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ELECTRON SCATTERING BY Yb: EXCITATION OF THE $4f^{14}6s6p\ ^3P_1$ STATE

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Electronic structure of ytterbium makes this alkaline-earth-like atom very interesting for investigation of a number of electron – atom collision processes, but only limited number of information is available for its electron – impact excitation. Kazakov and Hristoforov [1] obtained relative differential cross sections (DCSs) for near-threshold impact energies. Zetner *et al* [2] measured relative DCSs for the excitation of the $6s6p\ ^3P_{1,2}$ states at incident electron energies E_o = 10, 20 end 40 eV, and scattering angles (θ) up to 60°. The excitation cross sections have been calculated by Zetner *et al* [2] in the unitarised distorted wave (UDW) approximation and by Srivastava *et al* [3] in the relativistic distorted-wave (RDW) approach.

The apparatus used in this measurement is a conventional electron/atom cross-beam spectrometer [4]. The measurement was carried out at temperature of about 870 K for Yb 99.99% purity (target density about 3×10^{13} cm^{-3}). Angular distributions of inelastically scattered electrons were measured at incident electron energies E_o = 10, 20 and 40 eV, from θ = 2° to 150°. Uncertainty of the energy scale was estimated to be 1%. Overall energy resolution (FWHM) was about 65 meV and the angular resolution 1.5°. We applied the effective path – length correction to obtain the retaive DCSs.

In order to compare our DCS at E_o = 20 eV in shape with other available results we normalized present DCS to experimental data obtained by Zetner *et al* [2] at 10° (Fig. 1). Both experimental DCSs are strongly forward – peaked. This behaviour suggests that the singlet component of intermediate coupled $^3P_1$ state play an important role at this energy. Local DCS minimum between 40° and 50° is not confirmed experimentally. At higher scattering angles ($\theta \geq$ 50°) local minima of present DCS are similar in shape (but not in position) to those of the RDW calculation by Srivastava et al [3]. Deep local DCS minimum between 120° and 130° obtained in the UDW calculation by Zetner et al [2] is more pronounced than other two presented, and those obtained in present experiment and in RDW approach.

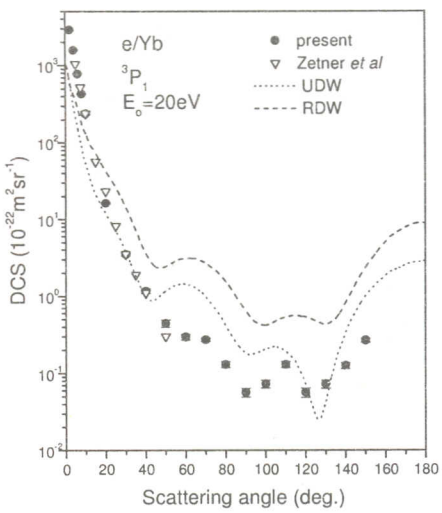

Fig 1. Differential cross section for excitation of the $^3P_1$ state of Yb at E_o = 20 eV.

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ELECTRON SCATTERING FROM THE GROUND STATE OF ZINC

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Electron scattering from zinc has been the subject of renewed interest over the last few years. To a large extent such interest was initiated by investigation of using zinc as a replacement for mercury in high-pressure discharge lamps [1] and the associated requirement for accurate collision data. We present results of a joint theoretical and experimental investigation of electron scattering from the $4s^2\,^1S$ ground state of zinc. Differential cross sections (DCS) for elastic scattering and excitations of $4s4p\,^1P^o$, $4s5p\,^1P^o$, $4s4p\,^3P^o$, $4s5s\,^1S$ states were measured at scattering angles between 10 and 150 degrees and a range of incident electron-energies between 10 and 60 eV. These cross sections have been put on the absolute scale and estimates of the integrated cross sections have been obtained. The convergent close-coupling calculations have been performed and compared with present and earlier experiments and other theoretical calculations. As an example we present for the $4s4p\,^1P^o$ state the DCS in Fig. 1 at 40 eV, and the ICS in Fig. 2. The interesting feature for this transition in Zn is the nonperturbative nature of the excitation process as emphasised in Fig.2 by a large differences between the First-Born Approximation (FBA) and the close-coulpling-based calculations, CCC and BSRM.

