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A recurrence network approach to analyzing forced synchronization in hydrodynamic systems[1] MEENATCHIDEVI MURUGESAN, YUAN-HANG ZHU, LARRY K.B. LI, Hong Kong University of Science and Technology — Hydrodynamically self-excited systems can lock into external forcing, but their lock-in boundaries and the specific bifurcations through which they lock in can be difficult to detect. We propose using recurrence networks to analyze forced synchronization in a hydrodynamic system: a low-density jet. We find that as the jet bifurcates from periodicity (unforced) to quasiperiodicity (weak forcing) and then to lock-in (strong forcing), its recurrence network changes from a regular distribution of links between nodes (unforced) to a disordered topology (weak forcing) and then to a regular distribution again at lock-in (strong forcing). The emergence of order at lock-in can be either smooth or abrupt depending on the specific lock-in route taken. Furthermore, we find that before lock-in, the probability distribution of links in the network is a function of the characteristic scales of the system, which can be quantified with network measures and used to estimate the proximity to the lock-in boundaries. This study shows that recurrence networks can be used (i) to detect lock-in, (ii) to distinguish between different routes to lock-in, and (iii) as an early warning indicator of the proximity of a system to its lock-in boundaries.

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