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Fractional dynamics of complex networks MALGORZATA TURALSKA, Duke University, BRUCE J. WEST, Army Research Office — The relation between the behavior of a single element and the global dynamics of its host network is an open problem in the science of complex networks. Typically one attempts to infer the global dynamics by combining the behavior of single elements within the system, following a bottom-up approach. Here we address an inverse problem. We show that for a generic model within the Ising universality class it is possible to construct a description of the dynamics of an individual element, given the information about the network's global behavior. We demonstrate that the individual trajectory response to the collective motion of the network is described by a linear fractional differential equation, whose analytic solution is the Mittag-Leffler function. This solution is obtained through a subordination procedure without the necessity of linearizing the underlying dynamics, that is, the solution retains the influence of the nonlinear network dynamics on the individual. Moreover the solutions to the fractional equation of motion suggest a new direction for designing control mechanisms for complex networks. The implications of this new perspective are explored by introducing a control signal into a small number of network elements and analyzing the subsequent change in the network dynamics.

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