Australian National University

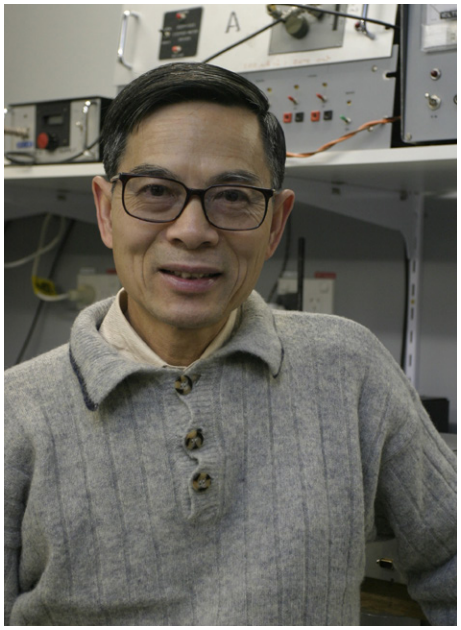
PUBLIC LECTURE

Photosynthetic membranes *in vivo* and *in vitro*

Wednesday 4 December 2013 1 – 2pm

Fred Chow Division of Plant Sciences

Slatyer seminar room R.N. Robertson Building (Bldg. 46), Linnaeus Way, ANU



Photosynthetic membranes (thylakoids – 'flattened sacs') perform the light-driven splitting of water molecules to release and channel the electrons and protons in the formation of two compounds (ATP and NADPH) that store the energy for turning CO_2 into carbohydrates. Thylakoids in plants are organized in stacks (grana) inter-connected by non-stacked membranes, a structure that helps in fine-tuning photosynthesis. The membranes carry net negative charge, so they repel one another electrostatically. Recent isothermal titration calorimetry measurements, however, strongly suggest that an entropy-driven attractive force overcomes the electrostatic repulsion to form the granal stacks.

There are four protein complexes in the thylakoid membrane: Photosystem II (PS II), Cytochrome bf complex, Photosystem I and ATP synthase. The Cyt *bf* complex is often a bottleneck limiting photosynthetic capacity, much more so than PS II. Quantification of photosynthetic capacity, PS II and Cyt *f* has established a seemingly robust relationship between the three parameters among plant species; this relationship gives the relative limitation by Cyt *bf* and PS II, and could be used to estimate the Cyt *bf* content in leaf tissue.

In addition to the linear electron flow from water to $NADP^+$, there is a cyclic electron flow which is rather hard to quantify, even after more than half a century since its discovery. Under some special conditions, such as high [CO_2], we obtained an upper estimate of the cyclic electron flux in leaf tissue based partly on a PS I signal, under conditions of increasing irradiance, temperature or water deficit.

Photosystem II, responsible for splitting water molecules, is itself inactivated by the light which it uses to do its work, and is continually repaired to ensure no net loss of activity. A signal from PS I, superior to chlorophyll fluorescence for assaying the functional fraction of PS II in leaf tissue, has been used to characterize the photoinactivation and repair in terms of rate coefficients. However, for describing the repair more exactly during the onset of high-light treatment, two rate coefficients (rather than one) need to be used, one for degradation of a damaged (D1) protein and the other for the new synthesis of D1 protein. The above examples illustrate the feasibility of probing the function of three of the four protein complexes *in situ* in leaves.

Presented by

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