Triplet Spin State Dependent Signal Transduction in Light-Oxygen-Voltage Sensitive Receptors

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Abstract:

How proteins transduce environmental signals such as light, stress or magnetic field vectors into responses, including mechanical and fluorescence, that activates subsequent actions remains a central and elusive question in biology. Flavin containing photoreceptors such as light-oxygen-voltage (LOV) sensitive proteins and cryptochromes are central to environmental signal entrainments across all kingdoms of life. I will discuss the molecular basis of light activation of light-oxygen-voltage (LOV) sensitive protein variants that elicit transduction of blue light excitation to mechanical energy or magnetic field dependent fluorescence, depending on the action of the excited triplet state formed upon light activation that serves as a central, spin state-dependent, molecular switch. Our study using electron and nuclear magnetic resonance spectroscopy of the mechano-responsive AsLOV2 protein shows hydration water as an active medium that drive long-range conformational changes to achieve efficient light-to-work signal transduction. We suggest that the magnetic field dependent fluorescent variant, MAGLOV, decouples the excited state triplet from engaging in mechanical movement and gives rise to a long-lived triplet state or charge transfer. In order to achieve direct detection and control over initialization of the excited state triplet in the ms=0, -1 or 1 spin sub-state, my group is building dual electron and nuclear magnetic resonance instrumentation at 7 T and 2K to initialize the electron spin population in a near pure state (99.7%) and to study the spin-dependent triplet state action center in “slow motion” by cryogenic cooling.