Scientific report on the Exchange Grant for visiting Prof. Michael Allan

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Inelastic electron scattering from rare gas atoms is an important elementary process in plasmas. Recent calculations of near threshold cross sections [1] show good qualitative agreement with experiment [2]. A more stringent test of the theory can be made by measuring absolute state-specific cross-sections, but these are sparse [3].

We have carried out an extensive set of measurements on the Ne*($2p^5$ 3s) and Ne*($2p^5$ 3p) configuration over an energy range of 2 – 3 eV above onset. In Fig. 1 one can see a measured electron energy loss spectrum which shows the 14 levels of the Ne*($2p^5$ 3s) and Ne*($2p^5$ 3p) configurations. In Table 1 their term in LS coupling and their excitation energy is given. We have studied the excitation of Ne atoms to all four levels of the Ne*($2p^5$ 3s) configuration, and to selected levels of the Ne*($2p^5$ 3p) configuration, in the near-threshold energy range (E = 16.6 – 19.2 eV). Much of the prominent anion resonance structure in this range [1, 3, 2] has been resolved. Previous work on angle-differential Ne*($2p^5$ 3s) excitation was only carried out at a few discrete impact energies above 20 eV. We carried out measurements at the angles (45°,90°,135°, and 180°) and measured the angular dependence of Ne*($2p^5$ 3s) and selected levels of Ne*($2p^5$ 3p). The work was carried out with a high resolution electron spectrometer involving a two-stage hemispherical electron monochromator and a two-stage hemispherical analyzer which are both differentially pumped [4]. The instrument incorporates a magnetic angle changer which allows to measure cross sections at backward scattering angles (around 180°) [5].

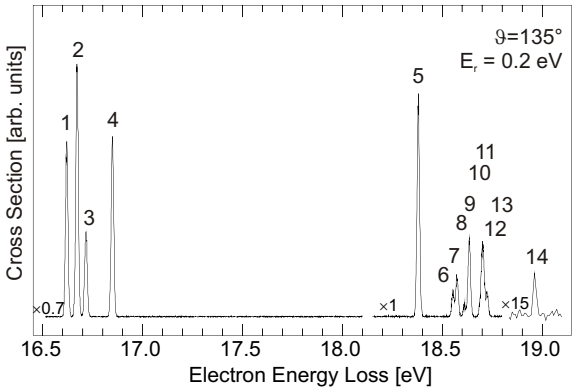

Figure 1: Energy loss spectrum of electrons scattered on neon under the scattering angle of $\vartheta = 135°$ with a residual energy of $E_\mathrm{r} = 0.2$ eV.

I was staying three periods in Fribourg with a total length of three months from Dec 2004 to March 2005. After becoming familiar with the instrument, I measured – under the guidance and in close contact to Prof. Allan – the angle-differential excitation cross section as well as the angle-differential elastic cross section. The evaluation of the data was mostly done in Fribourg and will be continued here in Kaiserslautern. First comparison with theory of the results for the Ne*(3s $^3P_2$) level

#	LS		Energy [eV]
1	3s	$^3P_2$	16.61907
2	3s	$^3P_1$	16.67083
3	3s'	$^3P_0$	16.71538
4	3s'	$^1P_1$	16.84805
5	3p	$^3S_1$	18.38162
6	3p	$^3D_3$	18.55511
7	3p	$^3D_2$	18.57584
8	3p	$^3D_1$	18.61271
9	3p	$^1D_2$	18.63679
10	3p'	$^1P_1$	18.69336
11	3p'	$^3P_2$	18.70407
12	3p	$^3P_0$	18.71138
13	3p'	$^3P_1$	18.72638
14	3p'	$^1S_0$	18.96596

Table 1: Excitation energy [6] of the 14 $Ne^*(2p^5\ 3s)$ and $Ne^*(2p^5\ 3p)$ levels. Same enumeration as in Fig. 1.

at a scattering angle of 135° shows good agreement both in shape and absolute value. The data will be presented in my PhD thesis as well as in a publication which will be prepared in summer 2005 in cooperation with Prof. Allan, Prof. Hotop and Prof. Bartschat. I will also give an oral presentation of the results at the EIPAM/EPIC conference in Viterbo.

Kai Franz

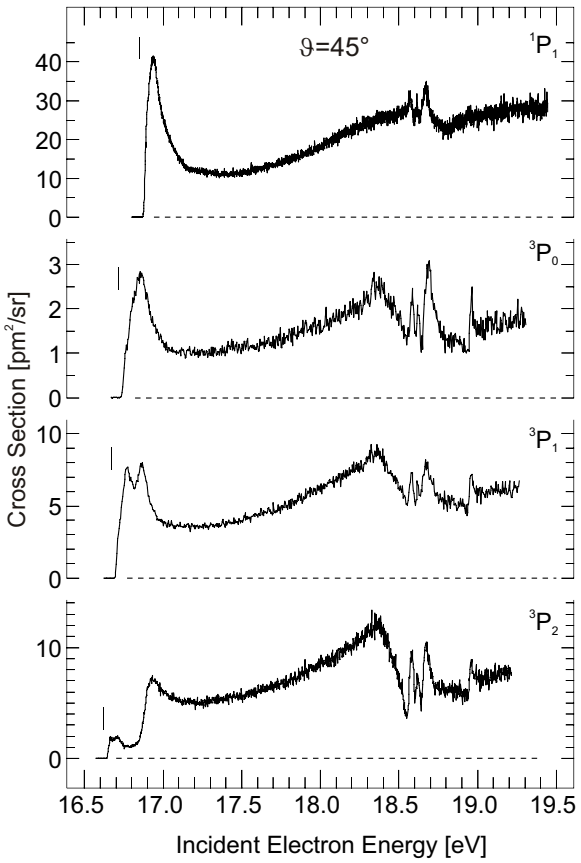

Figure 2: Absolute cross sections for excitation of the $Ne^*(2p^5\ 3s)$ configuration at a scattering angle of $\vartheta = 45°$, determined by calibration at an incident electron energy of 18 eV. The vertical line shows the onset of the given level.

References

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[3] S. J. Buckman and C. W. Clark, Rev. Mod. Phys. **66** (1994) 539

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