

Dynamics of Proton Transfer in Biological Systems

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Proton transfer is associated with several biological processes that include enzymatic reactions, signalling process and transport. Quantization of nuclear motion is of prime importance for hydrogen bonded systems and enzyme centers. Car-Parrinello molecular dynamics (CPMD) study was performed for anharmonic systems – intramolecularly hydrogen-bonded systems, to investigate the vibrational spectrum associated with the O-H stretching in Mannich base [1,2] and picolinic acid N-oxide [3]. The proton potential snapshots were extracted from the trajectory. The vibrational Schrödinger equation for the snapshots was solved numerically and the (O-H) envelope was calculated as a superposition of the 0 to 1 transitions. The potential of mean force for the proton stretching mode was calculated from the proton wavefunctions. Perspectives will be given for application of various computational methods to address tunneling in enzymatic reactions. Calculation of large H/D kinetic isotope effect in lipoxxygenase will be presented [4,5]. Relevance of nuclear quantum effects for enzymatic catalysis will be discussed.

pKa calculations of histamine and several carboxylic acids including bilirubin will be discussed in terms of their transmembrane transport [6,7].

- [1] A. Jezierska, J. J. Panek, A. Koll and J. Mavri, *J. Chem. Phys.*, 126 (2007) 205101-9.
- [2] A. Jezierska, J. J. Panek, U. Borštnik, J. Mavri and D. Janežič, *J. Phys. Chem B*, 111 (2007) 5243-5248.
- [3] J. Stare, J. Panek, J. Eckert, J. Grdadolnik, J. Mavri and D. Hadži, *J. Phys. Chem A*, 112 (2008) 1576-1586
- [4] M.H.M. Olsson, J. Mavri and A. Warshel, *Phil. Trans. Roy. Soc. B*, 361 (2006) 1417-1432.
- [5] J. Mavri, M.H.M. Olsson and A. Warshel, *J. Phys.Chem. B*, 112 (2008) 5950-5954.
- [6] K. Perdan-Pirkmajer, J. Mavri and M. Kržan, to be sub.
- [7] R. Borštnar, A. Roy Choudhury, J. Stare, M. Novič, J. Mavri, *ChemPhys Chem*, sub. 9/2009.