Terahertz clock for standard in THz frequency region

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Abstract:
To achieve the universal identification power in various spectroscopic and industrial applications, uncertainty of the output THz profile should be guaranteed by referencing by The International System of Units (SI). A terahertz comb is required which is comparable to the microwave frequency standard. In this proposed research plan, We will develop precise, broadband THz comb based on photo mixing of two independent optical frequency comb (OFC) phase-locked to a microwave frequency standard.

THz applications viz: spectroscopy, Imaging, Communication etc. has emerged as a new innovative mode for sensing and communication. One of interesting applications of terahertz is THz spectroscopy, gas analysis of atmospheric environment because many molecular gasses indicate characteristic absorption lines (THz spectral fingerprints) arisen from the rotational transition of molecules. Furthermore, there are many spectral fingerprints jostle in the THz frequency range. To separate and distinguish these spectral fingerprints, excellent uncertainty is required in THz spectrometer. If uncertainty of the output frequency is guaranteed by the microwave frequency standard, universal identification power will be achieved in spectroscopic applications.

Optical frequency comb (OFC) is an attractive frequency reference to transfer the excellent uncertainty of the microwave frequency standard to the optical region via coherent frequency linking. Recently, optical frequency synthesizer (OFS) i.e optical clock, phase-locked to a microwave frequency standard, has been realized by phase-locking a tunable single-frequency CW laser to one of the comb modes If two independent OFCs with mismatched output frequency of THz order (dual OFS) are constructed and outputs from them are optically heterodyned by a photomixer, the resulting CW-THz wave will be also traceable to the microwave frequency standard because the photomixing process is a coherent process and does not lose the uncertainty of OFC via conversion from optical to THz regions. Furthermore, if one OFC is operated at a fixed frequency and another OFC is tuned continuous, continuous tuning of CW-THz wave will be achieved over 1 THz. Based on this concept, We want to construct a broadband THz clock traceable to a microwave frequency synthesizer with uncertainty of 10^{-10}.

A THz comb traceable to the microwave frequency standard also plays an important role in various fields of THz science and technology because frequency is most fundamental physical quantity of electromagnetic waves.

References

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