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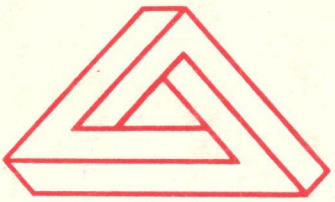

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DIFFERENTIAL CROSS SECTIONS FOR THE ELECTRON EXCITATION OF SODIUM ATOM

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Introduction: The electron impact excitation of the alkali metals, especially sodium, have been extensively studied during last years. The ground state is $3^2S_{1/2}$ with a comparatively weakly bound 3s valence electron and an inert core. The first ionization limit is at 5.139 eV and all peaks observed in energy loss spectra which result from the excitation of 3s electron are not far apart from the elastic peak. So, polarisation and absorption effects are expected to be dominant in differential cross sections (DCS) of electron scattering[1]. Also, the large coupling between 3s and 3p levels[2] and even between the whole group of states 3s, 3p, 3d, 4s, 4p and 4d is theoretically predicted[3]. The present measurements are undertaken in order to contribute to the investigations of these scattering phenomena.

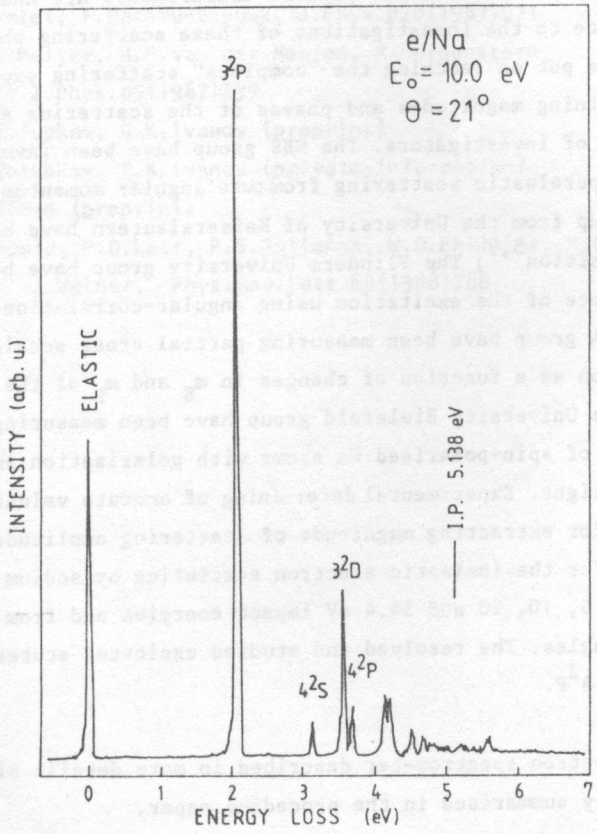
Much effort is put on reaching the "complete" scattering experiment on sodium and determining magnitudes and phases of the scattering amplitudes by several groups of investigators. The NBS group have been investigating spin-dependent superelastic scattering from pure angular momentum states of Na(^{2}P)[4-8]; the group from the University of Kaiserslautern have been studing in the 3P-3S transition[8,9]; The Flinders University group have been determining the coherence of the excitation using angular-correlation technique[10-13]; the JILA group have been measuring partial cross sections for electron excitation as a function of changes in m_S and m_L of the atomic electron[14,15]; the University Bielefeld group have been measuring electron impact excitation of spin-polarised Na atoms with polarisation analysis of the fluorescence light. Experimental determining of acurate values of DCS is a relevant point for extracting magnitude of scattering amplitude.

Relative DCS for the inelastic electron scattering by sodium atom have been obtained for 5, 10, 20 and 54.4 eV impact energies and from 0^o to 150^o scattering angles. The resolved and studied exciteted states are 3^2P, 4^2S, 3^2D and 4^2P.

Apparatus: The electron spectrometer described in more details elsewhere[17,18] was briefly summarised in the proceding paper.

Experimental procedure: The DCS of eash excited state was investigated separately. Count-rates of scattered electrons of particular energy loss were collected in the whole angular range except for the 3^2P state where two angular ranges 0^o-20^o and 10^o-150^o were necessary due to strongly forward peaked DCS.So, the 3^2P state was examined with two different intensities of atomic beam. The zero scattering angle was determined utilizing symmetrical count-rates at positive and negative scattering angles. By scanning energy loss spectra at particular scattering angle , the relative intensities of the excitation of the different states were established.

Results: In Fig.1 the energy loss spectrum at 10 eV impact energy and 21^o scattering angle is shown. The energy resolution as FWHM is 50 meV. Due to the variable interaction volume with the scattering angle, the corrections for a effective path lenght[19] were done in order to obtain relative DCS



from the experimental angular distributions. Neither atomic and electron flux densities nor absolute efficiency of detector were directly measured. To obtain absolute scale a normalization will be done to the known generalized oscillator strenghts, and to the experimental or theoretical values of the integral or total cross sections.

Discussion: DCS for electron excitation of sodium have been subject of several experimental and theoretical works. The list of the states, angular ranges and electron impact energies for which DCS are available is given in Table 1. The comparison of our results with the other available data will be presented on the Conference.

Table 1.

authors	Ref.	energies (eV)	scatt. angles	states
Shuttelworth et al.	20	54.4	0.0-21.5	3^2P
		100	2.7-13.5	
		150	0.0-15.9	
		250	0.0-13.0	
Buckmann & Teubner	21	54.4	10-145	3^2P
		100		
		150		
		217.7		
Srivastava&Vušković	22	10	10-120	3^2P,
		20		3^2S,
		40		3^2D+4^2P
		54.4		$4^2D+4^2F+5^2P+5^2S$
Teubner et al.	12	22.1	2-130	3^2P
		54.4		
Lorentz et al.	23	22.2	-120	3^2P
		54.4		
present		5.0	0-150	3^2P,
		10		4^2S,
		20		3^2D,
		54.4		4^2P
Hertel & Rost	24	25	0-30	4^2S
		50	0-25	
		100	0-20	
		500	0-10	
Mitroy et al.	25	10	0-180	3^2P
		20		
		22.1		
		54.4		
		100		
		150		

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