VECTORSIONAL CHAOS SYNCHRONIZATION AND POLARIZATION ENCODING IN SELF-PULSATING VCSELS

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The synchronization properties of chaotic systems have received much attention in the last decade motivated by the application in secure optical communications systems \cite{1}. To this purpose, also the polarization of the laser light revealed to be useful \cite{2}. We show that self-pulsating Vertical-Cavity Surface-Emitting lasers (VCSELS) can exhibit vectorial chaos, i.e. chaos in both intensity and polarization. We consider a Continuous Control synchronization Scheme (CCS), schematically shown in Fig. 1 and we assume that the Master (M) and Slave (S) systems are twin systems (same values of all parameters). Increasing the attenuation coupling $\Gamma$ over a certain critical value $\Gamma_c$, the trajectories of the M and S systems synchronize. We propose a novel information encoding scheme, where the phase of the vectorial field is modulated while the average total intensity is kept constant, exploiting the polarization degree of freedom. Our scheme represents a possible generalization of the previously developed Chaos Shift Keying (CSK) encryption systems \cite{3}.In our approach, the total intensity of the two VCSELS remains synchronized while the intensities in the polarization modes (de)synchronize following the phase modulation(Fig. 2). The message can be recovered by detecting the two linearly polarized components of the outcoming field (Fig. 3). Previous CSK systems were limited by the relaxation oscillation frequency, while our technique allows, in principle, for transmission of secure data at bit-rates attaining 100 Gbit/sec, since the Mean Synchronization Time (Fig. 4) is about 1.3 ps.

\textbf{FIG. 1.} Synchronization scheme.

\textbf{FIG. 2.} Polarization resolved return map.

\textbf{FIG. 3.} Message recovering

\textbf{FIG. 4.} Mean Synchronization Time

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