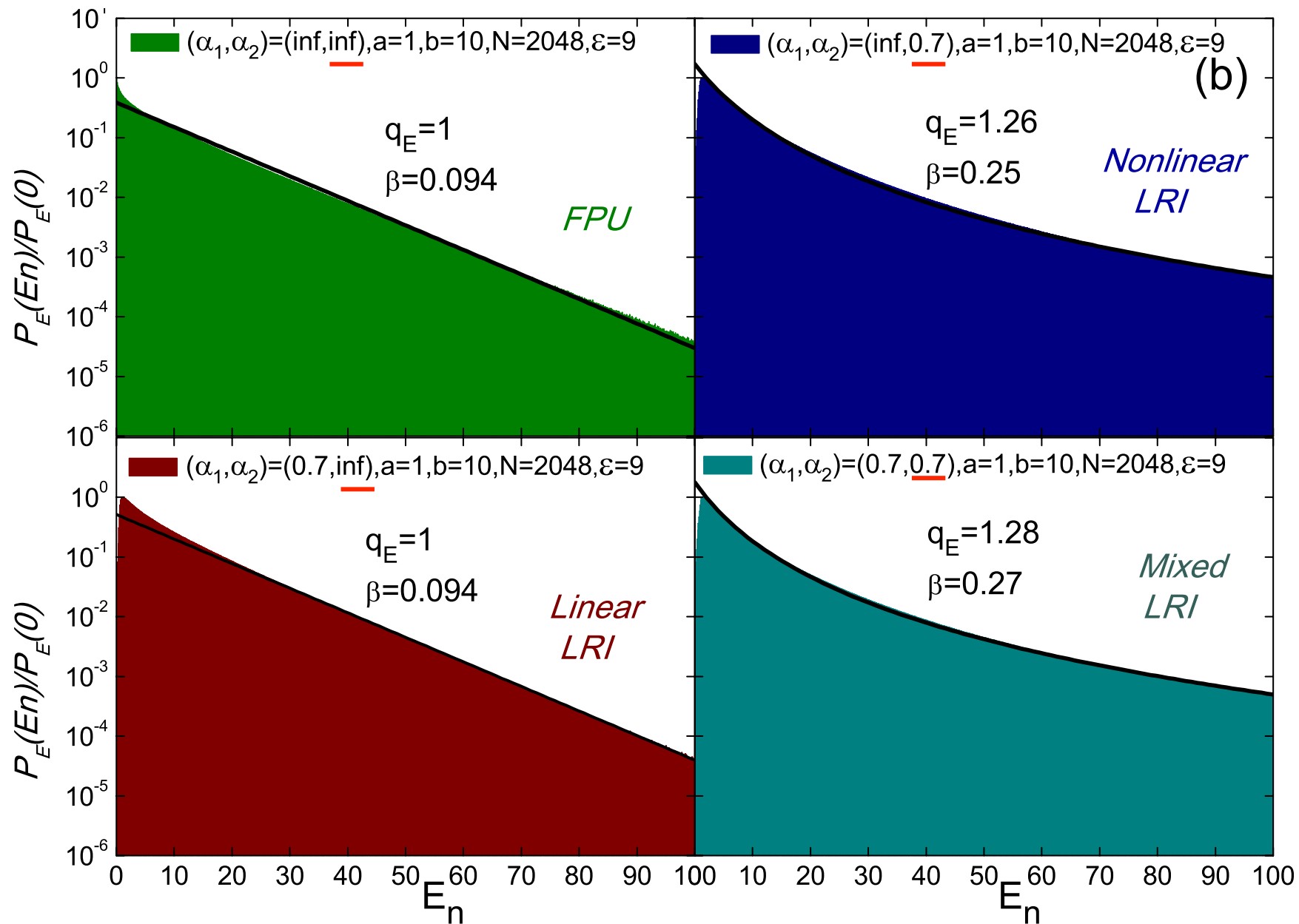


$\alpha = 1.4$
yields
 $q = 1$

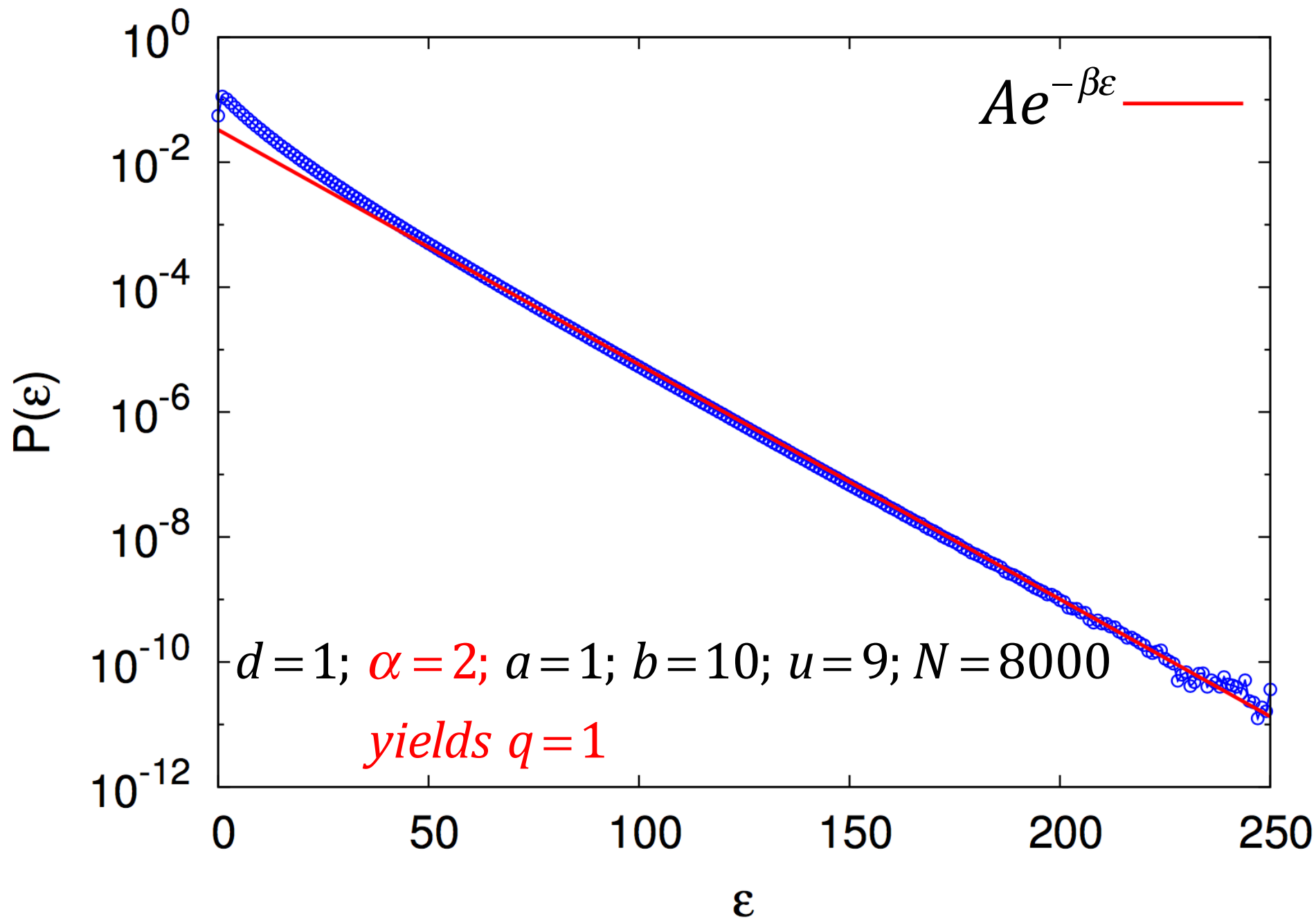


