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The dynein molecular motor and non-thermal equilibrium statistical physics

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10 am, IPGG amphi, 6 rue Jean Calvin, Paris 5

By Steven Chu,
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The transport of molecular cargos in neuronal cells is analyzed in the context of new developments in statistical physics. Our development of very bright optical probes enabled the long-term single tracking of molecular cargos in live neurons for tens of minutes. Our probes allowed individual molecular steps to be resolved at cellular ATP concentrations (three orders of magnitude higher than the in vitro studies) and led to a new, detailed quantitatively falsifiable chemo-mechanical model where two ATP molecules are hydrolyzed sequentially. The number of dynein motors transporting a cargo was found to switch stochastically from one to up to five motors during the journey from the distal axon to the cell body. The Fluctuation Theorem (FT) is used to show that the motion can be described by an effective temperature, T_{eff} as high as $T_{cell} = 30 \times 310\ K$, and an intuitive understanding of meaning of T_{eff} will be given. FT also sets a lower limit to the heat entropy that must be supplied to achieve a given precision in any physical operation. In the context of intercellular molecular transport, a smaller statistical variance in the displacement of the cargo vesicle demands a greater expenditure of energy.

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