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Routes to Chaos: from Period-Adding to Period-Doubling
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Abstract:

We report experiments on the chaotic behaviour in the oscillatory peroxidase-oxidase reaction, where horseradish peroxidase catalyzes the oxidation of NADH by molecular oxygen. The study of chaotic behaviour often involves the determination of the "route to chaos", i. e. the sequence of dynamical states that lead from a periodic to a chaotic state as one parameter is varied. The route to chaos provides information about the mechanism of the reaction. However, only a limited number of routes to chaos are known so far.

The dynamic states of the reaction were studied as the average concentration of NADH is changed. We determined the routes to chaos for the peroxidase-oxidase reaction. The system follows a period-adding route to chaos (period-1 -> period-2 -> period-3 -> period-4 -> period-5 -> ... -> chaos) when carried out at pH 6.3, while it follows the period-doubling route to chaos (period-1 -> period-2 -> period-4 -> period-8 -> ... -> chaos) when carried out at pH 5.1. All other parameters were the same in the different runs of the experiments, except the pH value. We explored the transition from the period-adding to the period-doubling route by determining the routes to chaos at intermediate pH values.