

Conformational changes in BLUF domains

A class of photoreceptors occurring in various organisms consists of domains that are blue light sensing using flavin (BLUF). The vibrational spectra of the flavin chromophore are spectroscopically well characterized for the dark-adapted resting states and for the light-adapted signaling states of BLUF domains in solution. Here we present a theoretical analysis of such spectra by applying density functional theory (DFT) to the Flavin embedded in molecular mechanics (MM) models of its protein and solvent environment. By DFT/MM we calculate flavin spectra for seven different X-ray and NMR structures of BLUF domains occurring in the transcriptional antirepressor AppA and in the blue light receptor B (BlrB) of the purple bacterium *Rb. Sphaeroides* as well as in the phototaxis photoreceptor Slr1694 of the cyanobacterium *Synechocystis*. By considering the dynamical stabilities of associated all-atom simulation models and by comparing calculated with observed vibrational spectra, we show that two of the considered structures (both AppA) are obviously erroneous and that specific features of two further crystal structures (BlrB and Slr1694) cannot represent the states of the respective BLUF domains in solution. Thereby, the conformational transitions elicited by solvation are identified. In this context we demonstrate how hydrogen bonds of varying strengths can tune in BLUF domains the CdO stretching frequencies of the flavin chromophore.

Furthermore we show that the DFT/MM spectra of the flavin calculated for two different AppA BLUF conformations, which are called Trpin and Metin, fit very well to the spectroscopic data observed for the dark and light states, respectively, if (i) polarized MM force fields, which are calculated by an iterative DFT/MM procedure, are employed for the flavin binding pockets and (ii) the calculated frequencies are properly scaled. Although the associated analysis indicates that the Trpin conformation belongs to the dark state, no clear light vs dark distinction emerges for the Metin conformation. In this connection, a number of methodological issues relevant for such complex computations are thoroughly discussed showing, in particular, why our current descriptions could not decide the light vs dark question for Metin.

Paul Tavan – Reseña biográfica

Paul Tavan estudió física en la Universidad de Würzburg (Alemania). Realizó su Tesis Doctoral en el Instituto Max-Planck de Química Biofísica de Göttingen y en la Universidad de Göttingen. Defendió su Tesis en 1978. Realizó estancias postdoctorales en Göttingen y en el Instituto de Química Física y Química Cuántica de la Freie Universität Berlin. Entre 1981 y 1982 trabajó en la Universidad de Cornell (Ithaca, NY, USA). Recaló en la Technische Universität München, donde defendió su Habilitación en 1988 y fundó el grupo de Biofísica Teórica. Desde 1993 es Profesor de la Ludwig Maximilian Universität München