NIM Guest Lecture

"Thermodynamics of information and its application to biochemical signal transduction"

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Abstract: In this decade, thermodynamics of information has attracted renewed attentions [1] because of the progress in both theory and experiment. This topic is related to the foundation of the second law of thermodynamics, and dates back to the thought experiment of "Maxwell's demon" in the nineteenth century. Modern theoretical works have revealed the quantitative role of information in the second law under measurement and feedback.

In this talk, I will discuss our recent results on thermodynamics of autonomous information processing. First, I will show that the second law of thermodynamics is generalized in the presence of complex information flow, where the transfer entropy (i.e., a quantitative measure of information flow) and the thermodynamic entropy production are treated on an equal footing [2]. Next, I will show that the generalized second law is useful to characterize the robustness of adaptation process of E. Coli chemotaxis [3]. We found that the transfer entropy characterizes the upper bound of the robustness, and that signal transduction inside E. Coli cell is efficient as an information-thermodynamic device, while it is dissipative as a conventional heat engine.

[1] J. M. R. Parrondo, J. M. Horowitz, & T. Sagawa, Nature Physics 11, 131-139 (2015).
[2] S. Ito & T. Sagawa, Physical Review Letters 111, 180603 (2013).
[3] S. Ito & T. Sagawa, Nature Communications 6, 7498 (2015).