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Origins of Chaos in Autonomous Boolean Networks[1] JOSHUA SOCOLAR, HUGO CAVALCANTE, DANIEL GAUTHIER, RUI ZHANG, Physics Department, Duke University — Networks with nodes consisting of ideal Boolean logic gates are known to display either steady states, periodic behavior, or an ultraviolet catastrophe where the number of logic-transition events circulating in the network per unit time grows as a power-law. In an experiment, non-ideal behavior of the logic gates prevents the ultraviolet catastrophe and may lead to deterministic chaos. We identify certain non-ideal features of real logic gates that enable chaos in experimental networks. We find that short-pulse rejection and the asymmetry between the logic states tends to engender periodic behavior. On the other hand, a memory effect termed "degradation" can generate chaos. Our results strongly suggest that deterministic chaos can be expected in a large class of experimental Boolean-like networks. Such devices may find application in a variety of technologies requiring fast complex waveforms or flat power spectra. The non-ideal effects identified here also have implications for the statistics of attractors in large complex networks.

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