EXTENDING THE PRINCIPLES OF THE FLYGARE: TOWARDS A FOURIER TRANSFORM THz SPECTROMETER

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With the commissioning of the SOFIA and Herschel observatories in the next few years, unprecedented access to interstellar THz radiation will be gained. It is therefore of great importance to extend the laboratory spectra of molecules detected at lower frequencies into the THz region as well as to measure the THz spectrum of new molecules targeted in observational studies.

A versatile spectrometer is needed for those purposes, not only with high sensitivity and resolving power, but also tunability over a very wide range of the frequency spectrum. This tunability is particularly important for studying large organic molecules, whose rotational spectra peak at millimeter-wave frequencies or lower, but which are expected to have low-lying, large amplitude vibrational modes in the THz region. These bands can lie at greatly varying frequencies depending on the molecule, and efficient, high sensitivity scanning algorithms are therefore needed to study them. We propose the design of a Fourier Transform THz spectrometer based on the principles of the traditional FTMW, or “Flygare”, spectrometer. The main radiation source will be the output from a photomixer chip in which two mid-Infrared lasers are combined to generate THz radiation. Non-linear effects on the surface of this chip allows difference frequency generation in the THz region, which has the advantage of being widely tunable. The disadvantage is that only low power levels can be achieved ($\sim 0.1\mu$W) that are insufficient for direct absorption measurements without very high sensitivity direct detectors. However, by employing a Fabry-Perot resonator and recording the time-domain spectrum of the FID of the excited molecules, followed by Fourier transformation, we hope to achieve very high sensitivity akin to the Flygare system.

Several aspects of the proposed system, such as maintaining a high Q factor for the cavity with frequency scaling, compensation for the low input power compared to the Flygare system, the proposed detection scheme as well as the impact of molecular properties at these frequencies will all be discussed with regards to the sensitivity and overall feasibility of the system.