ELECTRON-INDUCES FLUORESCENCE OF CARBON MONOXIDE

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Introduction

Carbon monoxide [CO] is a relatively abundant molecule in the Universe, and plays a crucial role as a life-forming precursor. It is one of the dominant carbon bearing molecules species in various extraterrestrial environments, including comets and centaurs. In particular, the $A^2\Pi - X^2\Sigma^+$ transition of the ionized form CO^+ is especially prominent in emission spectra of the cometary tails, a feature commonly referred to as the Comet Tail system. The spectroscopic diagnostics of such cometary volatiles are essential for solar system formation models [1]. Due to the lack of a permanent dipole moment in molecular hydrogen (H_2), CO is widely used as a tracer for H_2 in the interstellar medium [2]. Furthermore, CO is a significant component of planetary atmospheres, particularly on Mars and Venus. Monitoring CO in the Martian atmosphere is a valuable approach to studying its oxidizing capacity and overall atmospheric chemistry [3].

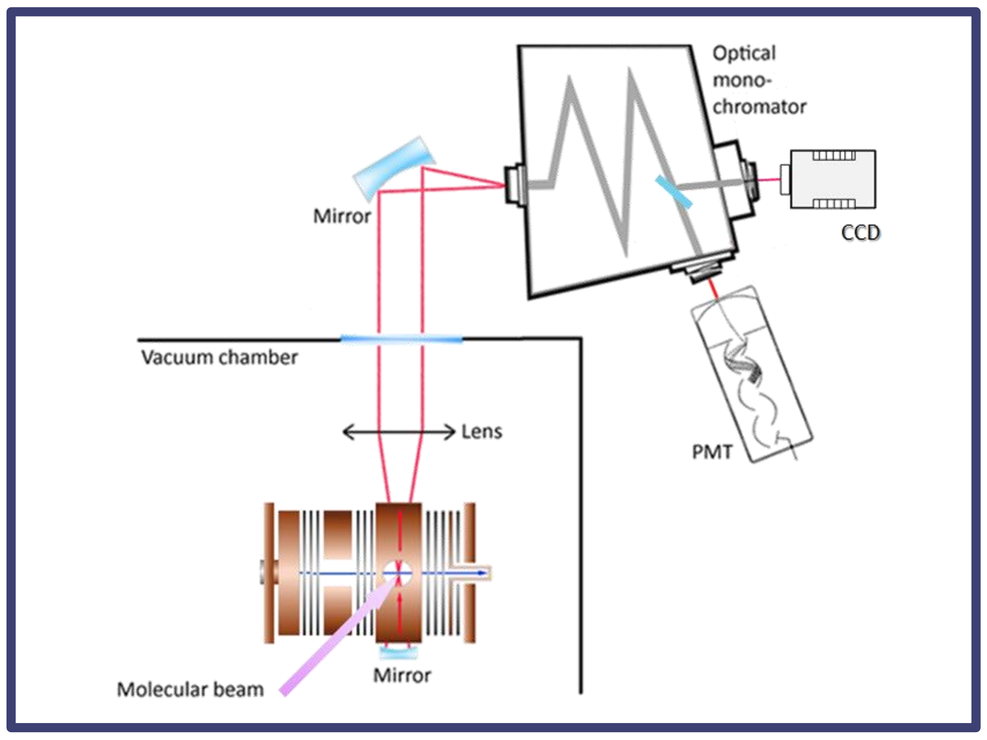

Fig.1: *Scheme of electron induced fluorescence apparatus.*

Experimental results

The emission spectrum of CO was measured in the wavelength range of 300 – 1000 nm at 50 eV electron energy and is depicted in Fig. 2 and 3. This spectral region is dominated by the Comet Tail system of CO^+ ($A^2\Pi - X^2\Sigma^+$), few emission bands of the Baldet – Johnson system of CO^+ ($B^2\Sigma - A^2\Pi^+$) and the emission lines of C and O in the higher wavelength region. Along with the emission bands of ionized CO^+, we have identified several emission bands of neutral CO.

