Angle-Resolved Study of Ar $2p_{1/2,3/2}^{-1}$ ns,d Resonant Auger Decay

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INTRODUCTION

After the excitation of an inner shell electron, an atom can relax nonradiatively through one of the following mechanisms, summarized here for the Ar $2p^{-1}4s$ resonance:

$2p^5 4s \rightarrow 2p^6 3s^2 3p^4 4s + e^-$	*Spectator Auger decay*	*(a)*
$2p^5 4s \rightarrow 2p^6 3s^2 3p^5 + e^-$	*Participator Auger decay - shake down*	*(b)*
$2p^5 4s \rightarrow 2p^6 3s^2 3p^4 4p + e^-$	*Participator Auger decay - shake up*	*(c)*
$2p^5 4s \rightarrow 2p^6 3s^2 3p^4 + 2e^-$	*Participator Auger decay - shake off.*	*(d)*

In previous non-angular-resolved studies of intensity distributions, it has been reported that the decay of the Ar $2p^{-1}4s$ states can be described well by the spectator model, while the decay of the Ar $2p^{-1}3d$ and $2p^{-1}4d$ states is dominated by shake up processes [1]. In its purest form, the strict spectator model assumes no interaction between the spectator electron, which was resonantly excited from an inner shell, and the core. Previous angular-resolved measurements of Auger decays, observed at the Ar $2p^{-1}4s$ resonance, have suffered from poor resolution in the photoelectron spectra [2], and such measurements of the $2p^{-1}3d$ and $2p^{-1}4d$ resonances have been unobtainable due to insufficient photon resolution.

RESULTS

We have reported angle-resolved measurements of the Ar $2p_{1/2,3/2}^{-1}4s$, 3d, and 4d resonant Auger decays which can be found in Farhat et al. [3]. These measurements were achieved using time-of-flight electron spectroscopy along with high flux synchrotron radiation from the Advanced Light Source. The intensity distributions and angular distribution anisotropy parameters (β) have been reported for nearly all of the $3p^4nl$ final ionic states, and a comparison of these measurements with previous results demonstrates good agreement. We have shown that a large majority of the β parameters are either small positive or negative, due to parity unfavored transitions. Also, as predicted by the spectator model, we found that the averaged β is isotropic in the case of the $2p_{1/2}^{-1}4s$ resonance. This result corroborates the work by Cooper [4] using the angular momentum transfer theory. In addition, our higher resolution measurements allowed the determination of individual large β values which appear much weaker in previously unresolved measurements due to a strong cancellation effect by neighboring lines.

It has also been demonstrated that while the intensity distributions between different resonances originating from different 2p spin states (i.e. $2p_{1/2}$ vs. $2p_{3/2}$) are not always similar, the extracted β parameters for the two resonances agree in many cases. Our results for the intensity distributions further support the prediction of the spectator model for the $2p_{1/2,3/2}^{-1}4s$ resonances, but demonstrate the breakdown of this model for the $2p_{1/2,3/2}^{-1}3d$ and $2p_{1/2,3/2}^{-1}4d$ resonances. While our results agree with much of the theoretical work for the $2p_{1/2,3/2}^{-1}4s$ resonances, we hope that this report, which is the first in the case of the β parameters for the $2p_{1/2.3/2}^{-1}3d$, the $2p_{3/2}^{-1}4d$ resonances, and for the intensity and β parameter for the $2p_{1/2}^{-1}4d$ resonance, will stimulate further experimental and theoretical work.

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