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Statistical Mechanics and Thermodynamics of Viral Evolution
BARBARA JONES, JAMES KAUFMAN, IBM Research – Almaden — Using methods drawn from physics we study the life cycle of viruses. We analyze a model of viral infection and evolution using the "grand canonical ensemble" and formalisms from statistical mechanics and thermodynamics. Using this approach we determine possible genetic states of a model virus and host as a function of two independent pressures–immune response and system temperature. We show the system has a real thermodynamic temperature, and discover a new phase transition between a positive temperature regime of normal replication and a negative temperature "disordered" phase of the virus. We distinguish this from previous observations of a phase transition that arises as a function of mutation rate. From an evolutionary biology point of view, at steady state the viruses naturally evolve to distinct quasispecies. The approach used here could be refined to apply to real biological systems, perhaps providing insight into immune escape, the emergence of novel pathogens and other results of viral evolution.

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