Fig. a.4 shows the excitation-emission function of the First Negative system of CO^+ ($B^2\Sigma - X^2\Pi^+$) at 230.3nm with a threshold energy of 20.0eV. Fig 4.b presents the third Positive system of CO ($b^3\Sigma^+ - a^3\Pi$) at 297.2nm with thersholds energy identified at 10.6 eV. Fig.4.c) shows signal from two excitation-emission functions measured at 402.2 nm. It consists emissions from the Asundi system of CO ($a'^3\Sigma+ - a^3\Pi$) and the Comet Tail system of CO+ ($A^2\Pi - X^2\Sigma^+$) with threshold energies at 10.2 eV and 18.0 eV respectively. The excitation emission function of the Ångström system of CO ($B^1\Sigma^+ - A^1\Pi$), depicted in Fig.4.d), was measured at 451.1 nm. Its threshold energy was determined at 9.5 eV.

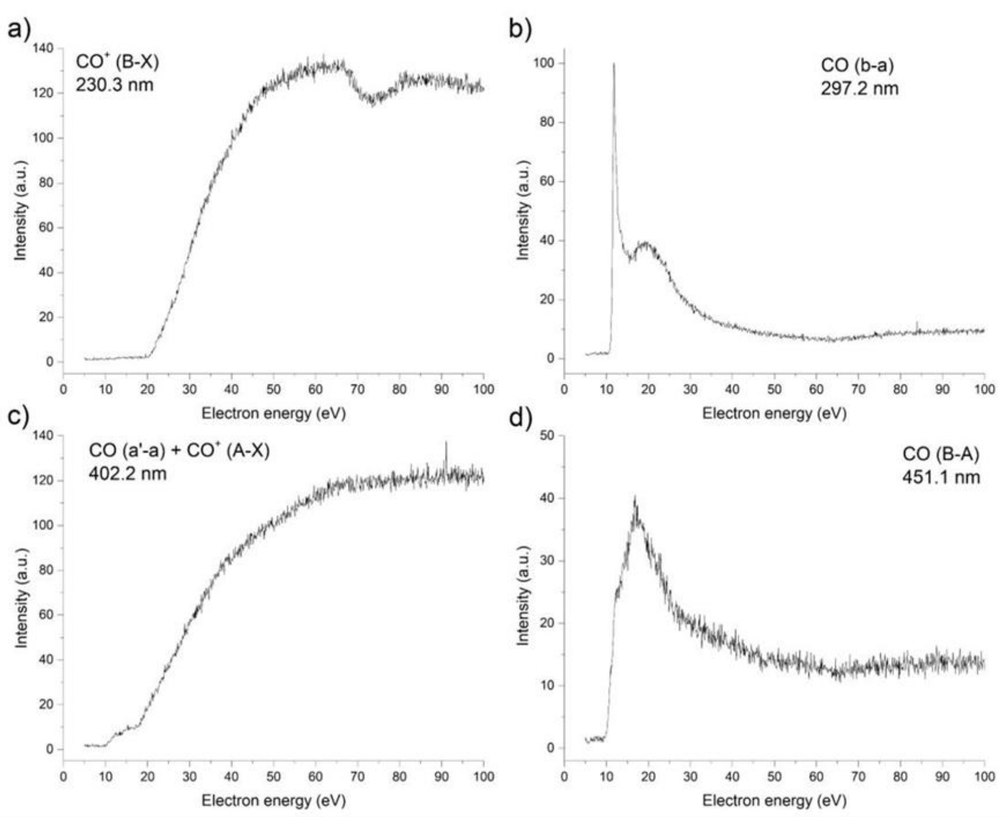

Fig. 4: *Excitation-emission functions: a) CO^+ ($B^2\Sigma - X^2\Sigma$) at 230.3 nm, b) CO ($b^3\Sigma^+ - a^3\Pi$) at 297.2 nm, c) CO ($a^3\Sigma^+ - a^3\Pi$) combined with CO^+ ($A^2\Pi - X^2\Sigma^+$) at 402.2 nm, d) CO ($B^1\Sigma^+ - A^1\Pi$) at 451.1 nm.*

Experimental setup

The experimental setup is located at Comenius University in Bratislava, Slovakia, and consists of a crossed-beam configuration combining an electron monochromator and a gas beam. The electron induced emission spectra are measured using a Czerny–Turner optical monochromator, which provides a spectral resolution of 0.3nm FWHM and is equipped with a photomultiplier that is sensitive between 185 and 900 nm, and a CCD camera operating at wavelengths from 300 to 1100 nm.

