INTERNSHIP TITLE	**Charged aqueous interfaces studied by Second Harmonic and Sum Frequency Generation**
PLEASE SELECT M1 OR M2	M2
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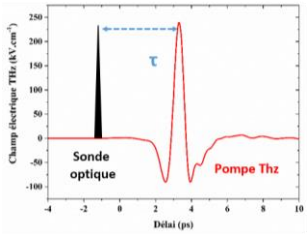
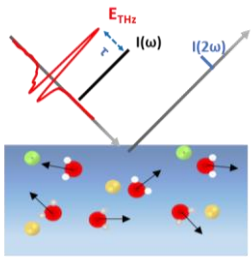
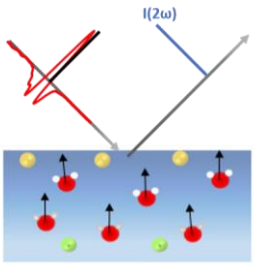
Interfaces of water and aqueous solutions play a prominent role in many technological and natural processes. The liquid/solid interface is the main driver for many electrochemical reactions. Water being present everywhere, the fields of applications are numerous.
The main idea of this project is to develop a hybridized second harmonic generation/ sum frequency generation (SHG/SFG) spectroscopy to study vibrational modes for aqueous interfaces. We will implement a method based on Terahertz field-induced surface charging and study its consequent interface dynamics through SFG/SHG spectroscopies. The main aim to apply an applied electrostatic potential (THz beam) and measure its impact on the air/water interface by SHG/SHG. It can be shown that the reflected SF signal is proportional to the effective surface nonlinear susceptibility $\chi_S^{(2)}(\omega_{IR})$ which spectrum gives the molecular vibrational strength and structural information about the network bonding in the Stern layer. A second experimental parameters $\chi_{DL}^{(2)}(\omega_{IR})$ offers quantitative information about the surface charge density σ, since it arises from the charge distribution in the diffuse Layer due to electrostatic field $E_0(z')$. To get the global understanding of the interfacial processes, both $\chi_S^{(2)}$ and $\chi_{DL}^{(2)}$ are needed.



Pump THz – Probe SHG



Pump-Probe out of phase: Properties at the interface



Pump-Probe in phase : Properties from the bulk

We shall start this project by measuring the surface nonlinear signal $\chi_{S,eff}^{(2)}$ for a charged interface and control the surface charge thanks to an intense THz field focus at the interface. We already built an SHG optical setup, and before the internship the THz beam will be implemented. During the internship, you will first study the water structure dynamics through SHG measurements. The second step will be the SFG setup implementation, i.e. adding an IR beam light. You will then be able to study the microscopic water structure, deduce the vibrational spectra of the Stern layer at the air/water interface as a function of electric field *for the first time* without adding any chemical, providing microscopic insight into the interfacial bonding structure at the air/water interface.

References:

Wen, Y.-C.; Zha, S.; Liu, X.; Yang, S.; Guo, P.; Shi, G.; Fang, H.; Shen, Y. R.; Tian, C., Unveiling Microscopic Structures of Charged Water Interfaces by Surface-Specific Vibrational Spectroscopy. *Physical Review Letters* 2016, *116*, 016101.
Dalstein, L.; Chiang, K.-Y.; Wen, Y.-C., Direct Quantification of Water Surface Charge by Phase-Sensitive Second Harmonic Spectroscopy. *The Journal of Physical Chemistry Letters* 2019, *10*,5200-5205.