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High resolution electron ejected spectra of He, Ne and Ar by high energy electrons

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Synopsis A systematic study of autoionisation region of rare gas atoms (He, Ar and Ne) by high energy electrons was carried out at ejection angles from 10° to 130°. The best obtained energy resolution of the ejected electron spectra was 45 meV. The high resolution and high sensitivity allowed us to see separated singlet from triplet states at high incident energies. Comparison with previous works gives a good agreement in energy positions of measured features.

The autoionising region of rare gas atoms has been studied extensively in the past by electron, photon and ion collisions, nevertheless the wide scale ejected electron spectra with high resolution that include angular analysis have not been systematically presented. We started with the measurements of He [1], Ne [2] and Ar [3,4] atoms at the high excitation electron energies from 500 eV to 2000 eV and span the ejected electron energies in the broad range (see Table 1), so that we were able to cover the regions of single and double excited autoionising states.

The experimental set-up consists of *a*) High energy electron gun mounted at the turn table that enables rotation from 10° to 130° around analyzer axis *b*) Gold plated platinum–iridium tube 30 mm long with the inside diameter of 0.5 mm used as a source of effusive beam of rare gases; *c*) High resolution electron analyzer with 7 channeltrons as detectors. The obtained energy resolution of ejected spectra was from 45 to 80 meV depending of the analyzer tuning. This is enough to resolve the singlet-triplet splitting in the ion core in Ne (0.098 eV) and Ar (0.177 eV).

Table 1. Ionisation energies and the range of measured ejected electron energies in eV.

	Ionisation (eV)	Ejected electron energies (eV)
He	24.59	32.0-55.0
Ne	21.56	12.0-46.0
Ar	15.76	5.5-22.5

The spectra are shown with subtracted background and without normalisation of the obtained data. The calibration point for ejected electron energy scale was taken from well known helium $(2s2p)^1P$ state in autoionisation region at 35.54 eV (60.13 eV) [5].

A series of ejected electron spectra was obtained for all three target atoms performing the systematic variation of incident energies and ejected angles. The spectra are rich in features, many of them not identified earlier. Further theoretical investigation is needed in order to assign the configuration of observed states.

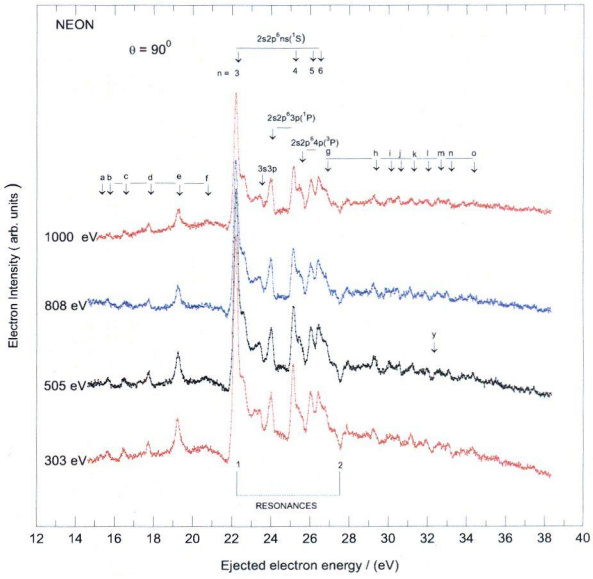

Figure 1. Ejected electron spectra of neon obtained at an ejection angle of 90° and incident electron energies or excited energies of 303, 505, 808 and 1000 eV respectively shown on the left hand side on the figure. The energy region of ejected electrons is from 14 to 38 eV or 35.56 to 59.56 eV of excitation energy with energy width per channel of 0.020 eV. Small arrows on the top of the figure show energy positions of the features, while vertical lines at the bottom of the figure mark positions of resonances.

References

[1] J. J. Jureta *et al* 2014 *Int. J. Mass. Spectrom.* **365-366** 114
[2] J. J. Jureta *et al* 2015 *Eur. Phys. J. D* **69** 74
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[4] B.P. Marinković *et al* 2015 *ICPEAC* **29** 231
[5] R. P. Madden and K. Codling, 1963 *Phys. Rev. Lett.* **10** 516

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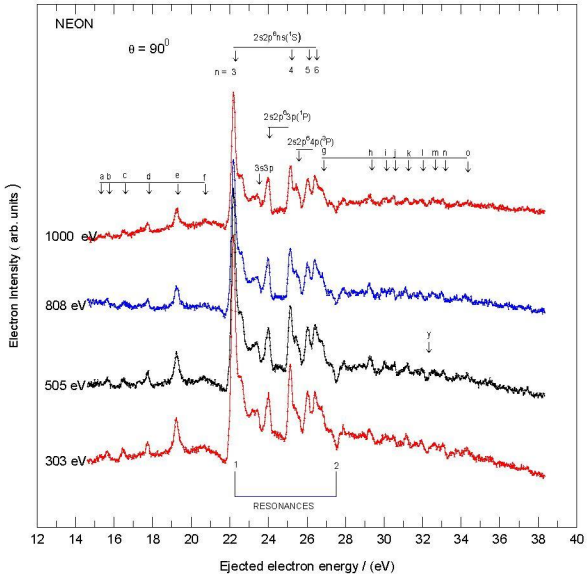

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