Information geometrical entropy production decompositions in chemical reaction networks

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Recently, information geometry has emerged as a framework to naturally connect the geometries appearing in the theory of chemical reaction networks (CRNs) to their inherent thermodynamical [1] and dynamical properties [2,3,4].

The classical Legendre duality in chemical thermodynamics between the spaces of chemical concentrations and potentials, which is induced by the convex potential functions, leads to a pair of dually flat Riemannian manifolds [1].

This talk will be focused on the dynamical aspects which are described by attaching vector bundles of flux and force vectors to the concentration and potential spaces [2]. The essence of the information geometrical framework is that these two bundles, again, constitute dually flat Riemannian manifolds, whereby the Legendre duality is induced by dissipation functions which are obtained from macroscopic fluctuation theory [5].

By applying generalized notions of orthogonality in information geometry, two decompositions of the entropy production rate are obtained, each of which captures gradient-flow and minimum-dissipation aspects in nonequilibrium dynamics [3]. Furthermore, it is shown how the framework naturally fits the thermodynamic uncertainty relations for CRN [6] into a geometrical perspective as a comparison of Riemannian metric tensors. From this, another information geometrical entropy production rate decomposition is derived [4].

References

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