The first 9 THz laser emission generated by optically pumped $CH_3{}^{18}OH$

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This year marks the fiftieth anniversary of the laser, and hence, fifty years of laser innovation (House Resolution 1310). LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. At the time of its discovery, critics ironically dubbed the laser as "the solution in search of a problem." The laser has proven to be just that. Today lasers are integrated in all aspects of our lives: at the checkout counter, in defense and medical applications, they are even used in laser light shows for entertainment.

The laser project at Central Washington University involves the discovery of new sources of light in the far-infrared region, spanning wavelengths from 20 to 1000 micron. For this project, a carbon dioxide laser was used to excite a far-infrared laser that operates using an isotope of methanol. Once a far-infrared laser emission was detected, its frequency was measured using a heterodyne (mixing) technique yielding a fractional uncertainty of a few parts in ten million.

During this investigation, four new far-infrared laser lines were discovered and twelve laser frequencies were measured for the first time. This includes the discovery of the 33.15 micron laser line whose frequency is the first 9 THz laser emission generated by this laser medium. These newly discovered and measured laser lines have expanded the frequency range for which this laser operates by a factor of three. This presentation will focus on discussing the experimental system and the process involved in the discovery and frequency measurement of far-infrared laser lines.

<u>Typical Reviewer Feedback to the Selection Committee</u>

Reviewers evaluate abstracts with scores ranging from 1(unacceptable) to 5 (exceptional). Typical reviewer scores for this abstract would range between 4 and 5. This abstract would score high in all categories with an overall average of either 4.33 or 4.67 (our goal is to have each abstract reviewed by three individuals in the discipline). Some items that could be fixed in this abstract include

a. *The use of millimeters rather than micron since more people would be familiar with it.*
b. *Most people may not understand the "fractional" in "fractional uncertainty," but the idea of uncertainty is conveyed.*
c. *Paragraph 3, sentence 2 will be impenetrable by the congressional office, but the first sentence attempts to soften this. The one thing that is missing is how this discovery might be important into the future. For example, revising the last paragraph to include something like "for use in fingerprinting molecules of atmospheric or interstellar interest."*

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The $CH_3{}^{18}OH$ isotopic form of methanol has been reinvestigated as a source of far-infrared (FIR) radiation by optically pumping it with a cw CO_2 laser. $CH_3{}^{18}OH$ is a slightly asymmetric top molecule with 12 fundamental vibrational modes, 11 of which are IR active. A primary reason for its success as a laser source is the excellent overlap of the strong absorbing C-O stretch vibrational mode with the CO_2 laser emission, both of which occur in the 900 to 1100 cm^{-1} region of the infrared spectrum. Equally important features are the complexity of the vibro-rotational spectra and the fairly large permanent components of the electric dipole moment.

The OPML system consisted of a CO_2 pump laser used to excite the $CH_3{}^{18}OH$ medium held within an FIR laser cavity. The CO_2 pump laser was capable of generating laser action out to 9*R*(58), 9*P*(60), 10*R*(58) and 10*P*(60) with powers up to 30 W. This radiation was then focused into a nearly confocal Fabry–Perot cavity configuration that utilizes an X-V pumping geometry. In all, four FIR laser lines were discovered and twelve laser frequencies were measured for the first time using heterodyne techniques. This includes the discovery of the 33.15 micron laser line whose frequency is the first 9 THz laser emission generated by this laser medium. This presentation will focus on discussing the experimental system and the process involved in the discovery and frequency measurement of far-infrared laser lines.

Typical Reviewer Feedback to the Selection Committee

Reviewers evaluate abstracts with scores ranging from 1(unacceptable) to 5 (exceptional). Typical scores would probably average around a 3 from most divisions. There is a wide range of problems with this abstract. It is filled with jargon and is technically dense. Most reviewers would probably score it very low readability, probably a 1. This would also translate into a low score in the applicant's ability to present (convey information) to a non-technical but educated audience. Will the student's presentation be this technical when discussing the work with someone visiting the event? While the abstract is technical, that does not necessarily indicate it has technical merit. Interest in this project beyond the select few researchers working in this area is unclear. The abstract does infer the work is complete (something that would be verified in the faculty member's letter of recommendation). Note that we highlighted the spelling mistake – abstracts have been received with such mistakes in them and such errors detract from the quality of the work.

An abstract like this would most likely never be selected for presentation at this event.