Atomic vapors for optical neural networks

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We present a theoretical proposal and first experimental results towards an optical neural network that uses saturable absorption in atomic vapor to implement the nonlinear activation function. A remarkable property of this nonlinear unit is that it enables all-oprical training of the neural network through backpropagation. Simulations show that, with readily obtainable optical depths, our approach can achieve equivalent performance to state-of-the-art computational networks on image classification benchmarks, even in deep networks with multiple sequential gradient approximations. With backpropagation through nonlinear units an outstanding challenge to the field, this result provides a feasible path towards truly all-optical neural networks.

[1] James Spall, Xianxin Guo, Thomas D. Barrett, and A. I. Lvovsky, Fully reconfigurable coherent optical vector–matrix multiplication, Optics Letters 45, 5752-5755 (2020).
[2] Xianxin Guo, Thomas D. Barrett, Zhiming M. Wang, A. I. Lvovsky, End-to-end optical backpropagation for training neural networks, arXiv:1912.12256.