Modeling structure and spectra of fluorescent proteins

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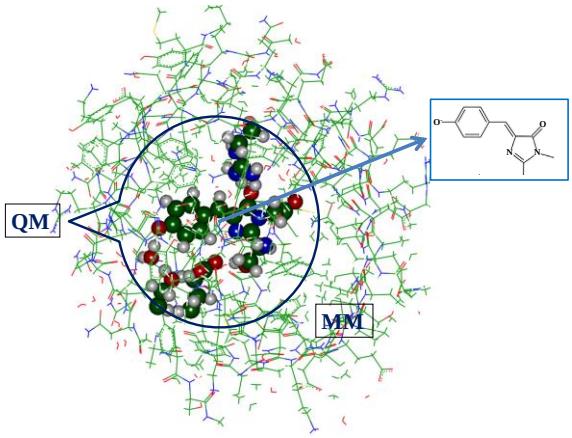
Quantum-based studies of fluorescent proteins, the important markers in live cells, are of great importance to understand the atomic details of their structure, and dynamics. Despite significant coverage this topic in the literature, plenty of details regarding properties of fluorescent proteins remain hidden, even considering the parent member of the family, the wild-type green fluorescent protein (wt-GFP). We apply quantum chemistry and quantum mechanics/molecular mechanics (QM/MM) approaches to characterize structures on the ground and excited electronic states as well as optical spectra of GFP and related proteins. Figure illustrates a model system with the chromophore molecule shown in the right-side inset.



The energy landscape along the assumed proton transfer route in wt-GFP involving the conventional A, I, and B conformational forms with different protonation states of the chromophore was computed and characterized [1]. We computationally constructed GFP variants in which the anionic chromophore is sandwiched between two tyrosine residues in a triple-decker motif [2]. We predict that excitation of the kindling fluorescent protein, the Ala143Gly variant of the natural chromoprotein asFP595, may result in fluorescence from the cationic form of the chromophore which is unusual for the members of GFP family [3]. The emission band from conformations with the *trans* cationic chromophore should be noticeably shifted to the blue side compared to the know red fluorescence from the *cis* anionic species in asFP595.

[1] Grigorenko, B.L., Nemukhin, A.V., Polyakov, I.V., Morozov, D.I., Krylov, A.I., *J. Am. Chem. Soc.*, in press, DOI: 10.1021/ja402472y.
[2] Grigorenko, B.L., Nemukhin, A.V., Polyakov, I.V., Krylov, A.I., *J. Phys. Chem. Lett.*, 4:1743, 2013.
[3] Grigorenko, B.L., Polyakov, I.V., Savitsky, A.P., Nemukhin, A.V., *J. Phys. Chem. B*, 117:7228, 2013.