中国科学院数学与系统科学研究院
Academy of Mathematics and Systems Science, CAS

生物信息学研究中心

Center of Bioinformatics

学术报告

题　　目： Emerging of Stochastic Dynamical Equalities and Steady State Thermodynamics from Darwinian Dynamics

报告人： **敖平　教授**

上海交通大学系统生物医学院

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摘　　要：

The evolutionary dynamics first conceived by Darwin and Wallace, referring to as Darwinian dynamics in the present paper, has been found to be universally valid in biology. The statistical mechanics and thermodynamics, while enormous successful in physics, have been in an awkward situation of wanting a consistent dynamical understanding. Here we present from a formal point of view an exploration of the connection between thermodynamics and Darwinian dynamics and a few related topics. We first show that the stochasticity in Darwinian dynamics implies the existence temperature, hence the canonical distribution of Boltzmann–Gibbs type. In term of relative entropy the Second Law of thermodynamics is dynamically demonstrated without detailed balance condition, and is valid regardless of size of the system. In particular, the dynamical component responsible for breaking detailed balance condition does not contribute to the change of the relative entropy. Two types of stochastic dynamical equalities of current interest are explicitly discussed in the present approach: One is based on Feynman–Kac formula and another is a generalization of Einstein relation. Both are directly accessible to experimental tests. Our demonstration indicates that Darwinian dynamics represents logically a simple and straightforward starting point for statistical mechanics and thermodynamics and is complementary to and consistent with conservative dynamics that dominates the physical sciences. Present exploration suggests the existence of a unified stochastic dynamical framework both near and far from equilibrium.

敖平，1983 年获北京大学物理学学士。1985 年获美国伊利诺大学香槟分校(University of Illinois at Urbana-Champaign, UIUC)物理学硕士。1990 年获 UIUC 物理学博士学位，导师为诺贝尔奖获得者 Prof. A. J. Leggett。1990-1994 年在美国华盛顿大学(University of Washington)物理系从事博士后研究，合作导师为美国科学院院士 Prof. D. J. Thouless。1994-2000 年任瑞典 Umea 大学物理系副教授。2000-2003 年任西雅图的美国系统生物学研究所(United States Institute for Systems Biology)高级研究科学家及访问教授，与研究所创始人之一美国科学院院士 Leory Hood 进行合作研究。2003-2008 年任华盛顿大学机械工程系副教授。2008 年回国任上海交通大学系统生物医学院特聘教授, 973 肥胖症项目首席科学家。