Dynamic studies of Water in *Saccharomyces cerevisiae*

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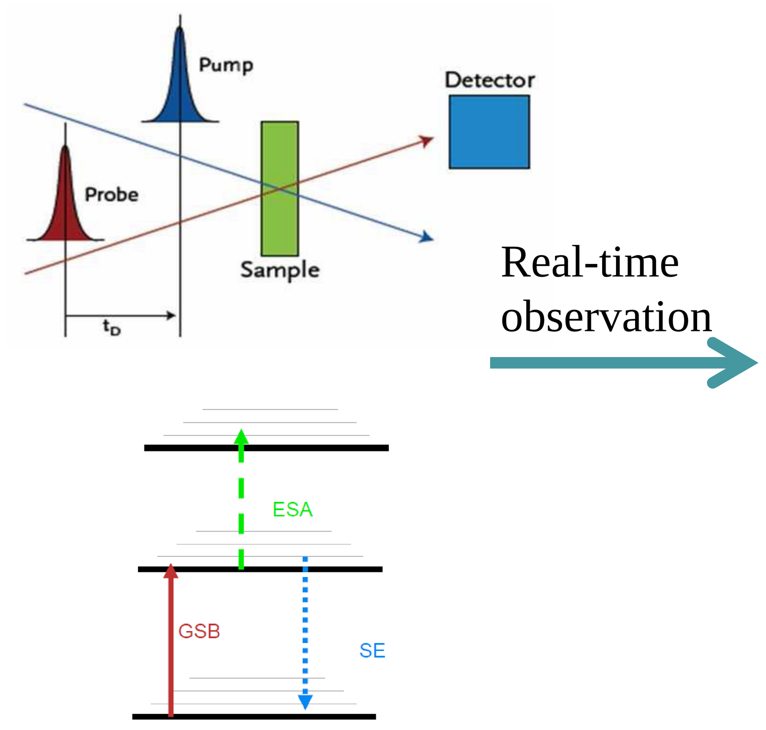
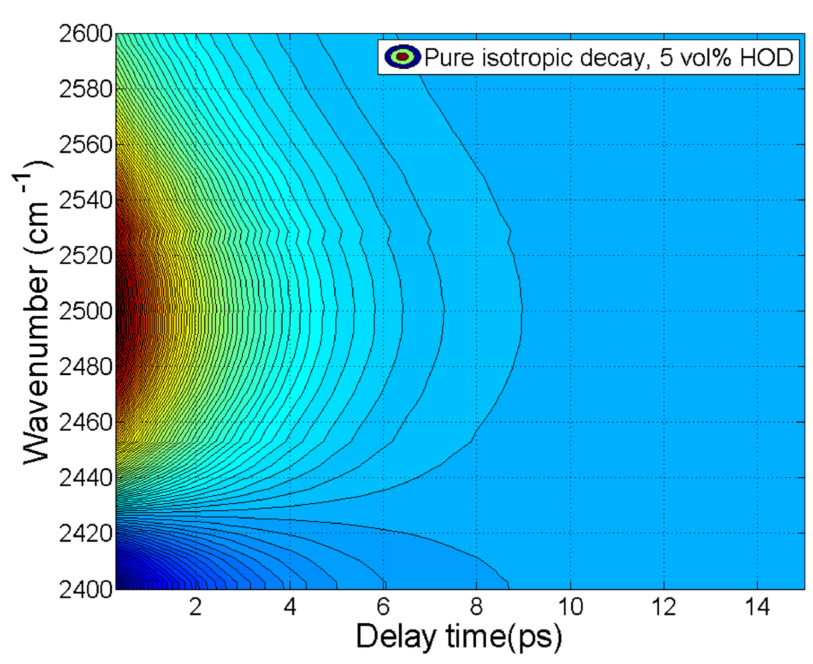
Introduction & Experiments

Scheme of Pump-probe spectroscopy





A. Isotropic signal ($\Delta\alpha_{iso}$)

$$\Delta\alpha_{iso} = \frac{\Delta\alpha_{\parallel} + 2\Delta\alpha_{\perp}}{3}$$

