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Sommario/riassunto	Long description: This work aims to contribute to our understanding of the effects of noise and non-uniform interactions in populations of oscillatory units. In particular, we explore the collective dynamics in various extensions of the Kuramoto model. We develop a theoretical framework to study such noisy systems and we show through many examples that indeed new insights can be gained with our method. The first step is to coarse-grain the complex networks. The oscillatory units are then characterized solely by their individual quantities, so that identical units can be grouped together. The second step consists of the ansatz that in all these groups the distributions of the oscillators' phases follow time-dependent Gaussians. We apply this analytical two-step method to oscillator networks with correlations between coupling strengths and natural frequencies, to populations with mixed positive and negative coupling strengths, and to noise-driven active rotators, which can perform excitable dynamics. We calculate the rich phase diagrams that delineate the emergent rhythms. Extensive numerical simulations are performed to show both the validity and the limitations of our theoretical results.