Calculation of muonic atom cascade dynamics in D-T mixtures

S.Z. Kalantari and M. Raisi
Department of Physics, Isfahan University of Technology, Isfahan, 84156-83111, Iran

The exotic atoms formation is followed by an atomic cascade consisting of multistep transition to lower atomic states. It is a complicated interplay of competitive collisional and radiative deexcitation processes [1, 2]. Despite a long history of theoretical and experimental studies, the kinetics of this atomic cascade is not yet fully understood[1, 3, 5].

In this paper we study the cascade processes of the muonic atoms of hydrogen isotopes. It is important for several reasons :first, cascade processes are done before muon catalyzed fusion cycle[5, 4] and affect the kinetic energy distribution of muonic atoms in the ground state[2, 5]. Spectra of muonic atoms in ground state are important to studies of muon catalyzed fusion cycle, because muonic molecular formation are dependent on collision energy of muonic atoms and molecules of the target. Therefore, cascade calculations are needed to determine the kinetic energy distribution of muonic atoms in the ground state[2, 6]. Second, the muonic atoms of hydrogen isotopes are the simplest among the exotic atoms and the cascade calculations of them can help us to realize the kinetics of cascade processes of the other exotic atoms, such as $x\pi^-$, xK^-, where x denotes the hydrogen isotopes.

This paper focuses on the muonic cascade in D-T mixtures and pure deuterium in the various densities, then the x-ray yields due to the radiative transition during the cascade are calculated. For this purpose the de-excitation of $d\mu$ and $t\mu$ atoms are simulated by a Monte-Carlo method, taking the energy dependence of collsional cascade processes into account. In addition, the time dependence of population of the excited levels of muonic atoms during the cascade as well as the dependence of deexcitation average time on the target density and tritium concentration are presented. The q_{1s} parameter is also calculated. The results of our simulation for the x-ray yields are confirmed by the existing experimental results for muonic deuterium atoms [7].

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