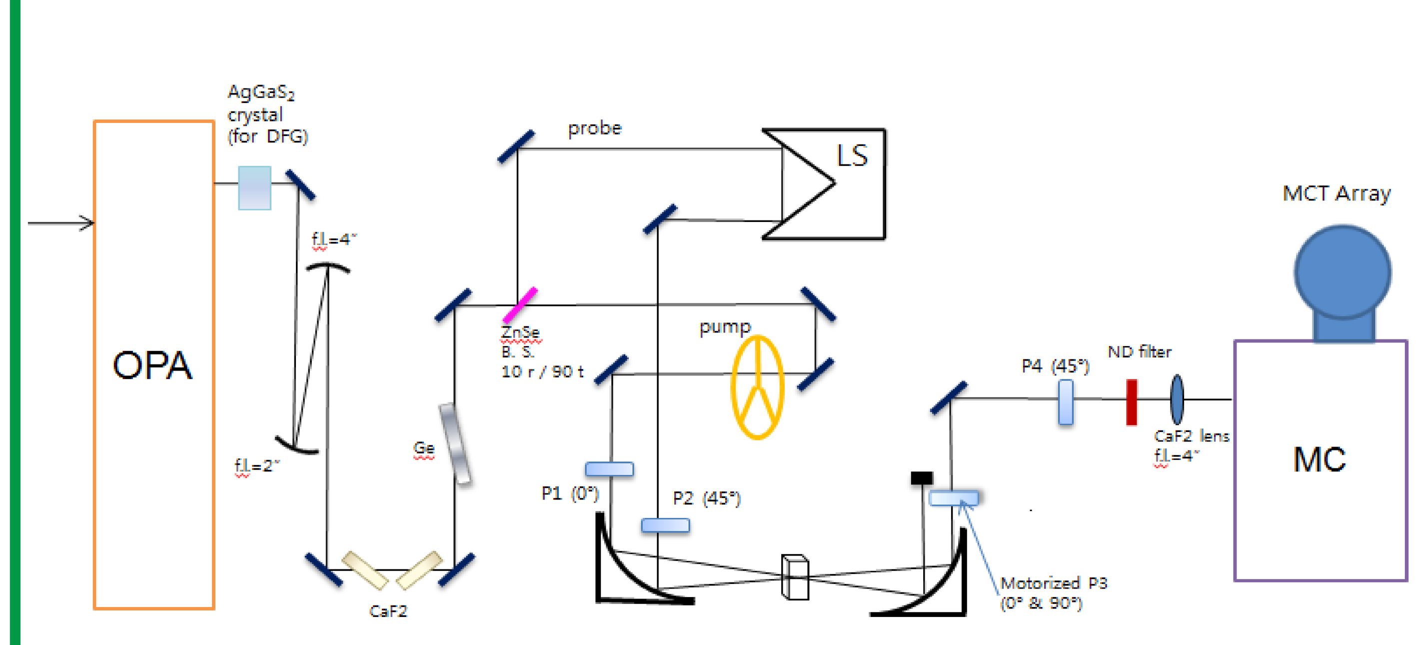
(related with **vibrational** relaxation)

B. Anisotropy ($R(t)$)

$$R(t) = \frac{\Delta\alpha_{\parallel} - \Delta\alpha_{\perp}}{\Delta\alpha_{\parallel} + 2\Delta\alpha_{\perp}}$$

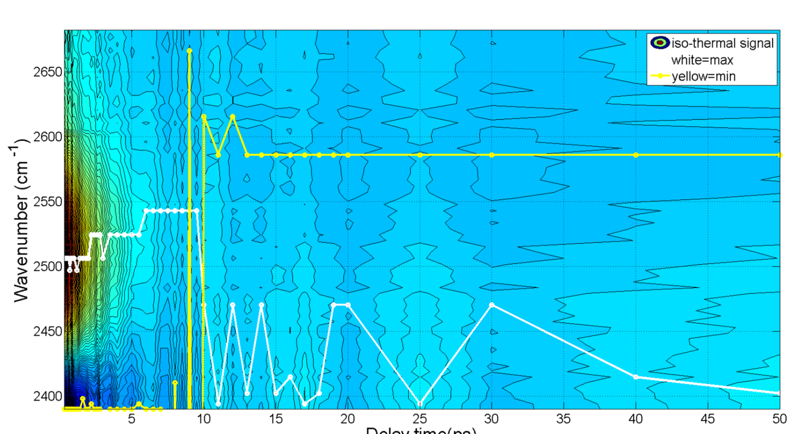
(related with **orientational** relaxation)