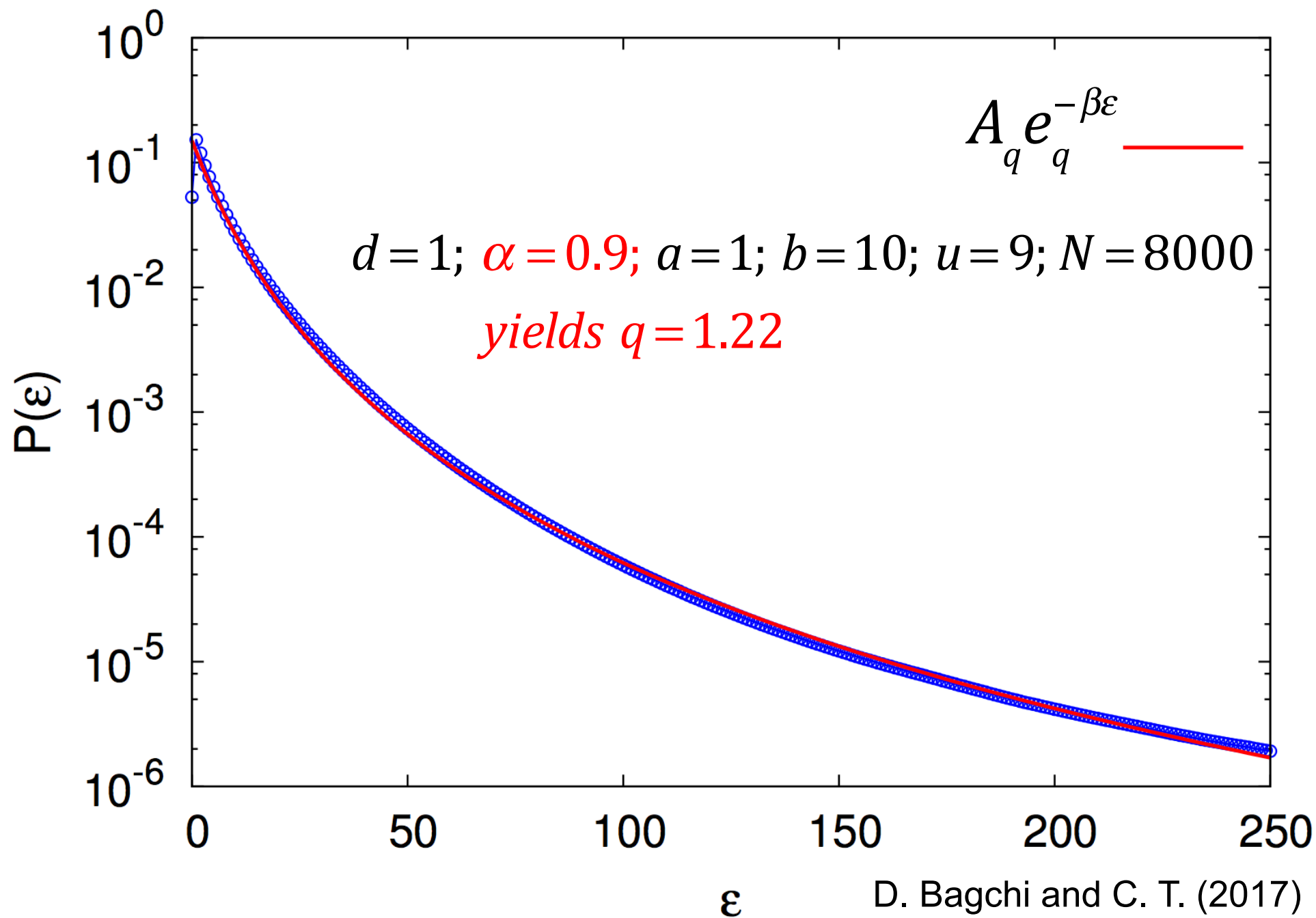
H. Christodoulidi, C. T. and