Contribution ID: **101** Type: **not specified**

Thermodynamic limits of sperm swimming precision.

Wednesday, 21 December 2022 09:30 (30 minutes)

I will briefly review the simplest thermodynamic uncertainty relation (TUR) and then I will show how it applies to the beating of a sperm's flagellum. Experiments show that the maximum precision is 10^(-2) s^(-1) which is of the same order of the maximum precision of each of the N \sim 10^5 dynein molecular motors that actuate the flagellum. For a molecular motor the TUR bound is almost saturated, this means that for the whole flagellum, that consumes N times the power of a single motor, the TUR largely overestimate the precision. Additional experiments however demonstrate that when the power consumption decays (e.g. under oxygen deprivation) the precision decays according to the TUR. These observations suggest a scenario where the dynamics of the N motors is highly coordinated, the motors fluctuations are correlated and the whole flagellum inherits their low precision. I will conclude showing how a well established model for active flagellar beating can be modified to incorporate the correlation ingredient, reproducing the observed experimental behavior.

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Session Classification: Session 9