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Neural Phase Oscillators Incorporating Noise and Correlated Sources of Heterogeneity

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The underlying mechanisms of how cortical networks process stimuli can be challenging, especially due to the stochastic and heterogeneous characteristics of neurons. To address this complexity, phase oscillators have proven useful for capturing information about neurological systems, especially as the models incorporate an experimentally measurable entity. To this end, the various forms of heterogeneity of neural attributes have been seen to significantly impact neural processing. Incorporating both intrinsic and network sources of heterogeneity, we study the population firing rate statistics in a coupled network of phase models. The relationship between these two forms of heterogeneity can lead to significant differences in the firing rate distribution. Our analytic theory captures the shape of the firing rate distribution and reveals how the interaction between intrinsic and network heterogeneity produces varying firing rate distributions. We are also able to validate this theory at a high-dimensional level, which allows us to evaluate our theory's applicability in excitatory networks, inhibitory networks, and joint excitatory-and-inhibitory networks.