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Erratum: Glassy Chimeras could be blind to quantum speedup: Designing better benchmarks for quantum annealing machines

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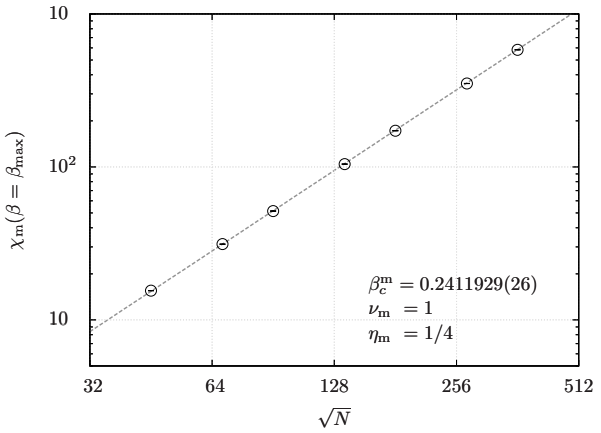

FIG. 1: Log-log plot of the FM susceptibility at its peaks $\chi_{\rm m}(\beta=\beta_{\rm max})$ as a function of the effective linear system size $\sqrt{N}$. The data fall onto a straight line, showing that corrections to scaling are very small. The dashed line has slope $2-\eta=7/4$.

In Ref. 1 (2014), Katzgraber *et al*. studied Ising spins on the Chimera topology [2] of the D-Wave Two quantum annealing machine both in the spin-glass (SG) as well as the ferromagnetic (FM) sector. For the simulations in the FM sector, the following critical parameters based on simulations of systems of up to $N=3200$ spins were computed: $\beta_c^{\rm m}=0.2402(3)$, $\nu_{\rm m}\approx 1$, and $\eta_{\rm m}\approx 2/5$. Here, $\beta_c^{\rm m}=1/T_c^{\rm m}$ is the inverse critical temperature, $\nu^{\rm m}$ the critical exponent of the FM correlation length, and $\eta^{\rm m}$ the critical exponent associated with the FM susceptibility. Using single-cluster updates [3], Monte Carlo simulations of up to $N=131\,072$ spins in the FM sector have been performed. A detailed finite-size scaling analysis of the specific heat, the magnetization, the susceptibility, and the Binder parameter and related cumulants, as well as three logarithmic derivatives of the magnetization together with an analysis of cross-correlations [4, 5] leads to the following estimates of the critical parameters: $\beta_c^{\rm m}=0.241\,1929(26)$, $\nu_{\rm m}=0.9980(15)$, and $\eta_{\rm m}=0.2513(14)$. Hence, the critical exponents of a FM Ising model on the Chimera lattice are in agreement with the exact values for the two-dimensional (2D) Ising model, namely $\nu_{\rm 2D}=1$ and $\eta_{\rm 2D}=1/4$ [6]. Therefore, both models share the same universality class [7]. Figure 1 illustrates the perfect agreement between our new simulations and the exact values. Plotted are the FM susceptibility at its maximum, i.e., for $\beta=\beta_{\rm max}(N)$, vs the number of spins, where $\chi_{\rm m}(\beta=\beta_{\rm max})\sim(\sqrt{N})^{2-\eta_{\rm m}}$. Indeed, the dashed line has slope $2-\eta_{\rm 2D}=7/4$ and is a guide to the eye. We would like to conclude by emphasizing the following points.

1. For the FM sector, only the critical exponent $\eta_{\rm m}$ is incorrect in Ref. [1], as well as the claim that the universality class of FM Ising models in 2D and on the Chimera topology might be different.
2. For the SG sector $\eta_{\rm q}=0$ or close to zero is plausible. However, simulations to verify this would be difficult.
3. The main conclusions of Ref. [1] remain unchanged.
4. We would like to caution researchers seeking quantum speedup based on systems with 512 qubits or less, because, while corrections to scaling are weak, they seem to persist up to large system sizes.

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[7] Yes, Peter, you were right.