NOVEL TUNABLE SOURCE FOR GENERATION OF THZ RADIATION

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This paper describes a new approach aimed at the realization of a multi-channel spectrum analyzer for terahertz radiation. The approach is based on the novel technology of whispering gallery mode resonators that is inherently suitable for spacecraft instrumentation.

Photons at terahertz frequency are the most ubiquitous in the universe. Aside from cold interstellar clouds, and other cosmic sources, water, and all water bearing and cold (less than 600K) bio-matter emit terahertz radiation. The ability to sensitively detect terahertz radiation with a spacecraft instrument is a powerful technique for remote detection of extra terrestrial biotic and pre-biotic matter. Such an approach however requires the ability of wide-spectral and narrow-band receivers to realize the function of multi-channel spectral analysis.

Current technology for generating spectrally pure terahertz signals to realize coherent detection is grossly lacking in performance and suitability for spacecraft applications, as compared with millimeter wave technology. The most effective means to generate terahertz radiation involves lasers locked to modes of a high finesse optical cavity, and used for heterodyne frequency generation. This approach has a number of disadvantages, including the requirement for a bulky cavity and limitations associated with broad line-widths.

The technology of micro-resonators can be applied to this problem. In particular, novel microtorus resonators recently developed at JPL can be used to generate a comb of frequencies, separated by a desired amount (say, 100 to 400 GHz) over a range of 1520 to 1575 nm. Because of the high Q of the resonators $\sim 9 \times 10^9$, the line-width of these lines are extremely narrow. With photomixing, such a comb can be used to synthesize a wide spectrum of terahertz frequency. We will also study and develop whispering gallery mode micro-resonators at terahertz frequency, to enable filtering and processing functions required for a spectrum analyzer.

Aside from applications to water and biomass detection, the development of sources and components mentioned above are extremely useful for terahertz astronomy, communications, and remote sensing of Earth. After completion of this seed effort, we anticipate funding from NASA and DOD for further development of this technology.