MIRRORING DOUBLY EXCITED RESONANCES IN NEON

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INTRODUCTION

The combination of high photon resolution and differential photoelectron spectroscopy techniques has allowed the discovery of new spectral features in the low-energy photoionization spectrum of neon. These resonances observed in the $2p^{-1}{}_{1/2,3/2}$ partial cross sections are attributed to LS forbidden doubly excited states with mirroring profiles [1]. The present results highlight the need for including relativistic interactions in the theoretical description of the photoexcitation process even for light systems.

EXPERIMENT

The experiment was performed on beamline 10.0.1 at the ALS. The apparatus consisted in two time of flight analyzers at 54.7^0 and 0^0 with respect to the electric field axis housed in a rotatable. The data was collected and displayed using a two dimensional acquisition technique consisting of recording data at closely spaced photon energies from which constant ionic spectra (CIS) were extracted as shown in Fig.1 to Fig.4. When the two photoelectron peaks corresponding to $2p^{-1}{}_{1/2,3/2}$ spaced by 97 meV are separated, the overall resolution of the CIS depends solely on the photon bandwidth. The spectral resolution was about 3 meV, close to the 10,000 resolving power obtainable at this beamline.

RESULTS

The present experiment follows up on previous work related to mirroring effects in Argon [2,3]. It gives the most detailed account of the resonant structure below the second ionization potential in neon up to date. In addition to the singly excited Rydberg series and the pronounced $2s^22p^4(^3P)3s(^2P)3p(^1P)$ excited state ,many new weak doubly excited states were observed. The strength of the experimental technique is fully demonstrated as most of the features can only be detected through the extraction of the corresponding branching ratio and at specific angles. Considering their energy position, they have been assigned with an LS forbidden triplet symmetry. For some of them, this is clearly confirmed by their mirroring profiles in the partial cross sections as shown in Fig.1 and Fig.2. The breakdown of LS coupling is further demonstrated by the branching ratio differing from the statistical value 2 by 10% throughout the whole spectral range. A complete calculation of the photoionization spectrum reproducing these highly correlated and spin-orbit induced resonances is still beyond the capabilities of available codes. However, it is hoped that this work will provide useful guidelines for further studies.

REFERENCES

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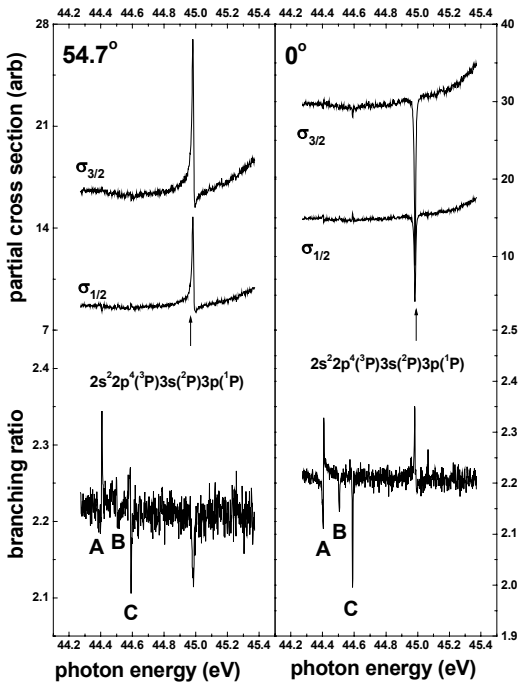

Fig.1: Partial differential cross sections meas-ured at the magic angle 54.7˚ and 0˚ with cor-esponding branching ratio in the vicinity of the first doubly excited state $2s^22p^4(^3P)3s(^2P)3p(^1P)$. Labels A, B, C indicate the position of the new doubly excited resonances.

