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Emission from Vertical-Cavity Surface-Emitting Lasers after Femtosecond Pulse Injection BOTAO ZHANG, Department of Physics & Astronomy, University of Pittsburgh, ALBERT HEBERLE, Department of Physics & Astronomy, Department of Electrical & Computer Engineering, University of Pittsburgh — Vertical-cavity surface-emitting lasers (VCSEL's) are important devices for optical communication and sensing. Many applications require single-mode operation, which can be achieved by suppressing multiple lateral modes with emission apertures of 10 micrometers or less and by restricting emission to one polarization by reduction of symmetry. Such single-mode lasers still can produce multi-mode emission when subject to high pump currents or high-frequency modulation. Here we will discuss the emission dynamics of single-mode VCSEL's after resonant optical injection of femtosecond pulses from a mode-locked Ti:sapphire laser. The VCSEL emission is time and polarization resolved by cross correlation on a nonlinear optical crystal. This all-optical technique gives access to the VCSEL dynamics without limitation from electronics. Our measurements show dynamics in the 10 GHz range stemming from ordinary and from polarization relaxation oscillations. Interference beats above 100 GHz show the importance of dynamic multi-mode behavior. The decay of these beats gives direct information on the roundtrip gain of the dynamically excited modes. Polarization resolved measurements show the feasibility of polarization switching on a subpicosecond time scale.

Botao Zhang
Department of Physics & Astronomy, University of Pittsburgh

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