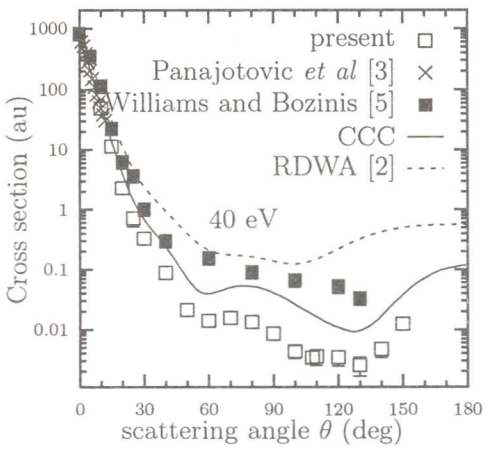

Fig. 1. DCS at 40 eV for excitation of the $4s4p^1P^o$ state of Zn.

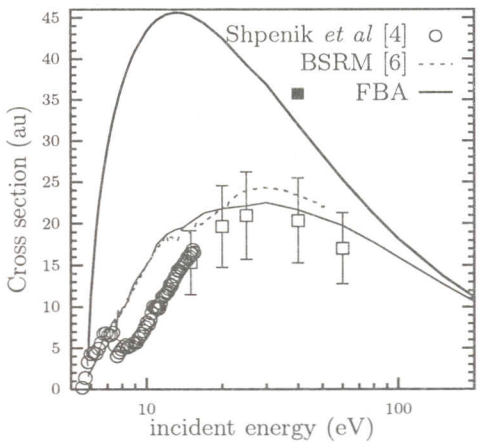

Fig. 2. Integral cross sections for excitation of the $4s4p^1P$ state of zinc.

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ELECTRON ENERGY LOSS SPECTRA OF GLYCINE AND TETRAHYDROFUAN MOLECULES

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Electron excitation of molecules important for biological systems has been the subject of our research. The investigation of these processes has been done in order to estimate relevance of electron interaction to radiation damage.

We have used two electron spectrometers, ESMA [1] and UGRA [2], to record energy loss spectra. The first spectrometer is equipped with the titanium oven heated by coaxial heater and hemispherical energy selectors both in monocromator and analyzer. The crucible was filled with glycine powder and heated to temperature from 440 K to 460 K in order to obtain effusive beam.

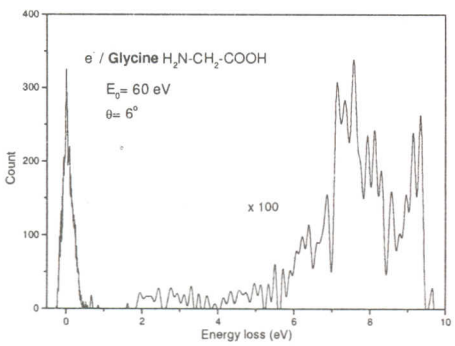

Figure 1: Electron energy loss spectrum of glycine and its fragments.

The second spectrometer consists of electron gun that produces an intense unmonochromated electron beam, perpendicularly placed needle for effusive molecular beam and double cylindrical mirror analyzer with a single channel electron multiplier. The 99.9% anhydrous THF was used, after several freeze-thaw cycles under vacuum.

The 60 eV electron energy loss (EEL) spectrum of glycine and its possibly fragments present in the effusive beam is presented in fugure 1. The EEL of gaseous THF, for incident electron energies of 50 eV (inset) and 100 eV, are presented in figure 2. The present results are in good agreement with the recent EEL spectra obtained with THF film deposited on a Pt(111) crystal [1], as well as with the latest near-threshold gas-phase measurements [2]. The electronic states of THF attributed to Rydberg states, according to the latest VUV analysis [2], are marked in the figure.

