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Magic state distillation with low overhead

SERGEY BRAVYI, IBM Watson Research Center

Most of error correcting codes used in fault-tolerant quantum computing permit an efficient implementation of high-fidelity encoded Clifford gates and Pauli measurements. On the other hand, implementation of encoded non-Clifford gates such as the $\pi/8$-rotation T usually requires distillation of certain quantum software states known as "magic states" and substantially increases the space and time overheads. To reduce the distillation overhead we propose a new family of stabilizer codes with an encoding rate $1/3$ that permit a transversal implementation of the T-gate on all logical qubits. The new codes are used to construct protocols for distilling high-quality magic states by Clifford group gates and Pauli measurements. The distillation overhead scales as $O(\log^{\gamma}(1/\epsilon))$, where ϵ is the output accuracy and $\gamma = \log_2(3) \approx 1.6$. Our techniques lead to a two-fold overhead reduction for distilling magic states with accuracy $\epsilon \sim 10^{-12}$ compared with the best previously known protocol.