Newly developed techniques for measuring magnetic field effects

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Magnetic field effect (MFE) measurements on photochemical reactions on valuable biomolecules have faced difficulties, particularly low field effect (LFE) measurements are challenging because sample degradation reduces the quality of data[1]. We approached this problem with the following concepts in mind; (1) Time-resolved transient absorption (TA) measurements at smaller absorbance values reducing pump laser power; (2) Simultaneous broadband wavelength measurements; (3) Observing short (sub-microsecond) to long (millisecond) time scales with a single excitation pulse. In an attempt to fulfil these requirements, we propose the super-cavity ring-down spectroscopy (S-CRDS) method[2]. CRDS has already been demonstrated to be an effective method for TA measurements[3], but the problem is that only one absorption at a single delay time and wavelength can be measured with a single excitation pulse. Therefore, multiple excitations are necessary for acquiring the time profile in conventional CRDS. In this new method, a super-continuum light source with a broadband pulse train of a few MHz is used as a probe light. It is worth mentioning that this method uses a light source where the intensity of a single pulse increases sufficiently to produce a CRDS signal as the light source repetition frequency reduces.

Furthermore, an investigation into methodologies for finding spin coherence in low field effects is underway. In theory, the origin of the low field effect is thought to be a convolution of coherent spin motion and spin mixing via level crossing. Although we have previously used nanosecond field switching methodologies to determine radical pair lifetimes in the low field region[4], a detailed analysis of transient absorption changes associated with small field jumping in the low field regime is expected to provide new information on their spin dynamics.

Recently, AWG (arbitrary wave generator)-based pulse EPR and NMR have been developed for spin manipulation. We propose AWG-based chemical reaction control of radical pairs in both low and high magnetic field regimes. Here we present a theoretical calculation of an optimised RF field using local optimisation theory[5] and manifest AWG-based reaction control. In high field, the selection of the hyperfine lines and anisotropic control in the rotating frame can be achieved through the optimised RF (MW) field.[6].

References

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