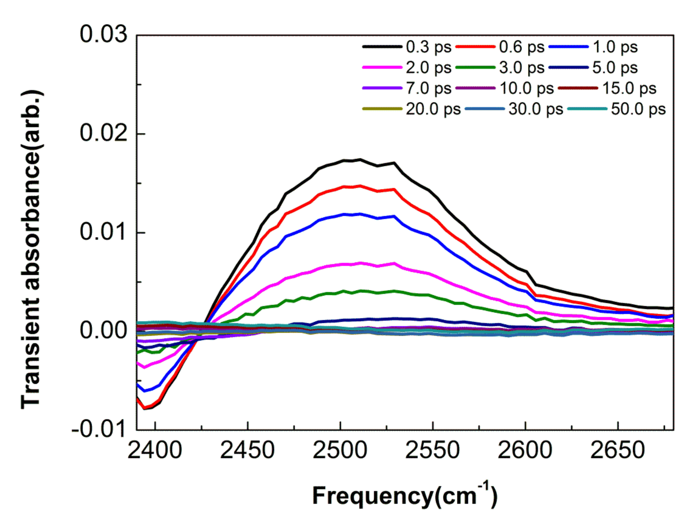
Layout of the pump-probe spectrometer

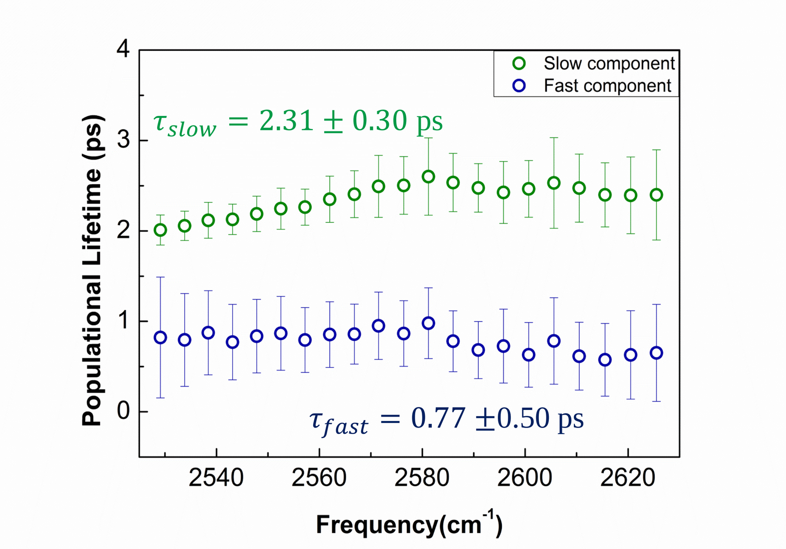


Experiment Results

Vibrational dynamics of intracellular water





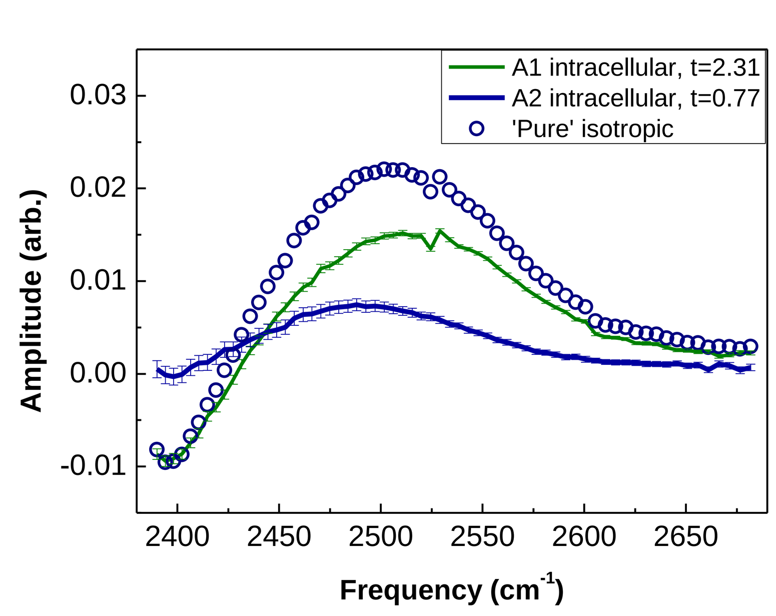


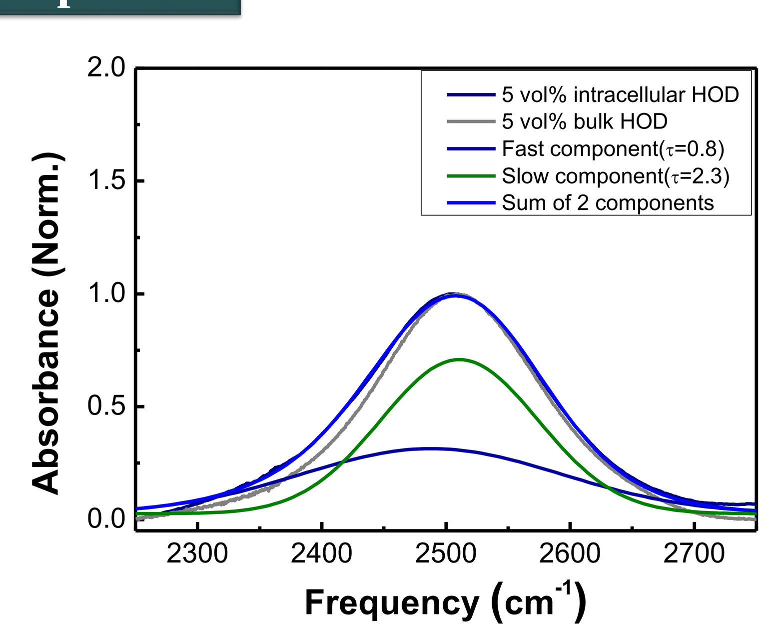
