Zero Eigenvalue Analysis for the Determination of Multiple Steady States in Reaction Networks

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A chemical reaction network can admit multiple positive steady states if and only if there exists a positive steady state having a zero eigenvalue with its eigenvector in the stoichiometric subspace. A zero eigenvalue analysis is proposed which provides a necessary and sufficient condition to determine the possibility of the existence of such a steady state. The condition forms a system of inequalities and equations. If a set of solutions for the system is found, then the network under study is able to admit multiple positive steady states for some positive rate constants. Otherwise, the network can exhibit at most one steady state, no matter what positive rate constants the system might have. The construction of a zero-eigenvalue positive steady state and a set of positive rate constants is also presented. The analysis is demonstrated by two examples.

Key words: Reaction Network; Multiple Steady States; Zero Eigenvalue Analysis.

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