Simulated quantum annealing of double-well and multiwell potentials

E. M. I., S. Pilati, Phys. Rev. E ***92****, 053304 (2015)*

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Motivations

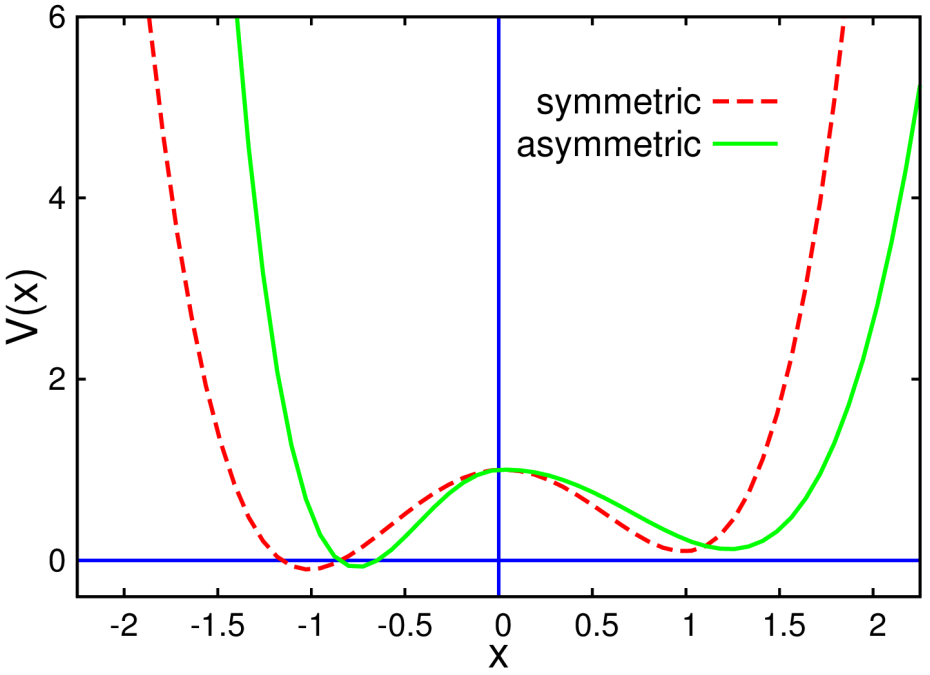
PIMC is the most popular *QMC* method that is used to implement simulated QA [1,2] on classical computers. However,

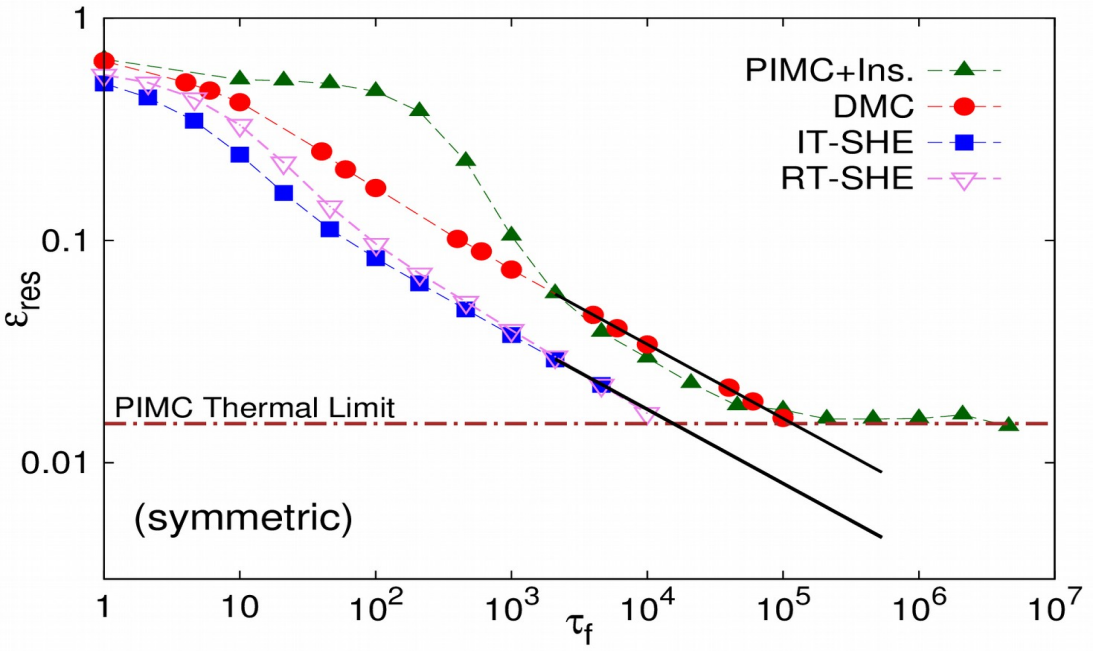
- Its has a *MC dynamics* that is not clearly related to dynamics of the Schrödinger equation(SHE).
- It has a *finite temperature* limitation.
- **Projective Monte-Carlo methods simulate the SHE in imaginary-time.**
- **It was conjectured that** $\varepsilon_{res}^{imaginary}(\tau_f) \leqslant \varepsilon_{res}^{real}(\tau_f)$ **[3,4].**