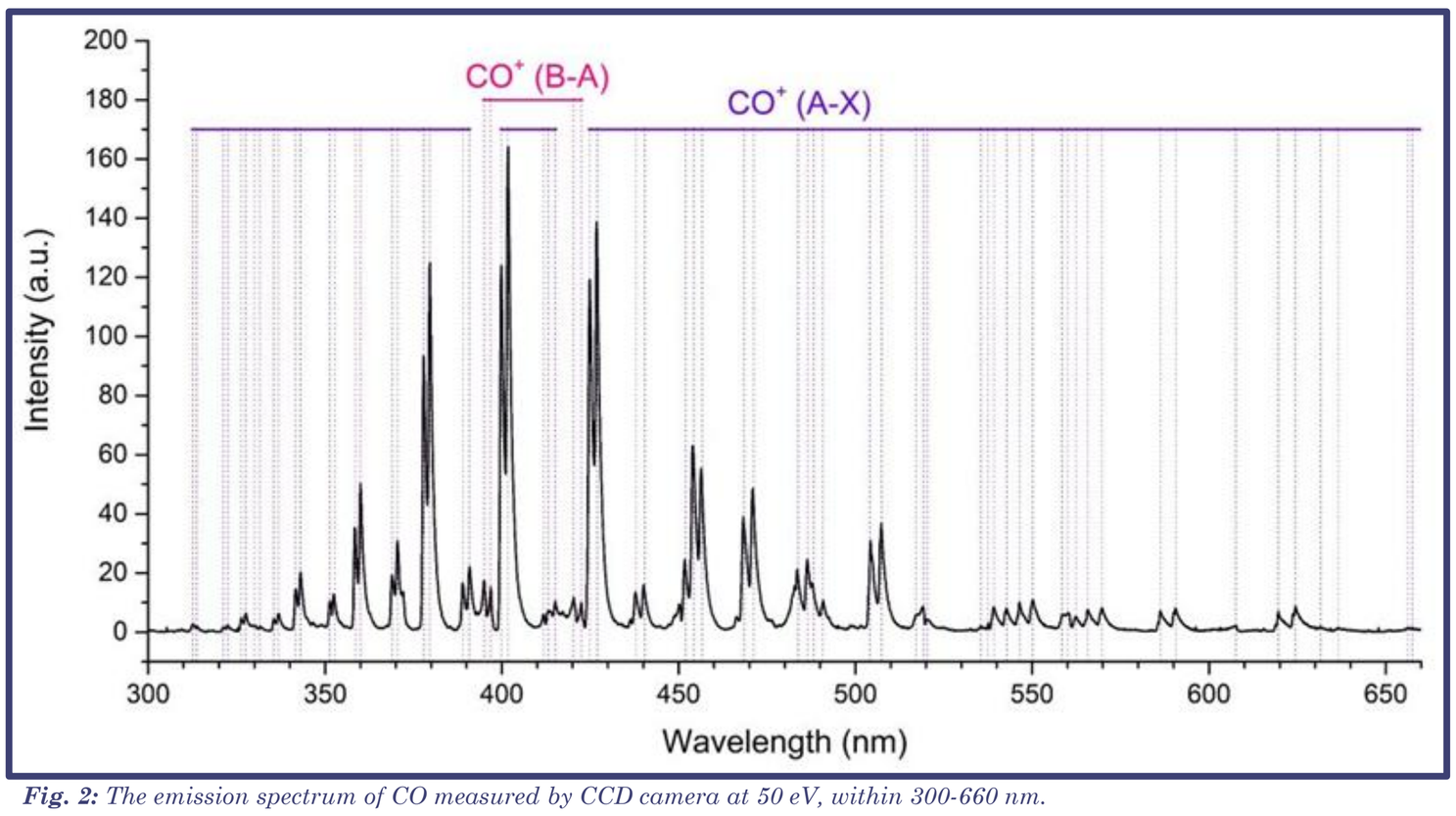

Fig. 2: *The emission spectrum of CO measured by CCD camera at 50 eV, within 300-660 nm.*

