

Influence of muon cascade and μ -molecule formation on the μ CF process kinetics in deuterium

Friday, September 9, 2011 3:00 PM (20 minutes)

The kinetics of muon-catalyzed-fusion processes (μ CF) in pure deuterium D₂ gas has been studied with regard to the epithermal effects of muonic $d\mu$ -atoms accelerated during the cascade.

For this purpose the kinetic energy distribution of $d\mu$ atoms in the 1S-state has been calculated using the modified quantum-classical Monte Carlo cascade method developed in [1]. This calculation has confirmed that most $d\mu$ atoms are not thermalized.

Hence the collisions of such epithermal $d\mu$ atoms with deuterium molecules D₂ lead to non-resonant formation of $dd\mu$ molecules [2] with high rates as compared to for thermalized $d\mu$. However, another process of non-resonant formation may also occur in the presence of non-thermalized $d\mu$ -atoms. In parallel with the resonant formation of the $dd\mu$ molecule in the weakly bound ro-vibronic ($J=v=1$) state, the non-resonant formation in the same $dd\mu$ -state is also possible. But in this case the emitted Auger electron of the D₂ molecule can carry away the released energy only for $d\mu$ -atomic collision energies $e>I$, where I denotes the ionization potential of the D₂ molecule. The calculated formation rates in the above-threshold energy region are about one order of magnitude higher than previously obtained in [2].

We have investigated the role of the epithermal non-resonant $dd\mu$ formation process described above for μ CF in D₂ gas. The time spectra of dd -fusion neutrons have been calculated by means of Monte Carlo simulations [3]. It has been shown that similarly to the peak revealed in experiments on μ CF in HD mixtures [4], non-resonant $dd\mu$ formation by non-thermalized $d\mu$ -atoms in the D₂ target can also be directly observed in the neutron time spectra at very short initial times, before the complete thermalization of $d\mu$ atoms.

References

- [1] M.P. Faifman, and L.I. Men'shikov, Proc. Int. Conf. MCF-07, Dubna, June 18-21, p.233 (2007).
- [2] M.P. Faifman, Muon Cat. Fus. 4 (1989) 341.
- [3] A. Adamczak, M. Faifman, Eur. Phys. J. D. 51 (2009) 341.
- [4] D.V. Balin et. al. Phys. El. Part. At. Nucl., 42, (2011) 185.

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Session Classification: Contributions III

Track Classification: Other exotic atoms and rare decays