Real-Time FTIR for Applications in Attoscience and Beyond

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Fourier transform infrared spectroscopy (FTIR) is one of the most sensitive spectroscopic techniques, which is useful for measuring weak spectral signatures. This project involves developing the software for a home-built FTIR spectrometer and optimizing the device for attosecond (1 as = 10^{-18} s) spectral changes. We convert the interferometric optical signal measured with a photodiode (light sensor) using an analog-to-digital converter (ADC), and store the data into memory using the Python programming language. This signal arises due to interference between two overlapping laser beams in the interferometer. Inherent limitations of this process are that it is relatively slow for large datasets and does not allow for signal analysis in real-time.

To overcome these limitations, we have adopted the Python library Bokeh to create a private web server that will allow for real-time observation of the signal in both time and frequency domains (through the Fourier transform). Python is a ubiquitous language, thus making this software quite versatile from a hardware implementation and collaboration point of view.

The development of such software is extremely valuable and will be applied to future experiments that involve extracting weak signals in the infrared regime. One possible application is chemical identification, for instance air and water pollutants[1]. The hope is that this could be useful in cleanup efforts to identify water pollutants in the Great Lakes, even in very small quantities.

[1] Chen, Y., Zou, C., Mastalerz, M., Hu, S., Gasaway, C., & Tao, X. Applications of Micro-Fourier Transform Infrared Spectroscopy (FTIR) in the Geological Sciences--A Review. *International journal of molecular sciences*, **16**(12), 30223–30250. doi:10.3390/ijms161226227 (2015)