Balancing the energy budget of steady-state photosynthesis

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The talk will cover progress the co-regulation of the light and dark-reactions of photosynthesis to balance the energy budget of the chloroplast without self-destruction. We will focus on the roles of the chloroplast proton motive force (*pmf*) in generating ATP and regulating the photosynthetic antenna and electron transfer and initiating photodamage. Cyclic electron flow around photosystem I (CEF1) is thought to balance chloroplast ATP/NADPH output to match downstream demands, but despite decades of work the regulation, pathway, catalytic and proton pumping capacity of the process remain controversial. At least four different pathways have been proposed for PQR, while neither the capacity of CEF1, or the system that regulates it are known. We isolated a new class of Arabidopsis mutant, *hcef* for high CEF1, which shows dramatically higher CEF1. Characterization of these mutants shows that

1) elevated CEF1 flows through NDH rather than other proposed pathways;
2) CEF1 is highly inducible and can achieve quite high rates;
3) CEF1 is critical for maintaining ATP levels under stress;
4) the NDH complex likely pumps protons, like its homolog in the mitochondrion, Complex I.

We will also address the role of the ATP synthase in regulating *pmf* and show that excess *pmf* can initiate high levels of photodamage of photosystem II *in vivo*.