Photoionization Time delay in atomic Barium

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Synopsis Wigner-Eisenbud-Smith (WES) photoionization time delay is calculated for atomic barium 5s subshell using Relativistic Random Phase Approximation (RRPA), RRPA *with* relaxation (RRPA-R) and the Relativistic Multi-Configuration Tamm-Dancoff (RMCTD) techniques. Electron correlations are treated differently in different many body methods; the WES time delay is sensitive to these differences. The present study is aimed at determining the suitability of various many-body methods for the study of the WES time-delay.

The time-delay in electron ejection into the continuum after photon absorption is of much interest [1-5]. Photoionization time-delay provides valuable dynamical information about electron correlation and relativistic effects in a many-electron system.

In the present work photoionization time delay is calculated for the first time for atomic barium. The high Z value of atomic barium requires careful treatment of relativistic and electron correlation effects. In the present work, the Wigner-Eisenbud-Smith (WES) time delay [6] for Ba5s subshell is calculated in the region of second Cooper minimum [7] using the (i) RRPA [8], (ii) and the RRPA-R [9] and (iii) the RMCTD approximation [10].

The results from the RRPA method are shown in the adjacent figure. The photoionization cross section of Ba5s undergoes a 'correlational Cooper minimum' well above the ionization threshold [7] (Fig. 1). The photoionization time delay in the relativistic $5s \rightarrow p_{1/2}$ and $5s \rightarrow p_{3/2}$ channels shows a dip ('time advancement') in the region of the Cooper minimum (Fig. 1). The time-delay calculated from RRPA-R and RMCTD are also determined (not shown) to understand the influence of different electron correlations from different many-body theories on the attosecond time delay.

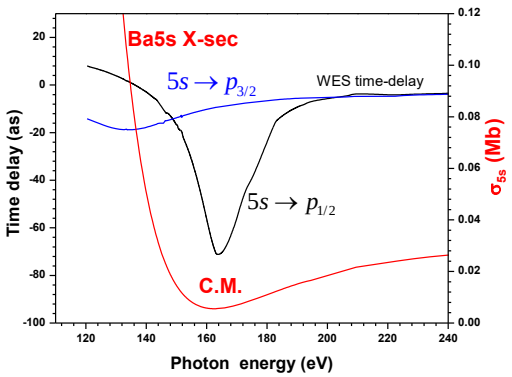

Figure 1: RRPA results for photoionization time delay in Ba5s channels in the region of second Cooper minimum. Black line: Time-delay in $5s \rightarrow p_{1/2}$ channel; Blue line: Time-delay in $5s \rightarrow p_{3/2}$ channel; Red line: cross-section.

References

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