Presenter

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Abstract

Title: *Nonlinear Optics and Optomechanics using High-Q Micro-resonators*

After a brief discussion of nonlinear optical sources (Raman and Parametric) based on microtoroid resonators, recent results which use radiation pressure in these devices either to: (1) create micro-wave-rate mechanical oscillations or (2) cool the mechanical degree of freedom to cryogenic temperatures are overviewed. The implication of these results for new science is discussed. Also, the recent application of toroids for cavity QED on-a-chip experiments is briefly described.

Micro-toroid optical resonators on silicon [1] are finding a range of applications in basic science. Besides providing optical modes having Q factors as high as 500 million, these devices also exhibit high-Q mechanical modes. This added feature has provided access to a range of new opto-mechanical phenomena which are driven by radiation pressure. After describing the processing and passive optical properties of these devices, the consequences of resonant energy buildup in a microscale, ultra-high-Q system will be described. Beyond laser sources based on Raman and parametric oscillation [2], radiation pressure created by the high circulating power within the resonator couples the optical and mechanical degrees of freedom. Under appropriate conditions, this coupling leads to regenerative, mechanical-oscillation, up to microwave rates, which is driven solely by radiation pressure from a continuous-wave optical pump [3,4,5]. This phenomenon is a manifestation of a more general physical principle of dynamic back action [6], and has a counterpart in which cooling of the mechanical mode is possible [4,6]. Along with recent demonstrations in cantilevers [7,8], demonstration of radiation pressure cooling of a mechanical mode from room temperature to 11°K using a microtoroid resonator will be discussed [9]. Finally, the use of fiber-based couplers in these toroidal devices enables high coupling efficiencies [10]. This feature as well their high Q, low mode volume and wafer-based design make them interesting cavities for study of strong-coupling physics. We will describe the recent observation of strong coupling in collaboration with the Kimble group at Caltech [11].

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Biography

***DR. VAHALA** is Ted and Ginger Jenkins Professor of Information Science and Technology and Professor of Applied Physics at Caltech. He also received his Ph. D. (85) in Applied Physics at Caltech. His research on micro-resonators has led to wafer-based devices operating in the Q regime above 100 million and has also provided low-loss methods for coupling directly to optical fiber. These devices have enabled micro-scale Raman and Parametric sources as well as cavity QED on-a-chip systems. His current research is focused on a range of opto-mechanical phenomena associated with radiation pressure in microresonators. Vahala is a Fellow of the Optical Society of America, was the first recipient of the Richard P. Feynman Hughes Fellowship and has also received both the Presidential Young Investigator and Office of Naval Research Young Investigator Awards. He has been a topical editor for the Journal of the Optical Society of America and Photonics Technology Letters, and was program co-chair for CLEO 99 and General Chair for CLEO 2001. Vahala also co-founded, Xponent Photonics, a manufacturer of photonic access modules.*