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Direct control of transitions between different mode-locking states of a fiber laser[1] FATIH ILDAY, TESFAY TEAMIR, ROMAN IEGOROV, GHAITH MAKEY, Bilkent University — Mode-locking corresponds to a far-from-equilibrium steady state of a laser, whereby extremely short pulses can be produced. Capability to directly control mode-locking states can be used to improve laser performance with numerous applications, as well as shed light on their far-from-equilibrium physics using the laser as an experimental platform. Here, we demonstrate direct control of the mode-locking state using spectral pulse shaping by incorporating a spatial light modulator at a Fourier plane inside the cavity of an Yb-doped fiber laser. We show that we can halt and restart mode-locking, suppress instabilities, induce controlled reversible and irreversible transitions between mode-locking states, and perform advanced pulse shaping on pulses as short as 40 fs. This capability can be used to experimentally investigate bifurcations, reversible and irreversible transitions, by selecting, steering, and even competing various mode-locking states. Such studies can explore collective dynamics of dissipative soliton molecules, and ultimately test emerging theories about far-from-equilibrium physics, where there is an acute lack of experimental systems that are sufficiently well controlled.

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