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Parabolic and irregular bursting in GnRH neurons: A modeling investigation

The release of gonadotropin-releasing hormone (GnRH) by synchronized GnRH neurons is required for fertility in all vertebrates of both sexes. The pulsatile release of this hormone has been hypothesized to depend on the intrinsic electrical activities of these neurons, which includes two endogenous modes of action potential burst firing: the parabolic and irregular bursting. The first mode is characterized by a slow wave in membrane potential that can underlie periodic clusters of action potentials with a spike-frequency that is parabolic (i.e., biphasic), whereas the second is characterized by clusters of action potentials that are separated by varying durations of interburst intervals and a relatively stable baseline potential. We have recently developed a stochastic Hodgkin-Huxley type model to explain how each mode of burst firing is produced based on differences in ion channel conductances. In this talk, I will present this model and demonstrate its agreement with experimental data. I will then show, using bifurcation analysis, that although the two modes of burst firing differ in their burst characteristics, they are both topologically equivalent, and that the latter exhibits more sensitivity to noise because it is closer to the firing threshold (a SNIC bifurcation).