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Queueing-Based Synchronization and Entrainment for Synthetic Gene Oscillators[1] WILLIAM MATHER, NICHOLAS BUTZIN, PHILIP HOCHENDONER, CURTIS OGLE, Dept. of Physics, Virginia Polytechnic Inst. and State University — Synthetic gene oscillators have been a major focus of synthetic biology research since the beginning of the field 15 years ago. They have proven to be useful both for biotechnological applications as well as a testing ground to significantly develop our understanding of the design principles behind synthetic and native gene oscillators. In particular, the principles governing synchronization and entrainment of biological oscillators have been explored using a synthetic biology approach. Our work combines experimental and theoretical approaches to specifically investigate how a bottleneck for protein degradation, which is present in most if not all existing synthetic oscillators, can be leveraged to robustly synchronize and entrain biological oscillators. We use both the terminology and mathematical tools of queueing theory to intuitively explain the role of this bottleneck in both synchronization and entrainment, which extends prior work demonstrating the usefulness of queueing theory in synthetic and native gene circuits. We conclude with an investigation of how synchronization and entrainment may be sensitive to the presence of multiple proteolytic pathways in a cell that couple weakly through crosstalk.

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