Semiconductor Lasers with Optical Injection and Feedback & Secure Communication

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A crucial ingredient for secure communications using lasers is that messages can only be recovered if the *parameters* of the transmitter and the receiver lasers are well matched and stable. Control parameters are also key elements which when properly combined allow one to produce very specific number-theoretical situations which provide useful insight in dynamical systems. We found that the standard two-level continuous-time model of loss-modulated CO_2 lasers to display networks of self-similar stability domains known previously only in discrete-time models based on mappings. [PRL **95**, 143905 (2005)]. We already found that similar networks exist in the parameter space of optically injected semiconductor lasers. Such regular networks may severely compromise the efficiency of semiconductor lasers for secure communication.

Here, we describe a broad theoretical investigation of the occurrence of stability domains embedded in chaos in optically injected semiconductor lasers. We also describe intricacies observed in the parameter space of the harder problem of semiconductor lasers with optical feedback [PRE **82**, 037202 (2010)] and some related electric circuits [PRL **101**, 054101 (2008)]. We briefly digress briefly about an additional enticing open problem, namely the synchronization in networks of mutually coupled lasers and the systematic classification of all periodic oscillations in nonlinear oscillators [Phys. Chem. Chem. Phys. **83**, 441 & 12191 (2011)].