Conservation and entropy-inspired Lyapunov functions
for positive polynomial systems

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Two partially overlapping class of positive polynomial systems, chemical reaction networks with mass action law (MAL-CRNs) and quasi-polynomial systems (QP systems) are considered. Both of them have an entropy-like Lyapunov function associated to them which are similar but not the same. Inspired by the work of Prof. Gorban on the entropy-functionals for Markov chains [1], and using results on MAL-CRN theory we characterize non-linear MAL-CRNs and QP systems that enable both types of entropy-like Lyapunov functions.

The starting point of the analysis is the class of linear weakly reversible MAL-CRNs that are mathematically equivalent to Markov chains with an equilibrium point where Kullback-Leibler divergence and the relative Burg entropy as generalized entropies (that are entropy level set equivalent) correspond to the two entropy-like Lyapunov functions.

Using translated X-factorable phase space transformations and nonlinear variable transformations, dynamically similar nonlinear MAL-CRNs and QP systems will be associated to the linear weakly reversible MAL-CRNs, and the level set equivalence of the above two generalized entropies will be investigated under these transformations.

[1] A. N. Gorban, P. A. Gorban, G. Judge: Entropy: the Markov ordering approach. Entropy, 2010, 12, 1145-1193.