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From Rocket Engines to Exoplanets: Dual Frequency Comb Spectroscopy of High Temperature and Pressure Lineshapes in Support of Extreme Environment Diagnostics

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Absorption spectroscopy provides a powerful means to probe harsh and remote environments ranging from rocket engines to exoplanet atmospheres. Accurate absorption spectroscopy is founded on high fidelity measurements of the absorption spectrum, and an accurate model for how the absorption spectrum evolves under different conditions. I will discuss work in the precision laser diagnostics laboratory to advance both high fidelity absorption measurements in harsh environments, and accurate absorption models to interpret those measurements. In particular, I will discuss the latest advancements in dual frequency comb absorption spectroscopy, especially for harsh combustion and atmospheric environments outside of the traditional laboratory. I will also discuss how we are using these same tools in controlled laboratory environments to measure absorption spectra and determine accurate absorption parameters to improve databases, especially at high temperature and pressure. For example, I will show recent results from a new laboratory optical facility that we built to achieve a uniform 46 centimeter pathlength through sample gases up to 1000 K and 50 bar (Fig.1). We have used this optical facility together with a dual frequency comb spectrometer to measure high-temperature and -pressure CO_2 to test and improve the temperature dependence of line mixing models. Altogether, these advancements are creating new opportunities for absolute, in situ sensing in a range of applications.

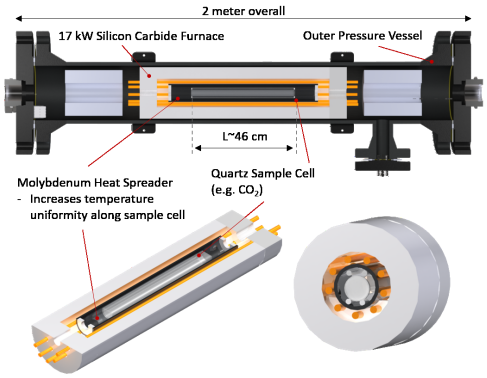

Figure 1: Schematic of new high-pressure and -temperature gas cell for dual frequency comb absorption studies.