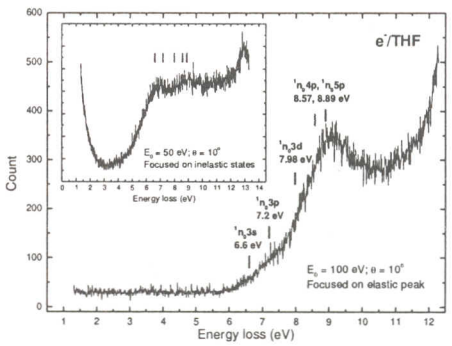

Figure 2: Electron energy loss spectrum of THF.

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ENERGY AND ANGULAR DISTRIBUTIONS OF POSITIVE IONS FROM ELECTRON INDUCED DISSOCIATIVE IONIZATION OF TETRAHYDROFURAN MOLECULE

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We report measurements of energy and angular distributions of positive ions (PI) produced by 10-200 eV electron induced dissociation of gaseous tetrahydrofuran (THF) molecule (C_4H_8O). The ionization processes play the most important role in molecular radiation damage of living cells. In particular, the investigation of dissociation of THF, which is the DNA backbone sugar-like analogue, is relevant for understanding the processes leading the damage of DNA sugar chain [1].

The experimental set-up was basically the same as used for electron scattering measurements (e.g. [2]), and was only slightly upgraded for efficient collecting of positive ions. In short, an unmonochromated electron beam was crossed perpendicularly to the target beam. The PI were energy analyzed by a double cylindrical mirror analyzer and detected by a single channel electron multiplier. The 99.9% anhydrous THF was used, after several freeze-thaw cycles under vacuum.

In figure 1a, we present preliminary obtained angular distributions of zero energy PI. In the inset of the same figure, a typical energy distribution of PI is shown. The uncertainty of the energy scale calibration does not allow an exact determination of the position of maximum yield of zero energy PI. Except the most intense low energy peak, at least two other groups of ions can be deduced from the spectrum in figure 1a, one between 0.7-2 eV, and the other with a peak at about 3 eV.

In figure 1b, we present the PI yield as a function of incident electron energy (E_0). The lowest ionization energy of THF is 9.74 eV [3]. The steep rise of signal above 14 eV has been also obtained in the previous measurements of electron-stimulated desorption yields of H^- [1], and was suggested to be the characteristic of nonresonant dipolar dissociation of C-H bounds.

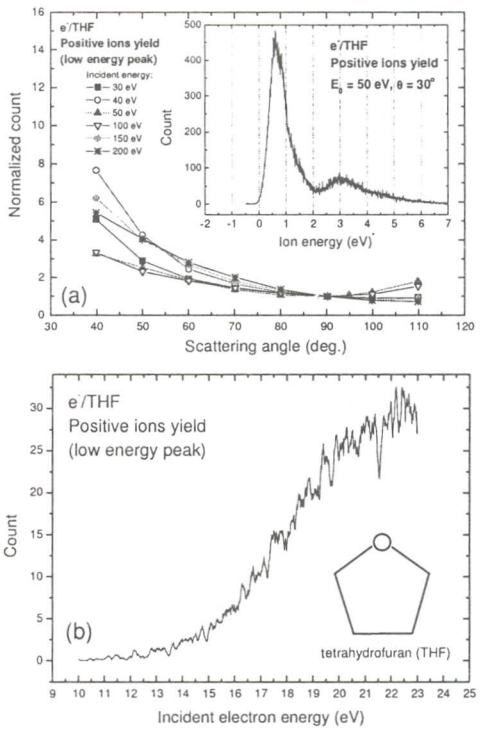

Figure 1: (a) Angular distribution of zero energy PI (normalized at 90°). Inset: Energy distribution of PI. (b) PI yield as a function of E_0.

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