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Reading Assignment 1

The Strogatz & Stewart paper discussed several applications of the coupled oscillator. The first notice of coupled oscillators began with Huygens noticing his pendulum clocks spontaneously synchronizing their rhythms. Mathematicians are now able to apply the coupled oscillator model to many different phenomena in the natural world. One example is a cloud of fireflies which, after some time has gone by, will all flash in unison with one another. Another example of coupled oscillation may be found in the pacemaker cells and how they are able to all operate in sync with the rest of the heart tissue. Coupled oscillation shows up even in everyday tasks. The opposing oscillations of one's legs walking, and the four coupled oscillations from a dog or cat are both good examples.

The paper titled "Synchronization of Pulse-Coupled Biological Oscillators" by Mirollo and Strogatz (1990) outlines a model by which pulse-coupled biological oscillators synchronize. This is to say, the method and system by which oscillating systems influenced by the systems around them, tend to synchronize over time. This mechanism is governed by the idea that a pulse oscillator, a system which "builds up" and then releases something at regular intervals, can be influenced by the buildups and releases around them. If an adjacent unit reaches its release point, then this gives a small boost to all the others around them. Over time, these small boosts cause each unit to reach its buildup with the same frequency and timing, thus synchronizing the units. The authors provide a proof of this result, which is outside the scope of this assignment.

Mathematical modeling has found connections between areas of science often though of as remote. Where is the obvious connection between pendulum clocks and heart cells? Modeling was able to shed light on their shared dynamic of coupled oscillation. Were it not for the models developed to describe two clocks synchronizing while on a wall, physicians might very well not understand the dynamics of the heart. Such modeling has led to a number of insights. For example, consider oscillators which have a wide range of possible frequencies. These systems tended to delve into chaos rather than develop spontaneous synchronicity. As it turns out, this same mechanism could be applied to modeling the decay of electrostatic waves in very thin plasma.