Fluorescence yield measurements of doubly excited He

Magnus Ström[1], Conny Såthe[1], Dajun Ding[1,2], Marcus Agåker[1] ,
Jan-Erik Rubensson[1]and Thomas Ward Gorczyca[3]
[1] Physics Department, Box 530, S-751 21 Uppsala Sweden
[2] Institute of Atomic and Molecular Physics and State Key Lab of Superhard Materials, Jilin University, Changchun 130023, China
[3] Department of Physics, Western Michigan University,Kalamazoo, MI 49008-5151

Introduction

The doubly excited states of helium have been studied extensively, since the pioneering synchrotron radiation work of Madden and Codling in the sixties [1]. Both experimental and theoretical advances over the years have increased the understanding of electron correlation and dynamics in this simple prototype system. By studying the fluorescence decay of the Rydberg series converging to the N=2 threshold we could recently demonstrate that relativistic effects are essential to understand the fluorescence as well as the photoionization spectrum close to threshold [2,3].

Here we extend the measurements to the region above the N=2 threshold (65.4 eV) up to the double ionization limit (79 eV). Although the fluorescence of the doubly excited states may contribute to the fluorescence signal, it is dominated by the 2p-to-1s transition in ionized helium (Fig 1). The measurements are performed at around 0.1mtorr, a pressure high enough to ensure a complete 2s-2p mixing. Hence, the signal can be used to monitor the partial N=2 population cross section. This method to study the partial cross section was introduced by Woodruff and Samson in the early eighties [4], and it has been followed by direct measurements of the partial electron yield [5,6]. The energy resolution in the present fluorescence yield spectra is around an order of magnitude better than earlier published data on partial cross sections.

Experiment

The measurements were performed at beamline 10.0.1, directing the unfocused beam into a gas cell. Ions and metastable atoms were discriminated against using a thin filter, with the materials (150nm Al/27nm C) chosen to get a high transmission at 40 eV and low transmission at around 20 eV, where decays subsequent to the 2p-to-1s transition in neutral helium may occur. The detector is based on 40 mm diameter micro-channel-plates, and mounted as close to the interaction region as possible.

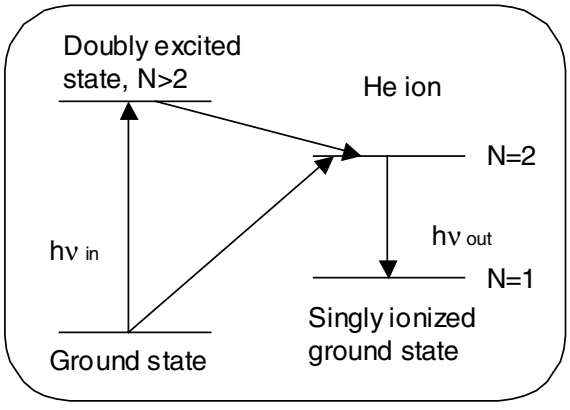

Fig. 1. The steep variations in the cross section are due to interference between the direct photoionization and the excitation-autoionization channels.

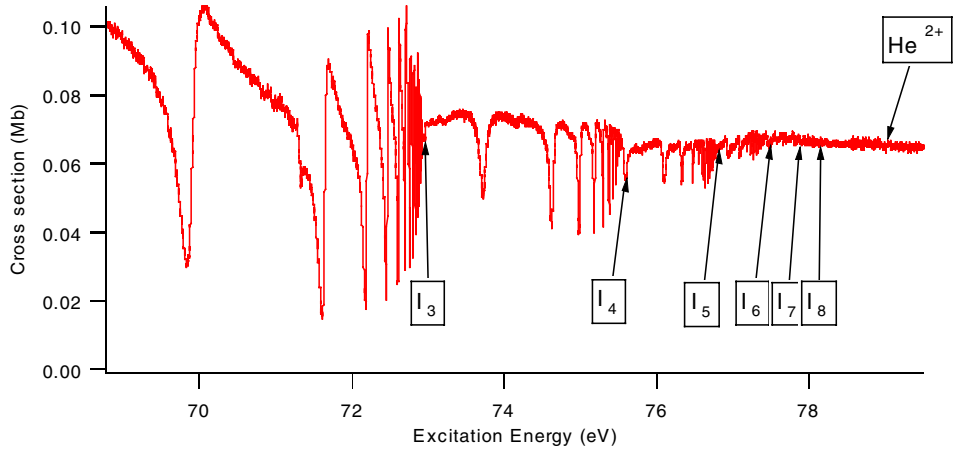

Fig 2. The whole range of states from N=3 to the doubly ionised limit.

Results & Discussion

Except for the decay of N=2 states in ionized helium, we consider contributions from higher N, as well as direct fluorescence from the doubly excited states of the neutral atom. One such case is the gain of intensity at the I_3 ionization threshold at 72.96 eV (Fig.3) where the N=3 state of the ion contributes to the intensity. We are presently working with the theoretical analysis to get a detailed understanding of the spectra. The data is normalized to the cross section measured by R.Wehlitz et al [7].

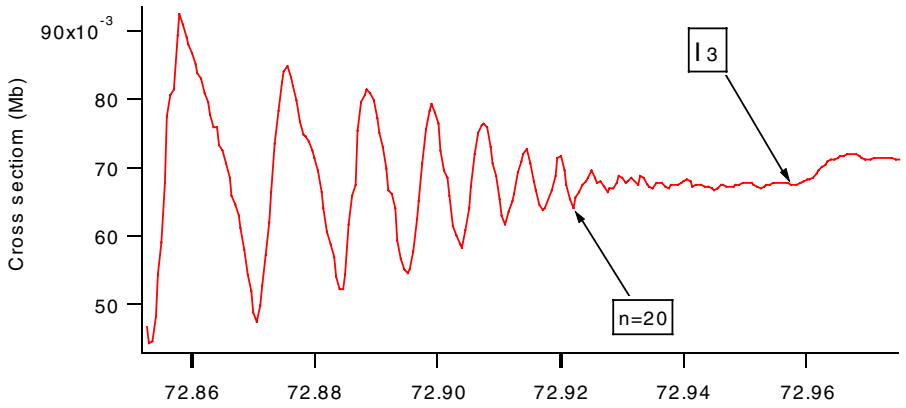

Fig 3. An increase of the intensity is observed at the N=3 threshold.

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Principal investigator: Jan-Erik Rubensson, Physics Department, Uppsala University.
Telephone: +46 (0)18 471 3562. Email: Jan-Erik.Rubensson@fysik.uu.se.