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Precision Mid-Infrared Frequency Comb Spectroscopy using a Cross-Dispersed Spectrometer

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Advances in optical technology have led to the commercialization and widespread use of broadband optical frequency combs for multiplexed measurements of trace-gas species. Increasingly available in the mid-infrared spectral region, these devices can be leveraged to interrogate the molecular fingerprint region where many fundamental rovibrational transitions occur. Here we present a cross-dispersed spectrometer employing a virtually imaged phased array etalon and ruled diffraction grating coupled with a difference frequency generation comb centered near 4.5 μm . The spectrometer achieves sub-GHz spectral resolution with a 30 cm^{-1} instantaneous bandwidth. Laboratory results for nitrous oxide isotopic abundance retrieval will be presented. Challenges relating to characterizing the instrument lineshape function, constructing a frequency axis traceable to the comb, and accurate spectral modelling will be addressed and progress towards incorporating a more compact laser frequency comb source into the system will be discussed.