Coherent network computing for the solution of hard optimization problems

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Mathematical optimizations



Computer science Enginee

Engineering

Economics

Physics

What can optics do?

In this talk

- How can we solve hard optimization problems using light?
- What are the experimental challenges?

Acknowledgements



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Optimizing spin orientations



What is the minimum energy?



Simulated annealing

T=0.0001





Spin glass simulator Coherent network computer

Coherent network computer (CNC)



- Qubits Spins Ising: $\phi_i \in \{+1, -1\}$ XY: $\phi_i \in [0; 2\pi)$
- Adjustable couplings J
- the CNC adjusts $\{\phi_i\}$ in order to minimize H

Towards all-optical CNC









Coherent Ising machine (Yamamoto) Coupled lasers (Davidson) Polariton BECs (Lagoudakis, Berloff) Photon BECs (Klaers)

BEC = Bose-Einstein condensate

Network of photon Bose-Einstein condensates



Experimental challenges



- Photon confinement in transverse plane
- Control of couplings between the photon BECs

How can we control the flow of light?



Mirror height profiles with atomic level precision



x (µm)

Thermo-responsive Josephson junction



Vretenar et al., Phys. Rev. Res. 3, 023167 (2021)

Photon density vs heating energy



Configurable 4-condensate system



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Dispersive vs dissipative coupling



Toebes et al., Commun. Phys. 5, 59 (2022)



Thank you for your attention.

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