Thermodynamic uncertainty relation of interacting oscillators in synchrony

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The thermodynamic uncertainty relation sets the minimal bound of the cost-precision trade-off relation for dissipative processes. Examining the dynamics of an internally coupled system that is driven by a constant thermodynamic force, we however find that the trade-off relation of a sub-system is not constrained by the minimal bound of conventional uncertainty relation. We made our point explicit by using an exactly solvable model of interacting oscillators. As the number (N) of interacting oscillators increases, the uncertainty bound of individual oscillators is reduced to $2k_BT/N$ upon full synchronization under strong coupling. The cost-precision trade-off for the sub-system is particularly relevant for sub-cellular processes where collective dynamics emerges from multiple energy-expending components interacting with each other.

† S. Lee, C. Hyeon and J. Jo, arXiv:1804.10362 (2018).