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RESONANCE IONIZATION OF SO_2 MOLECULE

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1. INTRODUCTION

The resonance ionization (RI) of an atomic system is a two-step process which can be represented by: (1) an m-photon (λ_1) absorption and transition from the ground state to an excited bound state, and (2) an n-photon (λ_2) absorption and transition from the excited bound state into ionization continuum. It is, generally, m+n resonantly enhanced multiphoton ionization, in opposite to direct nonresonance multiphoton ($\lambda_1 = \lambda_2$) ionization via virtual excited states (NRI). In this work, the simplest scheme,

$$m = n = 1, \quad \lambda_1 \neq \lambda_2, \tag{1}$$

is realised for SO_2 molecule in gas phase. SO_2 has C_{2V} symmetry, convenient for simpler formal approaches in interpretation of experimental results.

2. EXPERIMENTAL

The experiment is presented schematically in figure 1. The gas (SO_2+air) inlets in the interaction chamber, K, and intensively absorbs λ_1 photons from the Zn low pressure spectral lamp, S_1, focused by the lens, L, and selected by the interference filter, FI ($\lambda_1 = 213.8nm$). Absorption band of SO_2 due to $X \rightarrow C(^1B_1)$ transition is

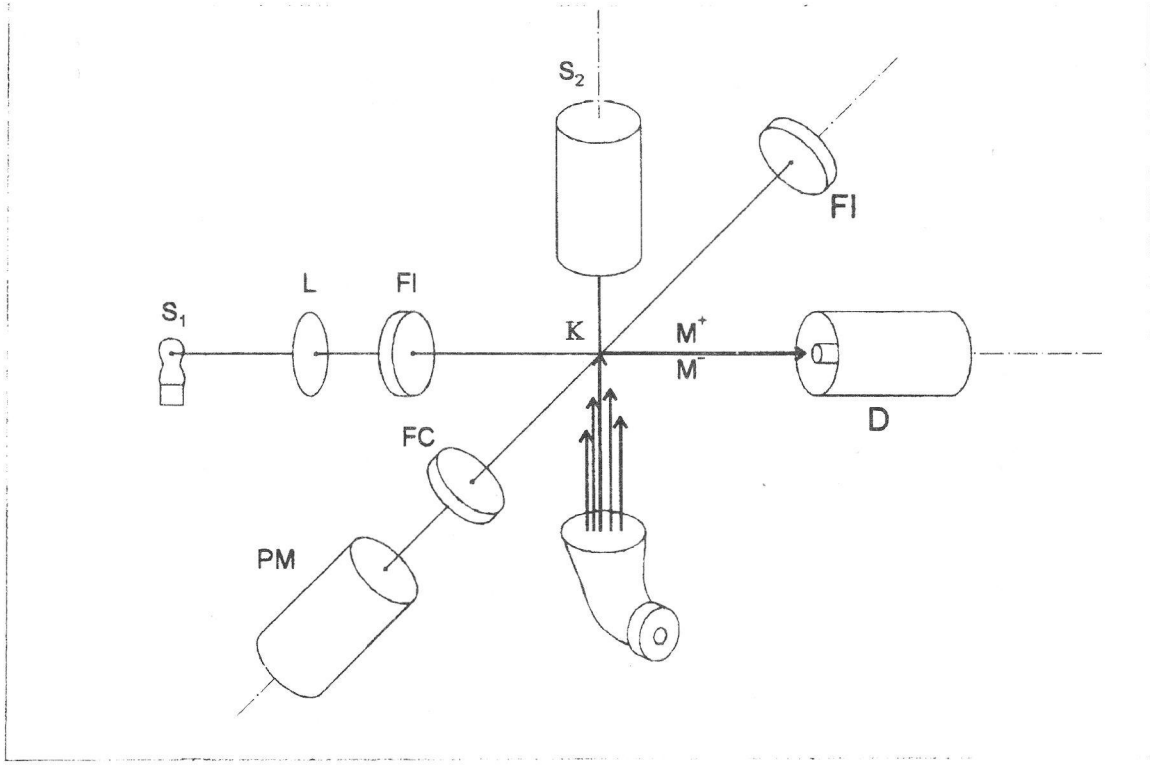

Figure 1. Schematic diagram of the resonance ionization apparatus

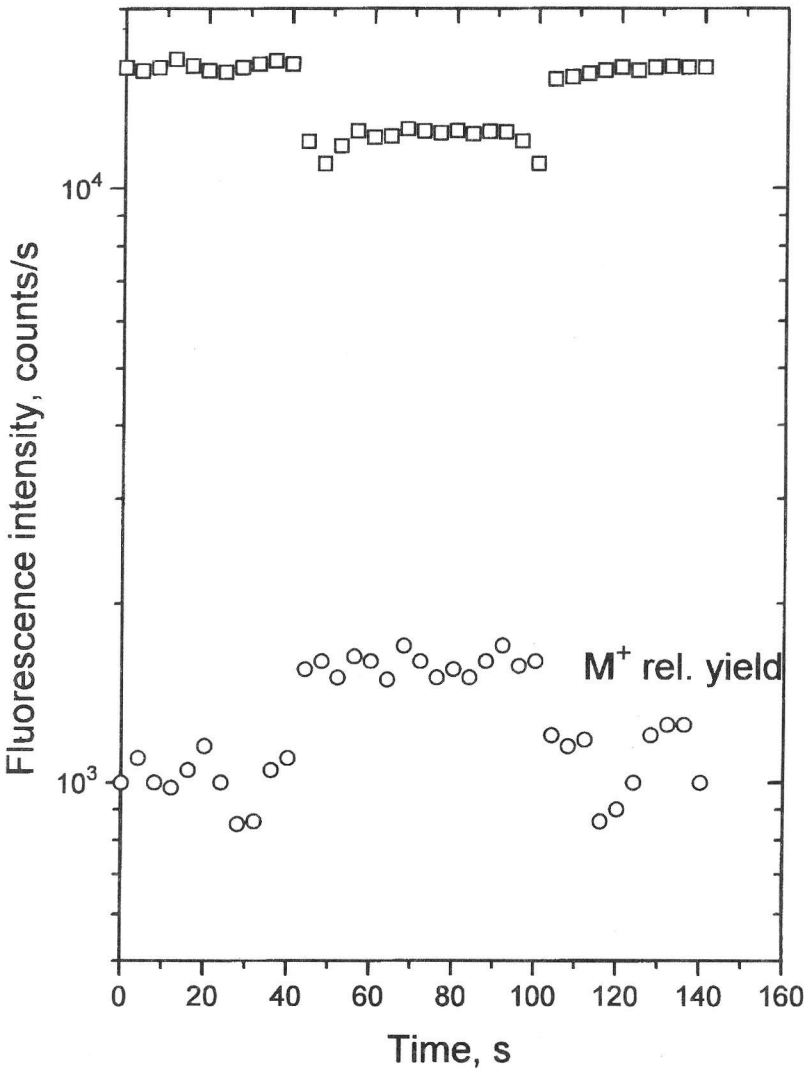

Figure 2. Fluorescence signal without and with Grimm-source, and relative yield of M^+ ions (bottom)

