Contribution ID: **243** Type: **Oral Presentation**

Controlling light harvesting with light

Tuesday, 4 July 2017 10:00 (40 minutes)

When exposed to intense sunlight all organisms performing oxygenic photosynthesis implement various photoprotective strategies to prevent potentially lethal photodamage. The rapidly responding photoprotective mechanisms, occurring in the light-harvesting pigment-protein antennae, take effect within tens of seconds, while the dramatic and potentially harmful light intensity fluctuations manifest also on shorter timescales. Here we show that upon illumination, individual phycobilisomes from Synechocystis PCC 6803, which in vivo under low-light conditions harvest solar energy, have the inbuilt capacity to switch rapidly and reversibly into light-activated energy-dissipating states. Simultaneously measured fluorescence intensity, lifetime and spectra, compared with a multi-compartmental kinetic model, revealed that essentially any subunit of a phycobilisome can be quenched, and that the core complexes were targeted most frequently. Our results provide the first evidence for fluorescence blinking from a biologically active system at physiological light intensities and suggest that the light-controlled switches to intrinsically available energy dissipating states are responsible for a novel type of photoprotection in cyanobacteria. We anticipate other photosynthetic organisms to employ similar strategies to respond instantly to rapid solar light intensity fluctuations. A detailed understanding of the photophysics of photosynthetic antenna complexes is of great interest for bioinspired solar energy technologies.

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Session Classification: Photonics

Track Classification: Track C - Photonics