Stevens Institute of Technology

Nanotechnology Graduate Program

Synchronization and Coherence in Large Arrays of High Power Semiconductor Lasers

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Semiconductor lasers are most compact and have inherently the largest electrical-optical conversion efficiency over all types of coherent light sources. A stacked array of broad-area semiconductor lasers with an overall emission aperture size of a few square centimeters can readily provide kilowatts of output power. The limitation in the application of high-power broad-area semiconductor lasers is their poor beam quality and broad spectrum. Theoretical and numerical work revealed that coherent coupling of a phase-locked laser array results in a very high light intensity which is proportional to N2 where N is the number of the lasers in the array. However, laser array is a highly nonlinear system and possesses a variety of complex behavior. Moreover, semiconductor lasers in array are inherently disordered due to fabrication constrains and distribution of the injected current into lasers. Consequently, dynamics of high power lasers array is very complex and synchronization of laser array is very challenging. In our talk we will overview experimental designs for laser beam combining and discuss our experimental results on coherent beam combining of high power array consisting of 49 lasers and two arrays (98 lasers). Our results demonstrate coherent beam combining from an array of 49 broad area lasers as well as wavelength and frequency synchronization of two high power arrays. We will discuss theoretical aspects and experimental challenges to achieve an excellent beam quality while maintaining high power emission from the array.

Dr. Yehuda Braiman is a senior research staff at the Center for Engineering Science Advanced Research (CESAR), Computer Science and Mathematics Division at Oak Ridge National Laboratory and Professor (Adjunct) at the Department of Mechanical, Aerospace, and Biomedical Engineering, University of Tennessee, Knoxville. Dr. Braiman received his PhD at the Tel Aviv University in 1993. He has published over 50 refereed journal papers, conference proceedings, and book chapters in the fields of nonlinear dynamics and chaos control, synchronization and coherent beam combining in large high power arrays of lasers, dynamics of arrays of superconductive Josephson junctions, friction at the atomic scale, and fracture propagation at the nanoscale.

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