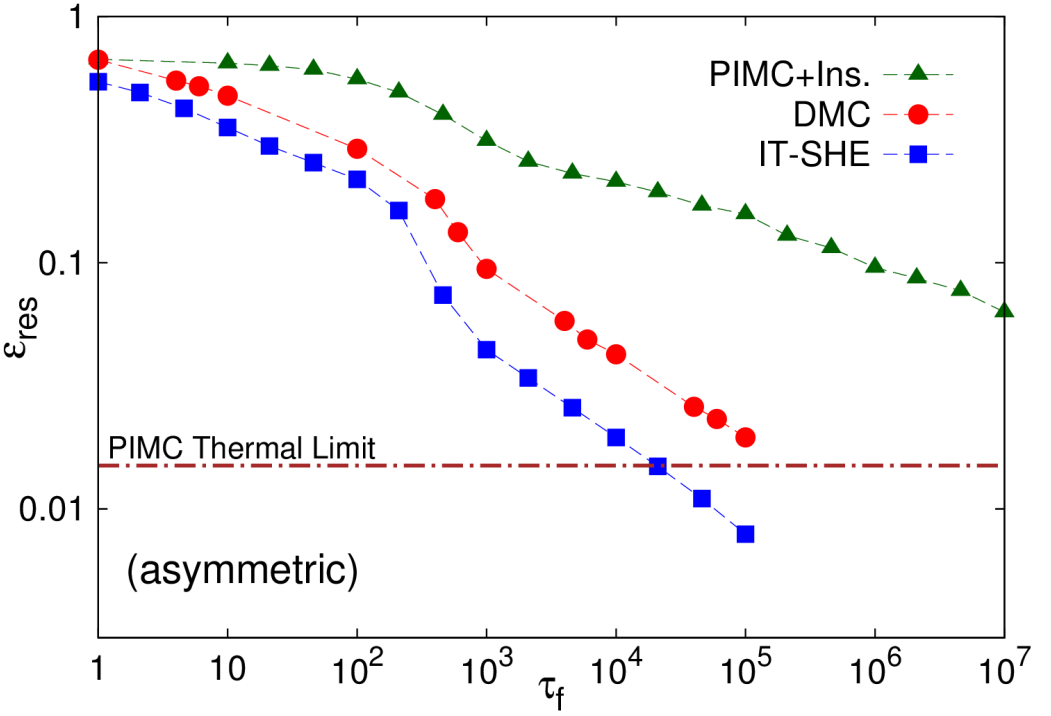
Could the Diffusion Monte Carlo simulate the imaginary-time dynamics of the SHE?

[1] G. E. Santoro, R. Martonak, E. Tosatti, and R. Car, Science 295, 2427 (2002)
[2] B. Heim, T. F. Rønnow, S. V. Isakov, and M. Troyer, Science 348, 215 (2015)
[3] L. Stella, G. E. Santoro, and E. Tosatti, Phys. Rev. B 72, 014303 (2005)
[4] S. Morita and H. Nishimori, J. Math. Phys. 49, 125210 (2008)

Double-well potentials







- **DMC performs asymptotically like deterministic IT-SHE**
- **DMC outperforms PIMC even with instanton move**