The process of vibrational energy relaxation leads to heating on the surrounding, so we need to consider them to study the 'pure' decaying[1].

$$\Delta\alpha_{iso} = \Delta\alpha_{iso,pure} + G(t)$$

(where, G(t) is thermal component)

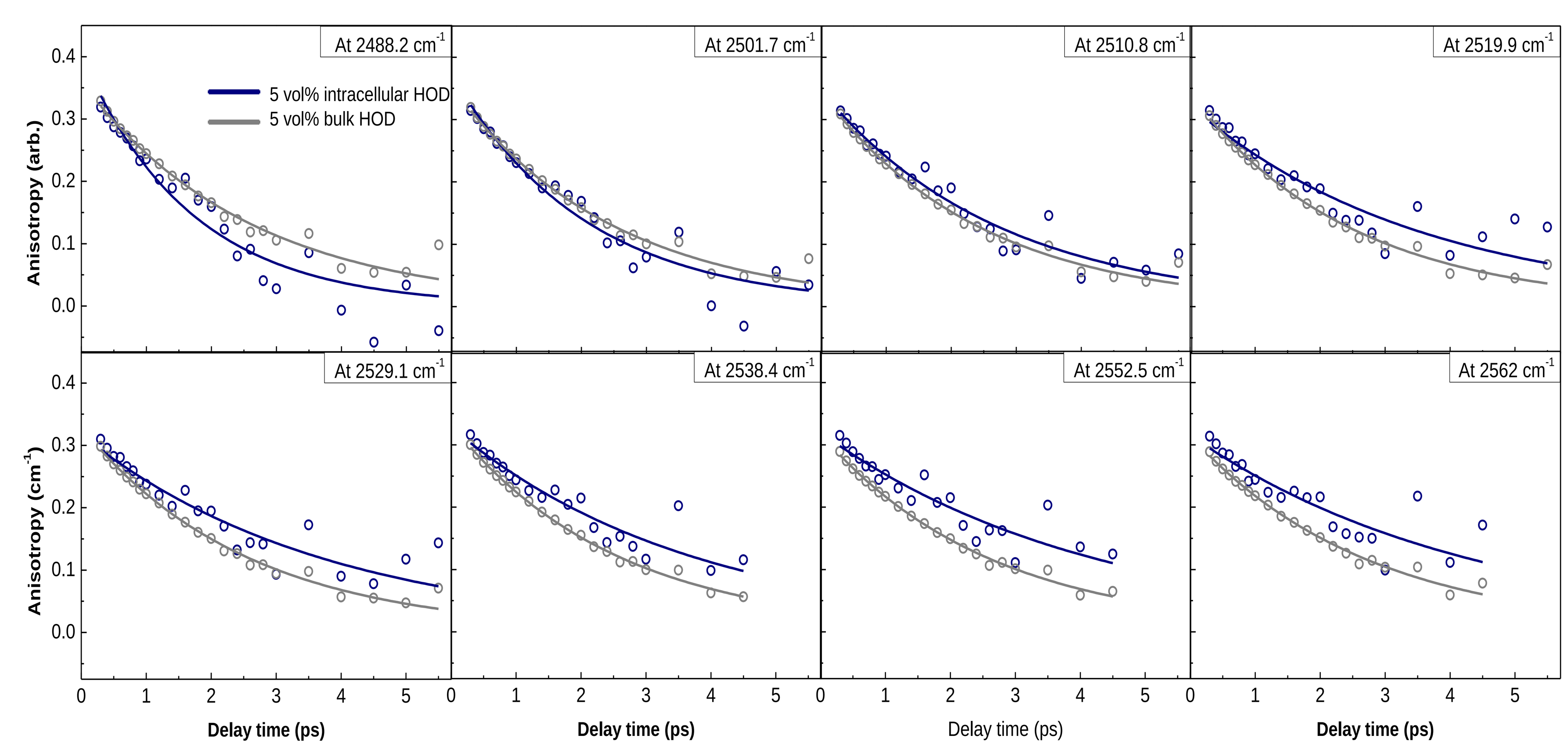
Populational ratio between fast and slow components



