Optimal oscillator mobility for synchronization arising from the gradual recovery of oscillator coupling

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Systems of moving oscillators that can interact between them are common in nature and in artificial systems. Previous theoretical works have shown that faster movement favors synchronization across populations of coupled oscillators[1–3]. An important assumption in these studies is that oscillators can immediately interact with their new neighbors after arriving at a new location. However, restoring coupling may not be instantaneous, an example being cellular systems where intercellular interactions may need some time to become fully established. How movement affects synchronization in this situation has not been examined. Here, we develop a coupled phase oscillator model in which we consider oscillator movement and the gradual recovery of coupling experienced by an oscillator after movement, characterized by a moving rate and a coupling recovery rate, respectively[4]. We find (1) an optimal moving rate for synchronization and (2) a critical moving rate above which achieving synchronization is not possible. These results indicate that the extent to which movement enhances synchrony is limited by a gradual recovery of coupling, suggesting that the ratio of time scales of movement and signaling recovery is critical for information transfer between moving oscillators.

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