MAR15-2014-001388
Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Self-Configuring Universal Linear Optics[1]

DAVID MILLER, Stanford University

Until recently, it was not clear whether we could make or even design arbitrary linear optical devices or transforms on light fields. A single thin dielectric structure or meta material layer is not sufficiently general, for example [1]. The canonical arbitrary linear problem is to separate and separately modulate arbitrary overlapping orthogonal light beams at a given wavelength without fundamental loss and then transform them into other arbitrary orthogonal beams; such a mode conversion corresponds to multiplying by an arbitrary matrix, so solving this problem in general enables arbitrary linear transforms (unitary or non-unitary) [2]. Recently we showed constructively how to implement any such linear transform [3,4], thereby solving the design problem in principle. Furthermore, we showed that this could be done entirely by training a mesh of interferometers and modulators with desired inputs and outputs, without any calculations and without any calibration of components [3,4]. This approach relies on simple single-parameter feedback loops that minimize power on detectors, in completely progressive algorithms, and could be implemented in silicon photonics. It could solve practical problems such as separating spatial modes in telecommunications [5], automatically aligning beams [3], and finding optimal channels through scatterers [6]. It offers new possibilities for self-configuring and self-stabilizing optical systems, and could enable complicated optics, such as for quantum networks and information, well beyond current capabilities. One interesting open question is how to exploit such approaches with nanoscale optics.

[1] D. A. B. Miller, J. Opt. Soc. Am. A 30, 238-251 (2013)
[2] D. A. B. Miller, Opt. Express 20, 23985-23993 (2012)
[3] D. A. B. Miller, Opt. Express 21, 6360-6370 (2013)
[4] D. A. B. Miller, Photon. Res. 1, 1-15 (2013)
[5] D. A. B. Miller, Opt. Express 21, 20220-20229 (2013)
[6] D. A. B. Miller, J. Lightwave Technol. 31, 3987 – 3994 (2013)

[1]This project was supported by DARPA InPho program, and by MURI grants (AFOSR, FA9550-10-1-0264 and FA9550-09-0704).