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Driven Phases of Quantum Matter VEDIKA KHEMANI, Harvard Univ, CURT VON KEYSERLINGK, Princeton University, ACHILLEAS LAZARIDES, RODERICH MOESSNER, Max Planck Institute, SHIVAJI SONDHI, Princeton University — Clean and interacting periodically driven quantum systems are believed to exhibit a single, trivial "infinite-temperature" Floquet-ergodic phase. By contrast, I will show that their disordered Floquet many-body localized counterparts can exhibit distinct ordered phases with spontaneously broken symmetries delineated by sharp transitions. Some of these are analogs of equilibrium states, while others are genuinely new to the Floquet setting. I will show that a subset of these novel phases are *absolutely stable* to all weak local deformations of the underlying Floquet drives, and spontaneously break Hamiltonian dependent *emergent* symmetries. Strikingly, they simultaneously also break the underlying time-translation symmetry of the Floquet drive and the order parameter exhibits oscillations at multiples of the fundamental period. This "time-crystallinity" goes hand in hand with spatial symmetry breaking and, altogether, these phases exhibit a novel form of simultaneous long-range order in space and time. I will describe how this spatiotemporal order can be detected in experiments involving quenches from a broad class of initial states.

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