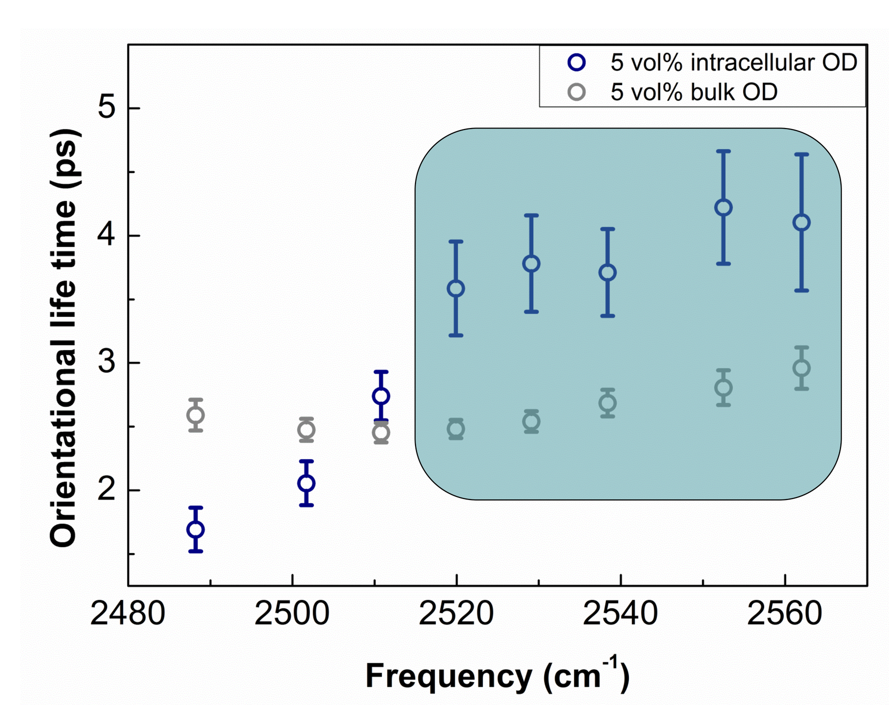


The populational ratio between the fast and the slow components is calculated as **2.12** (from the study of isotropic signal) and **1.46** (from the study of FT-IR spectrum)

Orientatioanl dynamics of intracellular water



Comparison of orientatioanl lifetimes in two systems



The time constants of reorientation are frequency-dependent and as frequency increases, OD stretching mode shows slow reorientational dynamics. This indicates that the OD molecules which interacted through relatively less and weakly hydrogen bond[2] are oriented.

This trend is already seen in the case of water on hydrophobic surface[3] and our investigation can be explained by the effect of hydrophobic surface in the cellular components.

Conclusion & Future work

Conclusion

We have studied the properties of water confined in *Saccharomyces cerevisiae* was studied by FT-IR and polarization-controlled pump-probe spectrometer. The corrected isotropic signal of intracellular HOD fits well by biexponential function and the populational lifetimes of both the fast (~0.77 ps) and the slow components (~2.31 ps) are different from the one of bulk HOD (~1.8 ps). And the reorientational lifetime of them shows frequency-dependent behaviors and relatively slow dynamics at high frequency regime. Both of results indicate that the properties of hydrogen bond are perturbed.

Future work

We need to study the origin of these interesting features by using another systems such as RMS which is widely used as model system of cell. And another techniques such as 2D-IR can be applied to this system to find more clues in these difference.

References

[1] Rezus, Y. L.; Bakker, H. J., Orientational dynamics of isotopically diluted H2O and D2O. *The Journal of chemical physics* **2006,** *125* (14), 144512.

[2] Wang, Z.; Pakoulev, A.; Pang, Y.; Dlott, D. D., Vibrational substructure in the OH stretching band of water. *Chemical Physics Letters* **2003,** *378* (3-4), 281-288.

[3] Rezus, Y. L. A.; Bakker, H. J., Observation of Immobilized Water Molecules around Hydrophobic Groups. *Physical Review Letters* **2007,** *99* (14);

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