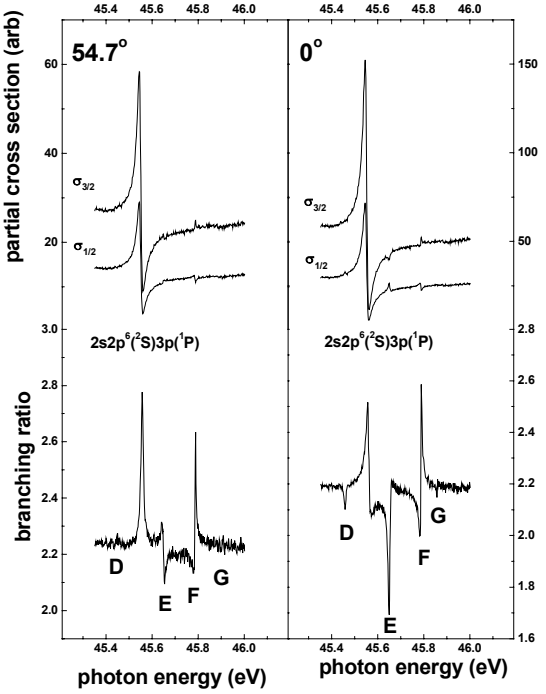

Fig.2: Partial differential cross sections measured at the magic angle 54.7˚ and 0˚ with corresponding branching ratio in the vicinity of the first singly excited state $2s2p^63p(^1P)$. Labels D, E, F, G indicate the position of the new doubly excited resonances.

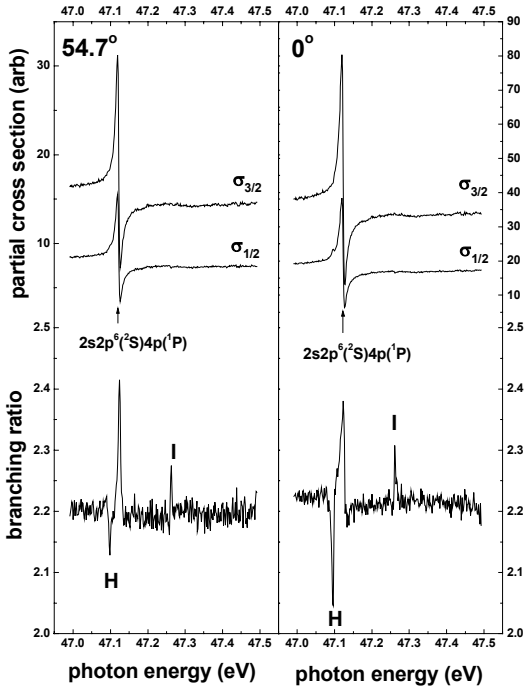

Fig.3: Partial differential cross sections measured at the magic angle 54.7˚ and 0˚ with corresponding branching ratio in the vicinity of the second singly excited state $2s2p^64p(^1P)$. Labels H, I indicate the position of the new doubly excited resonances.

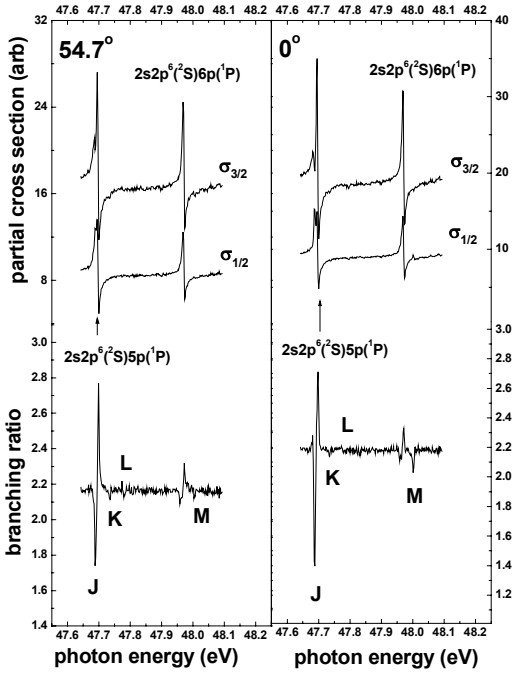

Fig.4: Partial differential cross sections measured at the magic angle 54.7˚ and 0˚ with corresponding branching ratio in the vicinity of the third and fourth singly excited state $2s2p^65p(^1P)$ and $2s2p^66p(^1P)$. Labels J, K, L, M indicate the position of the new doubly excited resonances.