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Synchronization patterns of an experimental ring of coupled optoelectronic oscillators

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Abstract—We experimentally study the complex dynamics of a unidirectionally coupled ring of four identical optoelectronic oscillators. The coupling between these systems is time-delayed in the experiment and can be varied over a wide range. We observe that as the coupling delay is varied, the system may show different synchronization states, including complete isochronal synchrony, cluster synchrony, and a splay-phase state. We are interested in understanding how these different states may emerge as the delay is varied. We analyze the stability problem through a master stability function approach, which we show can be effectively applied to all the different states observed in the experiment, including cluster synchrony and splay-phases. Our analysis points out the existence of multistability in the system. Our theoretical approach can be easily generalized to rings of arbitrary length and possibly bidirectional coupling.