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Inner-shell excitation of alkali-metal atoms

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Abstract. Inner-shell excitation of alkali-metal atoms, which leads to auto-ionization, is investigated. Comparison is made with other available data. Basic difficulties in making accurate calculations for inner-shell excitation process are discussed. Suggestions are made for further study of inner-shell process in atoms and ions.

Keywords. R-matrix; auto-ionization.

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Studies of the electron impact excitation of the inner-shell of alkali-metal atoms and alkali-like ions have been of growing interest for both theorists and experimentalists. One of the primary reasons for this interest stems from the fact that inner-shell excitation may lead to auto-ionization which plays a very important role in explaining the structure observed in the total ionization cross section curve. In recent years, a number of theoretical calculations (Tiwary 1976, 1981, 1982, 1983a–g, 1985, 1986, 1989, 1990; Tiwary *et al* 1983a, b, 1985, 1988; Tiwary and Rai 1973, 1975, 1976; Tiwary and Nicolaides 1983; Faisal and Tiwary 1980; Hibbert *et al* 1982; Kingston *et al* 1987; Srivastava and Rai 1977; Berrington *et al* 1978; Peterkop 1977) and experimental observations (Nygaard (1975) and Pejcev and Ross (1977)) have been made but there are striking discrepancies between the prediction of various theoretical methods in both qualitative as well as quantitative behaviour. Consequently, the existing theoretical situations are of special interest from both scattering and structure point of view in order to resolve the discrepancies.

Over the past decade, several quantum-mechanical approximations, e.g. plane wave Born approximation (PWBA), modified plane wave Born approximation (MPWBA), Vainshtein approximation (VPSA), Glauber approximation (GA), Coulomb Born approximation (CBA), asymptotic Green function approximation (AGFA), distorted-wave Born approximation (DWBA), quantum defect theory (QDT), Fano method, diagonalization method, close-coupling (CC); hyperspherical coordinate method, complex-rotation method, *R*-matrix method etc., have been employed to study the inner-shell process in atoms and ions.

Nygaard (1975) and Pejcev and Ross (1977) have measured the total ionization cross sections for the alkali-metal atoms by electron impact and have observed the structure in the results. This structure has been attributed to the excitation of the inner-shell electron which leads to auto-ionization.

We have investigated extensively the inner-shell process in alkali-metal atoms and