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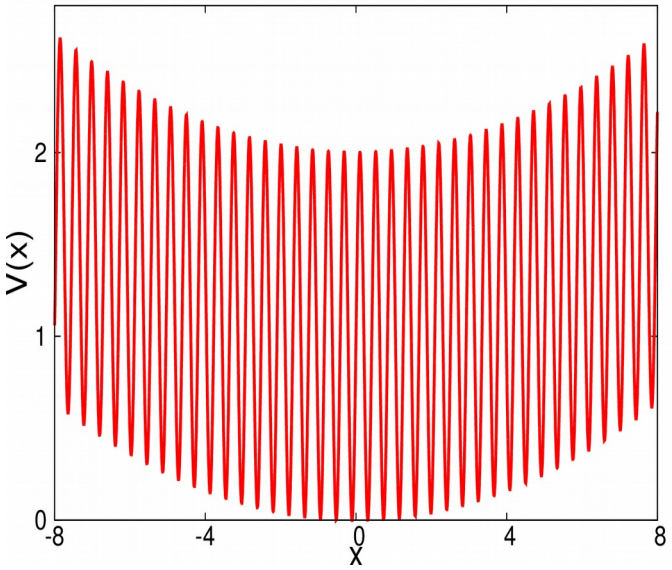
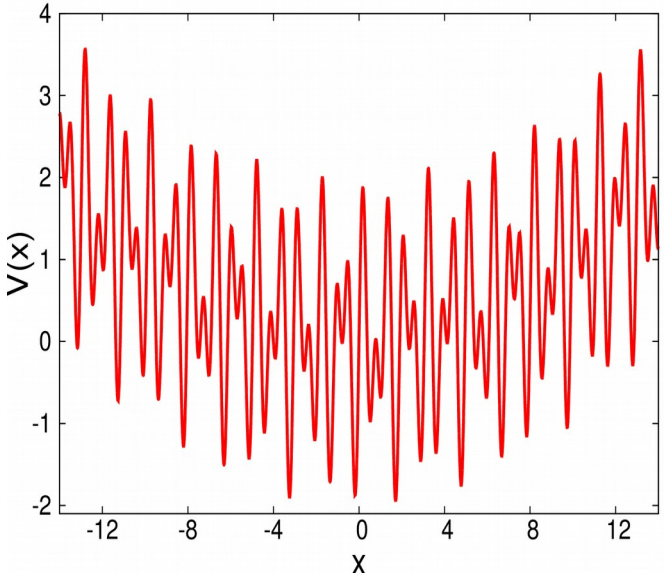
[5] Phys. Rev. B 72, 014303 (2005)
[6] Phys. Rev. B 73, 144302 (2006)

Multiwell potentials

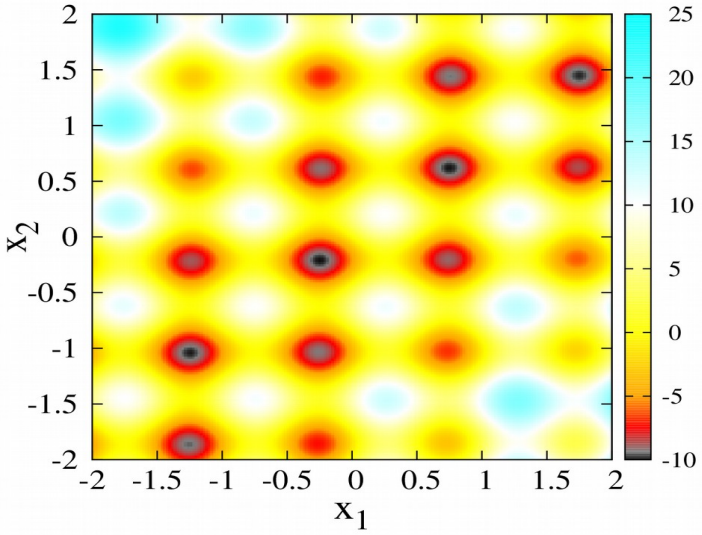
Washboard potential [7]



