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Remote control of molecular motors using light-activated gearshifting

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Engineering molecular motors with dynamically controllable properties will allow selective perturbation of mechanical processes in vivo and provide sophisticated components for directed nanoscale transport in vitro. We previously constructed myosin motors that respond to a change in [Ca++] by reversing their direction of motion along the polarized actin filament [1]. To expand the potential applications of controllable molecular motors, we have now developed myosins that shift gears in response to blue light illumination. Light is a versatile control signal that can be readily modulated in time and space, and is generally orthogonal to cellular signaling. Using structure-guided protein engineering, we have incorporated LOV photoreceptor domains into the lever arms of chimeric myosins, resulting in motors that robustly speed up, slow down, or switch directions upon illumination. These genetically encoded motors should be directly deployable inside living cells. Our successful designs include constructs based on two different myosin classes, and we show that optical velocity control can be implemented in motors that move at microns/sec speeds, enabling practical biological and bioengineering applications.

[1] Chen, L., Nakamura, M., Schindler,T.D., and Bryant Z. (2012). Nat. Nanotechnol. 7, 252-6.