T. Bountis, EPL **108**, 40006 (2014)

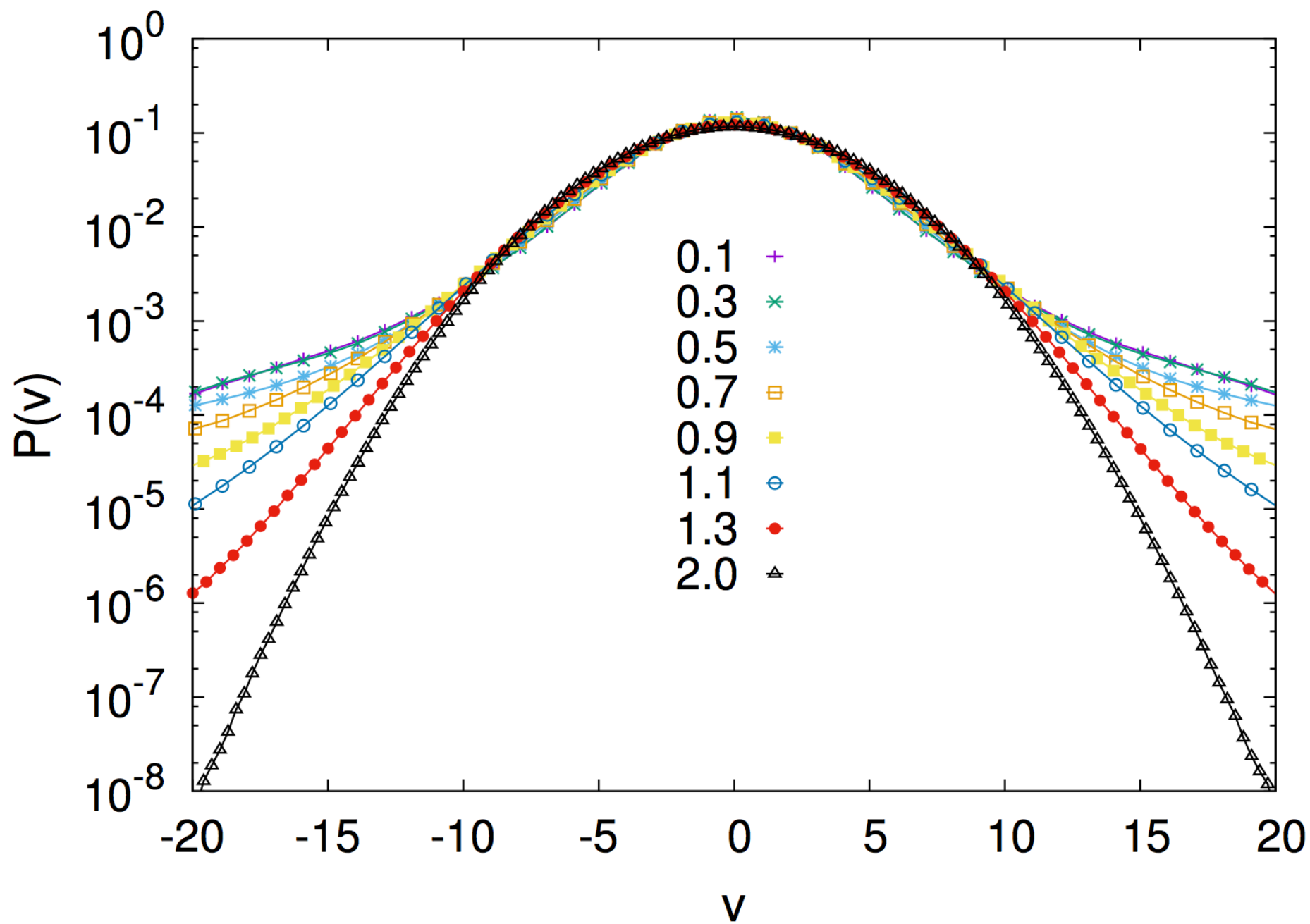
$$P(E)/P(0) = \left[1 - (1 - q_E)\beta E \right]^{\frac{1}{1-q_E}}$$

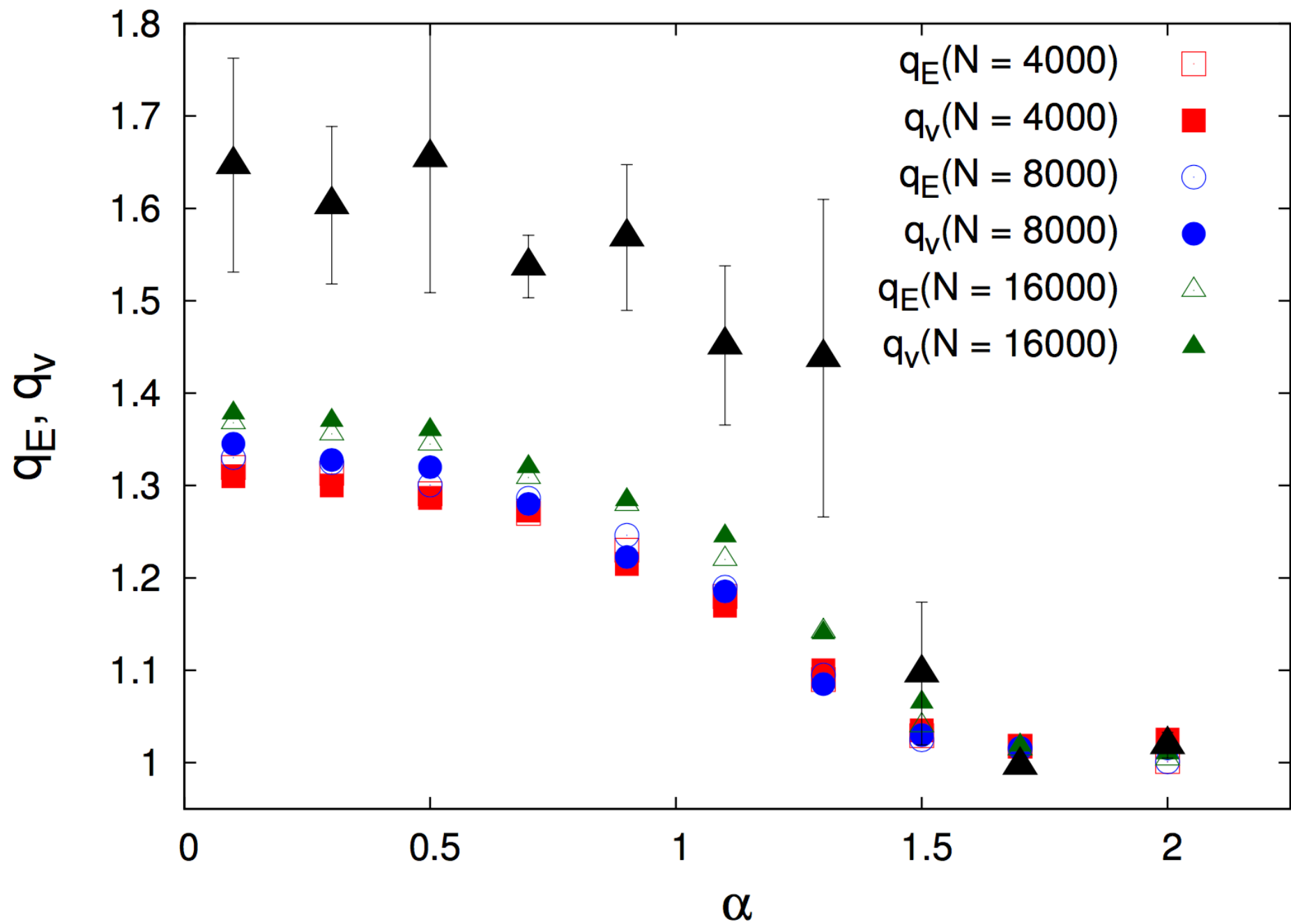


H. Christodoulidi, T. Bountis, C. T. and L. Drossos,
JSTAT 123206 (2016)









D. Bagchi and C. T. (2017)