A Bose-Einstein Condensate Computer

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What’s BEC?

In a BEC, the system has a large concentration of particles in the system ground state. Furthermore, due to bosonic final state stimulation, the speed of cooling is enhanced by a factor $N+1$, where there are $N$ particles in the final state.

A condensate is a new form of matter where all the particles sit in the same state. The graph above shows atoms at different temperatures, and below a critical temperature you can see all the atoms in the same place!

What do you mean by a “condensate”??

NP-complete problems as cost minimization

Example: The Graph Partitioning Problem (GPP) Given $2N$ points with arbitrary connections between them, divide the points into two groups (A and B) of $N$ points, minimizing the number of connections between them. Any kind of NP-complete problem can be formulated as GPP.

NP-complete problems can be typically formulated as a cost minimization problem.

Cooling to thermal equilibrium

Due to final state stimulation, the speed of cooling for large boson number is increased.

Direct Ising model simulation

Equilibration time for standard Ising model (above).

Speedups obtained using bosons for 2 and 4 site Ising models.

Conclusions

• Bosons speed up the equilibration time of the Ising model by final state stimulation. An enhanced ground state population is present due to bosonic statistics.
• The scaling with site number is probably a (large) constant, since no quantum coherence is present in the system. Introducing quantum coherence may help this.

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