Terahertz rotational spectroscopy of the SO radical

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The SO radical is a well-known interstellar species already identified in a wide variety of astrophysical environments (e.g. [1]). Despite intensive spectroscopic studies performed in the laboratory on this radical, no pure rotational transitions of SO have been reported at frequencies higher than 1.9 THz. We have recorded the pure rotational spectrum of SO in the THz spectral range using synchrotron-based Fourier-Transform (FT) FIR and continous wave (CW) THz techniques.

A FT-FIR spectrum of SO has been recorded at the AILES beamline of SOLEIL synchrotron in the spectral range 44-93 cm^{-1} using a resolution of 0.001 cm^{-1} allowing an accuracy on line position of 0.00007 cm^{-1} (~2 MHz). A multipass absorption discharge cell aligned to an absorption path length of 24 m has been used [2]. A continuous electrical discharge (1 A / 980 V) in a flowing mixture of H_2S, He, H_2 and air (respectively at pressure of 0.01, 1.15, 0.14 and 0.06 mbar) was used to produce SO.
On this spectrum, 102 transitions of SO have been identified with N''=31 to 65. Among the observed lines, 99 are detected for the first time (22 new transitions belong to the HIFI spectral windows). Due to our limited instrumental resolution, transitions involving N'' ranging from 31 to 43 show unresolved fine structure triplets.

We also have recorded a high resolution THz spectrum of SO using CW-THz technique [3]. This radical was produced using a radiofrequency discharge of 50 W in a continuous flow of air within a pyrex cell containing sulfur. 105 pure rotational transitions of the main isotologue ^{32}SO have been recorded in the spectral region 731 GHz – 2.511 THz ($16 \leq N'' \leq 58$). All of these transitions present a completely resolved fine structure. Thanks to a very good signal-to-noise ratio, an accuracy on frequency down to 7 kHz has been reached. We also have recorded pure rotational transitions of both ^{34}SO and ^{33}SO in natural abundance. 48 transitions of ^{34}SO, and 21 of ^{33}SO, have been recorded in the respective spectral ranges 716 GHz – 1.338 THz ($17 \leq N'' \leq 32$) and 723 GHz – 978 GHz ($16 \leq N'' \leq 22$).

These new data, combined with data of the litterature (see e.g. [4]), have been used to determined effective molecular parameters of these three isotopologues using the SPFIT/SPCAT suite [5]. A significant improvement on the determination of these parameters has been obtained.

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