The first real-time movie of the chemical reaction that allows vision

Vision is based on one of the fastest photo-chemical processes ever known in nature. In fact, from the moment a photon hits the retina of the eye (or rather one of its molecules called rhodopsin), the first reaction is concluded in much less than a millionth of a millionth of a second. Such process is so quick that it defied experimental observation until now. Scientists from the CNR and Politecnico di Milano, in collaboration with University of Bologna, University of Berkeley (USA), University of Oxford (UK) and Max Planck Institute in Mülheim (Germany), have finally succeeded in the enterprise of "photographing" the very first events of the chemical process responsible for human vision.

Using a special camera that picks up the individual frames using ultrafast laser flashes of light (lasting a few billionths of a millionth of a second), it was possible to record a movie of this process in real time. The combination of this information with theoretical simulations, carried out using advanced and efficient computers with complex algorithms, enabled reconstructing the fast conformational change of the molecule responsible for human vision.

The experiment provided the most convincing evidence so far for the existence of a phenomenon known as conical intersections, which can be seen as 'chemical black holes': singularities that connect different electronic states of the matter. These are points which capture molecules, dramatically accelerating the chemical reaction and making it extremely efficient. Until now, these features were predicted only theoretically, resisting any attempt to their direct observation. In this research conical intersections have been observed experimentally for the first time, demonstrating the validity of theoretical predictions.

This ultrafast process constitutes the first step of the complex biochemical mechanism that leads to the propagation of an electrical stimulus to the brain, which ultimately allows human vision. Natural evolution has engineered this mechanism in order to make it so efficient -many animals, including humans, can detect even the faintest light in the darkness- because it constitutes a key factor for the survival of the species. This extraordinary sensitivity of the eye has been made possible thanks to the extreme rapidity of the photo-chemical reaction, which has been recorded here for the first time.