Institute for Optical Sciences (IOS)

Professor Graham R. Fleming, from the University of California, Berkeley will visit the Institute for Optical Sciences from 25 to 27 May 2011, as part of the Institute’s Distinguished Visiting Scientists program.

Graham Fleming currently serves as UC Berkeley’s Vice Chancellor for Research, a position which he assumed in April 2009. Fleming served as the Deputy Director of Lawrence Berkeley National Laboratory from 2005 through 2007. Through joint appointments as Melvin Calvin Distinguished Professor of Chemistry at UC Berkeley, and Founding Director of both the Berkeley Lab’s Physical Biosciences Division and UC Berkeley’s California Institute for Quantitative Biosciences (QB3), he has re-shaped the intersection of physical and biological sciences, while maintaining his own investigations into ultrafast chemical and biological processes, in particular, the primary steps of photosynthesis. Throughout his administrative career, Fleming has remained a highly active scientific researcher. He has authored or co-authored more than 400 publications, and is widely considered to be one of the world’s foremost authorities on ultrafast processes. In addition to his many other activities, Fleming has given numerous talks around the world on the inter-relation and inter-complexity of energy, climate and photosynthesis. In 2007, Fleming led the effort (with co-chair Mark Ratner) to define Grand Challenges in Basic Energy Science for DOE/BES, resulting in “Directing Matter and Energy: Five Challenges for Science and the Imagination.”

Prof. Fleming will give the following 3 lectures during his visit at the IOS:

**Lecture 1 — Grand Challenges in Energy: Supply, Demand and Consequences**

Wednesday, May 25 at 2 p.m.
McLennan Physical Labs, Room 102
60 St. George Street, Toronto

The provision of sustainable energy is the defining problem of the 21st century. The energy “problem” is a set of inter-related technological, scientific, economic, environmental and sociological challenges. In this talk, I will discuss these challenges and illustrate some potential solutions by means of examples of specific programs at UC Berkeley and Lawrence Berkeley National Laboratory.

**Lecture 2 — Quantum Mechanics for Plants**

Thursday, May 26 at 2 p.m.
McLennan Physical Labs, Room 102
60 St. George Street, Toronto

The low energy density of solar radiation necessitates dense packing of the light absorbing components (chromophores) of the light harvesting system of photosynthetic organisms. The close spatial proximity of the chromophores, chiefly chlorophyll or bacteriochlorophyll, leads to new electronic structure, dynamics, and emergent properties of the light harvesting system. In this talk, I will discuss how the interaction of structure, energetics and dynamics leads to the ability to transfer excitation between hundreds of chromophores en route to the photochemical reaction center with near unit quantum efficiency at low light levels. I will discuss the recent work demonstrating the existence of quantum coherence effects, the possible functional role of coherence, and the origin of the observed decoherence.
Plants are subject to widely varying light levels during each day from the diurnal cycle, clouds, the motion of the canopy, and shading. Light levels in excess of that which can drive the electron transfer and subsequent chemical steps of photosynthesis leads to accumulation of reactive oxygen species and consequent damage to the photosynthetic apparatus. To minimize this damage, plants have a sophisticated feedback mechanism called non-photochemical quenching (NPQ) that dumps excess excitation to heat. In full sunlight, the top leaves of a tree may be degrading 70-80% of the absorbed light directly to heat. We have developed a systems model of the major, rapidly reversible, component of NPQ, called qE. By combining two systems, one of which is proportional to the integral of the error signal (lumen pH), and one of which is proportional to the double integral of the error signal, the plant is able to both switch on and off the quenching process rapidly. I will discuss the application of similar ideas to artificial systems through our collaboration with D. Gust; A. Moore and T. Moore, in which we developed and characterized a hexad system with pH tunable quenching.

For more information on these lectures please contact Emanuel Istrate.