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Superluminal ring laser as a Holy-Grail of precision metrology: Rotation sensing, accelerometry, fiber-optic sensing and gravitational wave detection

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A superluminal ring laser (SRL) is a laser in which the group velocity of light far exceeds, by a factor as large as a million, the vacuum speed of light, without violating special relativity or causality. This behavior results from the so-called fast light effect, corresponding to critically tuned anomalous dispersion. The anomalous dispersion is produced by adding inside the ring cavity an auxiliary medium that produces a narrow dip in the broad-band gain profile produced by the main gain medium. In an SRL, the change in the laser frequency, as a function of a change in the cavity length, is enhanced by a factor of nearly a million, when compared to that of a conventional ring laser. This effect can be used for enhancing the sensitivity of many devices, including a gyroscope, and accelerometer, and a fiber optic sensor. It can also be configured to realize a novel type of gravitational wave detector. We have realized an SRL using a buffer gas loaded Rb vapor cell, pumped on the D1 line, as the main gain medium, and an additional Rb vapor cell for producing the anomalous dispersion via Raman induced pump depletion. In this talk, the author will describe the behavior of this SRL, and outline the various applications we are pursuing, including rotation sensing and accelerometry for inertial navigation under GPS-denied conditions, and gravitational wave detection. He will also describe a fiber-optic based SRL, employing dual peaked Brillouin gain, for ultra-sensitive, general purpose fiber optic sensing.

Biography

Selim M Shahriar received his Undergraduate (Physics and EECS, 1986), Doctoral (EECS, 1991) degrees from MIT. He is Professor in the Dept. of Electrical Engineering and the Department of Physics and Astronomy, and the Director of the Solid State and Photonics Research Interest Group at Northwestern University, Evanston, IL. He has published 367 papers, including 114 in peer reviewed journal. He is a member of the LIGO Scientific Collaboration and a Fellow of OSA and SPIE.

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