isolated in UV-absorption spectrum of the air [1]. Maximum of the SO_2 fluorescence, in the wavelength region of 320-340 nm, detects by photomultiplier, PM (EMI 9813 QB), after filtering by Corning filter, FC. The interference filter vis-a-vis PM, FI, is an excellent mirror for the fluorescence, and a window for λ_1 photons, as well. The part of the apparatus just presented is actually an fluorescence detector of SO_2 in the air.

As the second photon source we used a hidrogen Grimm-type source, S_2, [2] rearanged to give larger intensity, with the MgF_2 lens as front-side window. Because there is no strong evidence of L_α emission from S_2, an aim of our experiment is to check this. Namely, L_α photons have sufficient energy to ionize SO_2 excited to $C(^1B_1)$ state.

The indication of RI process is a decrease in fluorescence signal when S_2 is turned on (figure 2). Because a number of different processes are possible energetically, the proof of existence of the RI process is appearance of positive ions in the ion detector, D, (Institute of Physics, Belgrade, type CDJ04-AT, computer assisted) in the time interval when the fluorescence signal is decreased (figure 2. bottom).

We conclude that the apparatus designed and bult is suitable for further investigation of RI process in SO_2 due to his basic importance, and because it is a candidate for application in air-pollution monitoring.

Acknowledgement

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