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Stability of Zero-Sum Games in Evolutionary Game Theory JOHANNES KNEBEL, TORBEN KRUEGER, MARKUS F. WEBER, ERWIN FREY, Ludwig-Maximilians University Munich — Evolutionary game theory has evolved into a successful theoretical concept to study mechanisms that govern the evolution of ecological communities. On a mathematical level, this theory was formalized in the framework of the celebrated replicator equations (REs) and its stochastic generalizations. In our work, we analyze the long-time behavior of the REs for zero-sum games with arbitrarily many strategies, which are generalized versions of the children's game Rock-Paper-Scissors.[1] We demonstrate how to determine the strategies that survive and those that become extinct in the long run. Our results show that extinction of strategies is exponentially fast in generic setups, and that conditions for the survival can be formulated in terms of the Pfaffian of the REs' antisymmetric payoff matrix. Consequences for the stochastic dynamics, which arise in finite populations, are reflected by a generalized scaling law for the extinction time in the vicinity of critical reaction rates. Our findings underline the relevance of zero-sum games as a reference for the analysis of other models in evolutionary game theory.

[1]J. Knebel, T. Krueger, M.F. Weber, E. Frey, Phys. Rev. Lett. 110, 168106 (2013).

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