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Stability of cycles in a game of Rock-Scissors-Paper-Lizard-Spock

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Abstract

We study a system of ordinary differential equations in \mathbb{R}^5 that is used as a model both in population dynamics and in game theory, and is known to exhibit a heteroclinic network formed by three types of elementary heteroclinic cycles. We show the asymptotic stability of the network for parameter values in a range compatible with the two interpretations of the equations. We obtain estimates of the relative attractiveness of each one of the cycles by computing their stability indices. For the parameter values ensuring the asymptotic stability of the network we show that if one of the cycles has a weak form of attractiveness, then the other two are completely unstable. We also show the existence of an open region in parameter space where all three cycles are completely unstable and the network is asymptotically stable, giving rise to intricate dynamics that has been observed numerically by other authors.

Keywords: heteroclinic cycle, heteroclinic network, asymptotic stability, essential asymptotic stability, fragmentary asymptotic stability, Rock-Scissors-Paper-Lizard-Spock game

AMS classification: 34C37, 34A34, 37C75, 91A22, 92D25

1. Introduction