Resonance of coefficient of variation induced by rebound currents for stochastic inhibitory inputs

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We study a Hodgkin-Huxley type neuron model describing the firing properties of an endogenously oscillating subthalamic neuron [1] incorporating a low-voltage activated (T-type) calcium current when the cell is affected by random alpha function inhibitory inputs (frequency, λ). The postinhibitory rebound current (parameterized by its maximal conductance, G_T) caused by the brief inputs can induce output spikes in response to two or more coincident arrivals or even a single strong enough inhibitory arrival [2]. Thus the output firing sequence becomes random, while the firing rate increases with λ. For small G_T, the coefficient of variation (CV) of the output spike sequence also increases with λ, but when the rebound is strong, the CV exhibits an unexpected and prominent local maximum at a preferred input frequency. At the preferred frequency, the firing rate has a maximum slope. Weaker input amplitudes can increase the preferred frequency, but the cell's firing rate, at the preferred λ, is independent of the input strength. This phenomenon may be useful in characterizing and identifying cells [3] that receive complex pattern of inhibitory inputs like those in subthalamic nucleus with T-type calcium currents [4].

References

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