Spectroscopic Detection of $^{14}CO_2$: Towards Parts Per Quadrillion Sensitivity

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Measurement of radiocarbon concentration has important and countless applications in several fields of investigation, e.g. environmental monitoring, nuclear security, dating of biological samples, pharmacology. Our group has already demonstrated that saturated-absorption cavity ring-down (SCAR) spectroscopy[1], performed on the very strong transitions of radiocarbon dioxide ($^{14}CO_2$) around 4.5 micron[2], enables the detection of this isotopologue at extremely low concentrations, well below the natural abundance of 1.2 ppt, and even at high enrichment values[3]. Recently, we have been improving the experimental apparatus in order to simplify it, to increase the achievable sensitivity and to move towards a field-deployable analyzer. The comb-referenced difference-frequency-generated source has been replaced by a pair of quantum cascade lasers directly emitting at 4.5 micron and referenced to a molecular transition. The dry-ice cooling of the spectroscopic cavity has been replaced by a Stirling cryo-cooler operated at a lower temperature. Preliminary results show that this new setup is very promising in terms of overall sensitivity, robustness, compactness and simplicity in view of field-deployable instrumentation.

References
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