Use of a Synchronized Laser Array as a Source for Quantum Communication*

Y. Braiman,[1] Y. Liu,[1] H. K. Liu,[1] J. Barhen,[1] R. E. Meyers,[2] and K. S. Deacon[2]

[1]Center for Engineering Science Advanced Research
Computer Science and Mathematics Division Computing and Computational Sciences
Directorate Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6355

[2]Army Research Laboratory
AMSRL-CI-CS
2800 Powder Mill Road
Adelphi, Maryland 20783

We describe applications of an array of high power semiconductor lasers to beam steering and optical switching. Our array consists of 19 high power semiconductor lasers (808 nm wavelength). Each laser is capable of emitting 1W of power. We have experimentally demonstrated injection locking of individual, multi-mode, broad-area laser diodes in a compact laser array (operated as slave lasers) with a single-mode laser diode (as the master) [1,2]. When injection locking occurs, most of the output power is emitted in one longitudinal mode. The stable phase relationship between the injection-locked lasers has been verified via interference patterns. A synchronized broad-area laser array (SBLA) can produce a highly coherent light source whose output intensity is proportional to the square of the number of lasers in the array. Therefore, high contrast optical intensity modulation can be achieved by utilizing the nonlinear response of the total output intensity to the injected light, resulting in fast optical switching. Another application of SBLA is as phased array antenna. The goal is to eliminate unwanted signals entering the SBLA's field of view, while enhancing reception in a certain direction. Beamforming algorithms for the SBLA are derived and the SNR for each wavefront is obtained using a spectral estimator.

Semiconductor laser array capability provides a unique opportunity, not only for free-space adaptive optical communication, but also for free-space quantum adaptive optical communications through the atmosphere. It is described how quantum communication which provides quantum ultra-security can take advantage of the fast optical switching in frequency or polarization to achieve gigahertz or faster rates, electronic steering for efficient tracking of satellites and mobile ad-hoc networks, and beam adaptation for turbulence compensation.

References

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