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The Morris Lecar neuron model gives rise to the Ornstein-Uhlenbeck leaky integrate-and-fire model

We analyse the stochastic-dynamical process produced by the Morris Lecar neuron model, where the randomness arises from channel noise. Using multi-scale analysis, we show that in a neighborhood of the stable point, representing quiescence of the neuron, this two-dimensional stochastic process can be approximated by an Ornstein-Uhlenbeck modulation of a constant circular motion. The firing of the Morris Lecar neuron corresponds to the Ornstein-Uhlenbeck process crossing a boundary. This result motivates the large amount of attention paid to the Ornstein-Uhlenbeck leaky integrate-and-fire model. A more detailed picture emerges from simulation studies.