STEVENS Institute of Technology

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Seminar in Nonlinear Systems

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Domesticating Instabilities: The Case of Diode Lasers Subject to Delayed Feedback

Thursday, Sept 26, 2002
3:30 pm
Pierce 218

Abstract: Semiconductor lasers are critical components of a variety of modern photonic systems such as fiber and diode pumped solid state devices. However when they are subject to even small amounts of feedback or external injection from an external reflector or even a distant laser, then radiation emitted from diode lasers exhibits a plethora of instabilities and irregular chaotic transitions. Recent experiments in semiconductor lasers subject to optical feedback as well as experiments with pairs of mutually coupled diode lasers have renewed the interest to dissect these experiments with simple delay rate equations. We will review two novel cases. Diodes pumped close to threshold with long cavities and biased well above threshold with ultrashort cavities. When diode lasers are biased near threshold and subject to moderate optical feedback, low frequency fluctuations appear in their radio-frequency spectrum that are evident as dropout events in the intensity time traces. Traditionally these events were observed to occur at sporadic time intervals. However, recent experimental measurements have shown that there are regions of the pumping current where these events appear at regular time intervals. The case of ultrashort cavities presents us with similar but ultimately more dramatic phenomena, such as periodic self pulsations and high speed oscillations. Applications on laser bandwidth enhancement as well as optical generation of microwaves will be reviewed.