

# **Controlling nonlinear dynamics of complex lasers**

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Nonlinear light-matter interactions induce irregular pulsations and filamentation in high-power multi-mode lasers. To control the nonlinear interactions between the lasing modes and the gain material, we manipulate the spatial structure of cavity resonances and vary their characteristic length scales. By tailoring the cavity geometry of a broad-area laser, we are able to disrupt the coherent nonlinear processes that form self-organized structures and cause temporal instabilities. With spatio-temporal instabilities suppressed, we utilize the spatio-temporal interference of numerous lasing modes to achieve massively-parallel ultrafast random bit generation with a chip-scale laser diode.