Application of Quotient Rings for Stability Analysis in Chemical Systems

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Concepts from algebraic geometry (polynomial rings) can be used to determine analytically the stationary solutions in chemical reactions systems, more generally, systems of ordinary differential equations of polynomial form. The stability analysis via the Jacobian matrix often leads to complicated expressions which can hardly be analyzed. It is shown that these expressions can be simplified by forming quotient rings of the corresponding polynomial ring. The coefficients in the characteristic equation of the Jacobian can be represented by the normal forms obtained by generating the quotient rings so that their sign changes in dependence of a kinetic parameter and, hence, the stability can be determined. The procedure is illustrated using a well-known surface reaction.