Quasi-disordered potential



2-particles potential

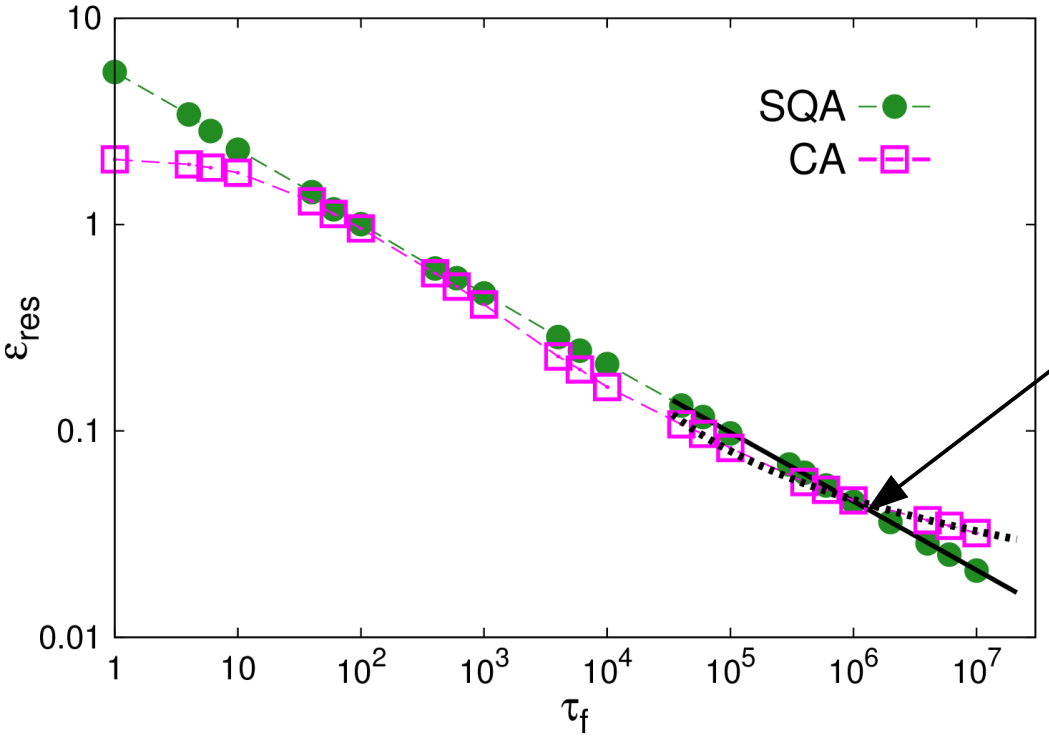


Complexity

- **Will DMC-QA keep stable performance?**
- **Can it outperforms CA?**

[7] Y. Kabashima and S. Shinomoto, J. Phys. Soc. Jpn. 60, 3993 (1991).

SQA vs CA



2-particles potential

$$\varepsilon_{res}^{SQA} \sim \tau_f^{-1/3}$$

$$\varepsilon_{res}^{CA} \sim \ln^{-1}(\tau_f)$$

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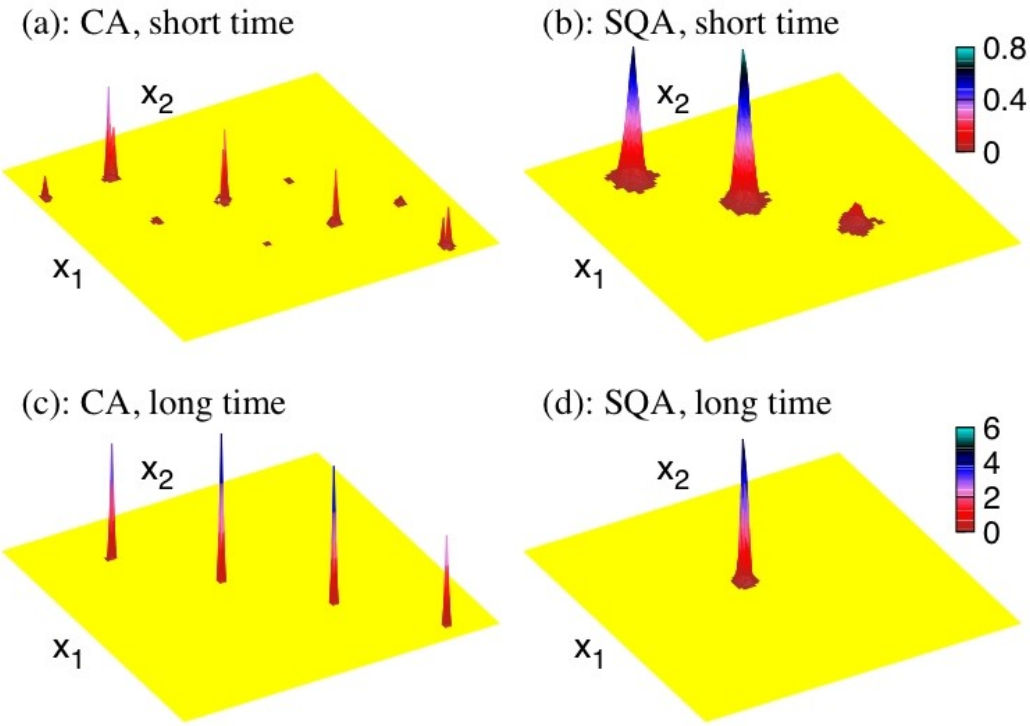
Simulated quantum annealing outperforms CA



Thanks for your attention!