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THE ENERGY-LOSS SPECTRA OF CADMIUM AUTOIONIZING LEVELS EXCITED BY 15 TO 60 eV ELECTRONS

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The autoionizing levels in cadmium have been a subject of many investigations utilizing different techniques: photoabsorption /1/2/3/, electron-ejected spectroscopy /5/6/, electron impact ionization /6/. Here, we present the first high resolution energy-loss spectrum of cadmium autoionizing levels.

Scattered electrons due to excitation of autoionizing levels were observed from the first ionization limit (8.994 eV) up to 18 eV. Incident electron energies were between 15 to 60 eV. The angle of observation was from 0° to 150° with respect to the incident electron beam. Spectra were obtained with an energy resolution of approximatively 40 meV.

A crossed electron-atom beam technique has been used in the electron spectrometer already described earlier /7/. The atomic beam has been produced by heating Cd metal in a wire heating oven to 310°C.

An energy-loss spectrum of cadmium autoionizing levels is shown in Fig.1. Incident electron energy is 40 eV and angle of observation is 5°. On this spectrum autoionizing levels which are due to inner shell excitation of one 4d electron and due to simultaneous excitation of two 5s electrons are present. As a result of excitation of one 4d electron, series of $4d^{9}5s^{2}(^{2}D_{3/2,5/2})nl$ type are obtained and such levels are the most prominent in our spectra. Lines which are due to simultaneous excitation of two 5s electrons can be attributed to the $4d^{10}5p$ nl configurations and have much lower intensities. Classification of these states was given by Mansfield /2/ and Pejčev et al. /5/. Line at 10.83 eV is due to double scattering (twice the energy loss corresponding to the strong $5^{1}P$ excitation at 5.417 eV).

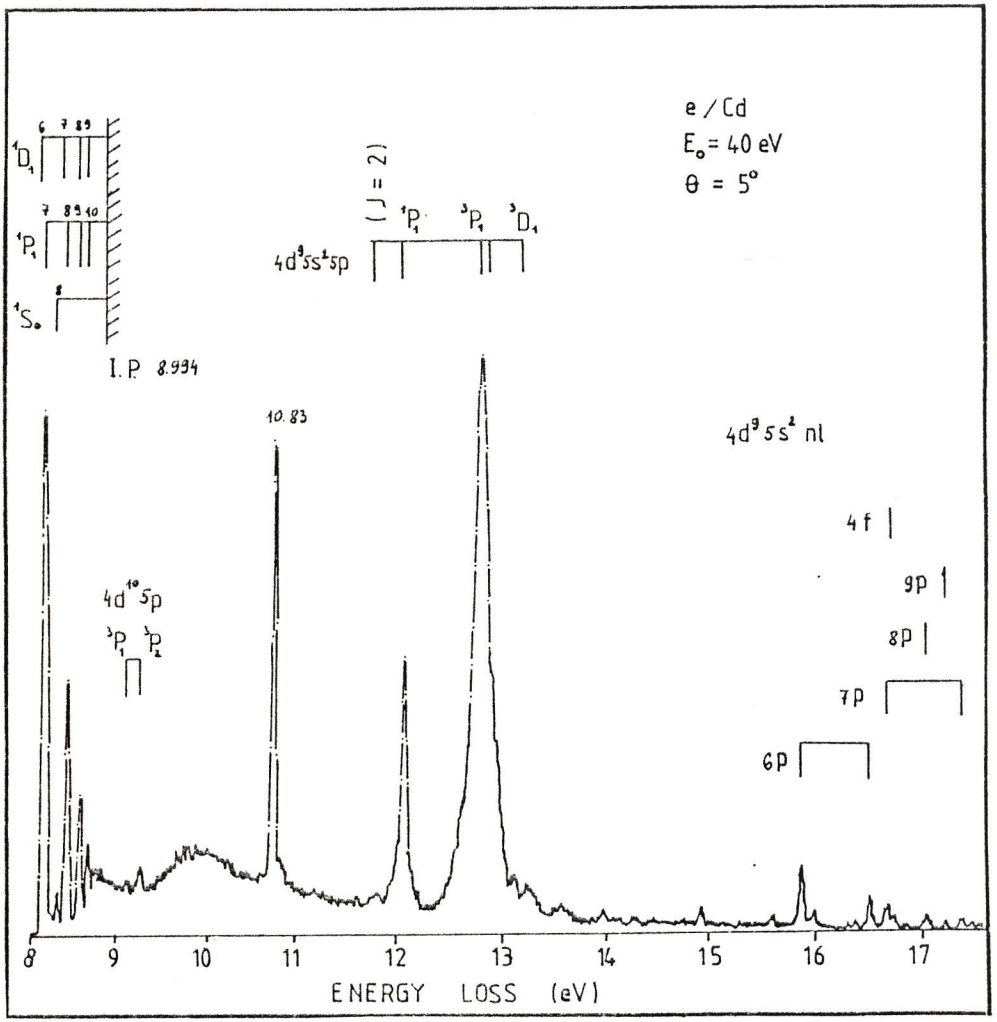
e / Cd
E₀ = 40 eV
θ = 5°
(J = 2)
¹P₁ ³P₁ ³D₁
4d⁹5s²5p
6 7 8 9
¹D₂
7 8 9 10
¹P₁
8
¹S₀
I.P 8.994
10.83
4d⁹5s² nl
4f
9p
8p
7p
6p
4d¹⁰5p
³P₁ ³P₂
8 9 10 11 12 13 14 15 16 17
ENERGY LOSS (eV)

Fig.1.

Comparing these spectra with ejected-electron spectra of Pejčev et al. /5/ which were superior in resolution (20 meV), it can be concluded that the range of observation is extended down to the first ionization limit. Most of lines in this spectrum are optically allowed transitions because the incident energy is relatively high and scattering angle small. But at low incident energies and large angles of observation optically forbidden lines are present in spectra. Still, on the spectrum in Fig.1 there are some optically forbidden lines such as $4d^{10}5p^2\ ^3P_1, ^3P_2$ and $4d^{9}5s^25p$ (J=2).

In addition, we have measured differential cross sections (DCS) for electron impact excitation of the $4d^{9}5s^25p\ ^1P_1$, $^3P_1$ states. DCS are put on the absolute scale by normalization to the optical oscillator strenghts.

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