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Tipping in Ecological Systems Driven by Periodic Climate Variability

Tipping points refer to abrupt, substantial, and often irreversible transitions in dynamic systems that can be triggered by minor perturbations. Four tipping mechanisms are recognized: bifurcation-induced tipping (B-tipping) focusing on the magnitude of changes, rate-induced tipping (R-tipping) focusing on the rate of changes, noise-induced tipping (N-tipping) emphasizing the role of randomness or noise, and phase-induced tipping (P-tipping) highlighting the timing or phase of changes. In this talk, I will introduce another plausible way to trigger sudden shifts: a deterministic system can be driven to a tipping point by periodic external forcing inputs whose amplitude never crosses the critical threshold.