Physical Sciences Seminar

Force generation and force sharing by elastically coupled molecular motors

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Many active cellular processes such as organelle transport, spindle organization, and beating of flagella and cilia are driven by molecular motors kinesin, dynein and myosin. These motor proteins can act collectively to generate large forces, as in the large-scale organization of the mitotic spindle by kinesin and dynein, and the role of myosin during actomyosin contraction. Forces generated by different types of motors can increase additively or sub-additively with increasing motor number, depending on the motor type. Both experimentally and theoretically, however, the underlying mechanism of force generation and force sharing by ensembles of motors remains controversial. Here we address this issue by introducing a theoretical model for cargo transport by elastically coupled molecular motors. We outline the collective force generation profiles of different types of motors and show that the variation in these profiles is mainly determined by the difference in the detachment rates of single motors. We find that motors with a high stall force value cooperate more poorly than weak motors due to an increased probability of strain-induced unbinding events from the filament. Forces generated by weak motors, on the other hand, can even increase super-additively with increasing motor number for motors with low force-dependent unbinding rates or for fast and weak motors. We compare our theoretical results with experimental data on kinesin-1 and illustrate that its sub-additive force generation profile arises from strain-induced unbinding and not from unequal force sharing between the individual motors.

Tuesday, July 3, 2018 04:00pm - 05:15pm
Meeting room 1st floor / Central Bldg. (I01.1OG - Zentralgebäude)

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