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Synchronization of Degrade-and-Fire Oscillations in Synthetic Gene Circuits

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This talk reviews our recent work on the synchronization of synthetic gene oscillators operating in the degrade-and-fire regime. Computational modeling and theoretical analysis show that the key mechanism of oscillations is a small delay in the negative feedback loop. In a strongly nonlinear regime, this time delay can lead to long-period oscillations in gene expression that can be characterized by “degrade and fire” dynamics. I will present experimental, analytical, and computational results for the intra-cellular as well as population-wide synchronization when oscillators are coupled either by common protease enzymes or by coupling the oscillators to a quorum sensing machinery that produces chemical inducers freely diffusing through cell membranes.