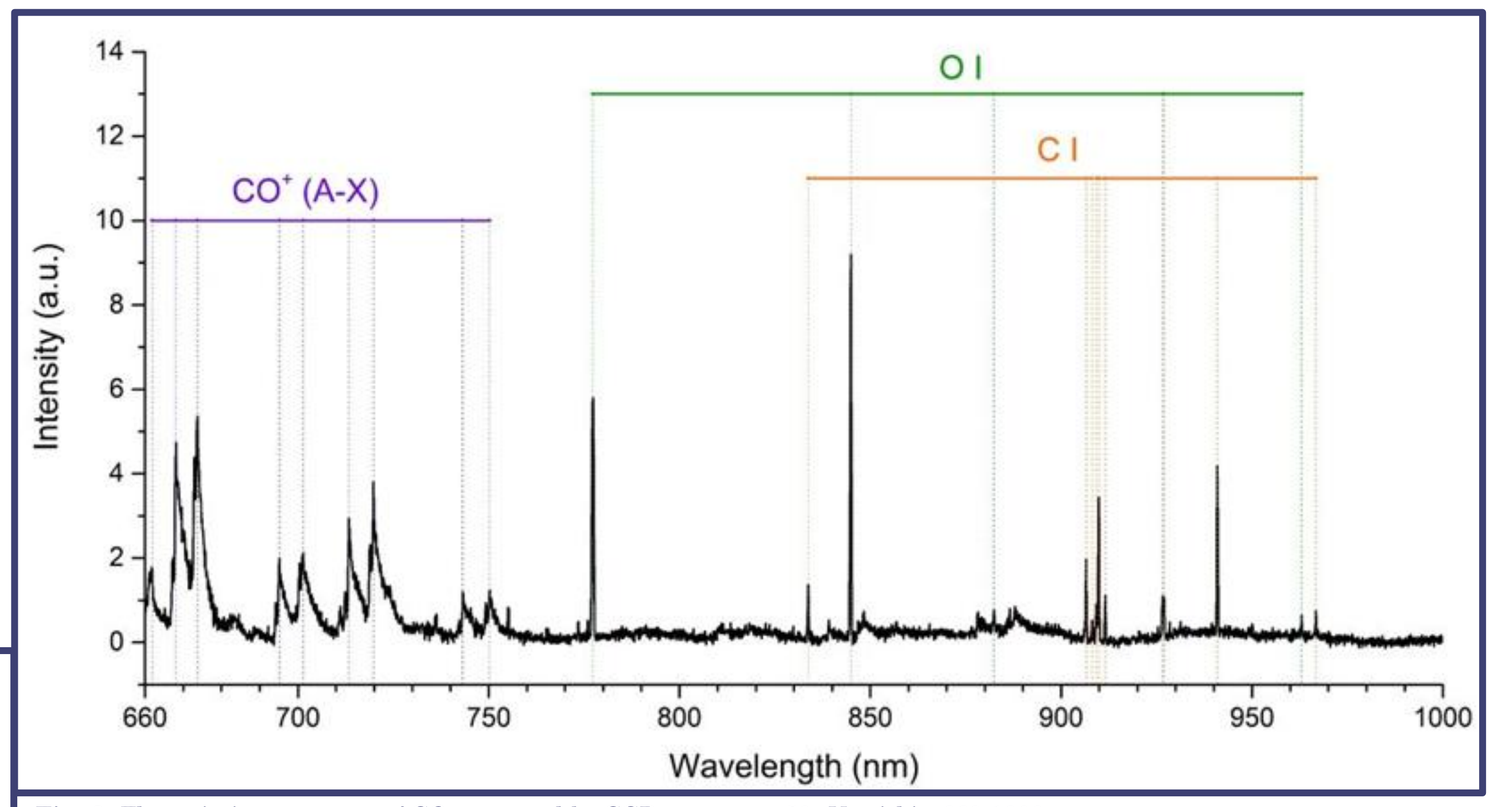

Fig. 3: *The emission spectrum of CO measured by CCD camera at 50 eV, within 660-1000 nm.*

Further research will be focused on the emission of neutral CO, that is visible at lower electron energies, and also the threshold energies of all identified transitions will be estimated. The data will be calibrated to absolute values of the cross sections, which will make it suitable as a reference data for astrophysical research.

References

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