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Absorption Cross Sections of Sulfur Dioxide Isotopologues and the Dual Beam Spectrometer

Denise Mahler (1), Carl Meusinger (1), Sebastian Danielache (2), Yuichiro Ueno (2), Remy Jost (3), and Matthew S. Johnson (1)

(1) Department of Chemistry, University of Copenhagen, Copenhagen, Denmark, (2) Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology, Tokyo, Japan, (3) Laboratoire de Spectrometrie Physique, Universite Joseph Fourier de Grenoble, France

SO2 plays a key role in the atmospheric sulfur cycle, and is a precursor for sulfate. As a major contributor to aerosol formation in the stratosphere and troposphere, sulfate precipitates with time and deposits in sediments and rocks. Given its importance and complex photochemistry, the study of atmospheric processes involving SO2, has been of great interest to many researchers around the world, for many years (1 and references therein). The interest in ultraviolet spectra of SO2, including spectra of the different isotopologues, has recently increased, as it was shown how the photolysis of SO2 has an influence on isotopic enrichments and can cause mass independent fractionation (MIF) observed in rocks older than 2.4 billion years (also called Archean MIF)(2). Absorption cross sections of the different isotopologues of SO2 are needed for a more thorough understanding of these processes.
A dual beam spectrometer was designed and built for the purpose of measuring high-precision absorption cross sections of the isotopologues 32SO2 , 33SO2 , 34SO2 and 36SO2 . The absorption cross section of 36SO2 has to our knowledge not been measured before.
The dual beam spectrometer is an optical setup, which uses a monochromator and through beam splitter to lead ultraviolet light of a specific wavelength from a deuterium lamp through two equivalent cells. The cells are filled with different SO2 isotopologues and the transmittance of light going through the cells is measured with a photo multiplier tube (PMT). The pressures in the two cells are determined very precisely with a differential pressure gauge, which allows for high sensitivity measurements. This means that relative absorption cross sections at a wide range of wavelengths can be measured precisely with the dual beam spectrometer. Further analysis allows determination of the wavelength dependent fractionation factors and the isotope effects of different isotopologues(1). The dual beam spectrometer and the level of precision are described and first measurements presented.
1 S. O. Danielache, C. Eskebjerg, M. S. Johnson, Y. Ueno and N. Yoshida, JGR-A 113(D13), D17314, 2008.
2 Y. Ueno, M. S. Johnson, S. O. Danielache, C.Eskebjerg, A. Paudey and N. Yoshida, PNAS 106(35) 14784, 2009.