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

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The kinetics of muon-catalyzed-fusion processes (μCF) in pure deuterium D2 gas has been studied with regard to the epithermal effects of muonic dμ-atoms accelerated during the cascade.
For this purpose the kinetic energy distribution of dμ 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 dμ atoms are not thermalized.
Hence the collisions of such epithermal dμ atoms with deuterium molecules D2 lead to non-resonant formation of ddμ molecules [2] with high rates as compared to for thermalized dμ. However, another process of non-resonant formation may also occur in the presence of non-thermalized dμ-atoms. In parallel with the resonant formation of the ddμ molecule in the weakly bound ro-vibronic (J=v=1) state, the non-resonant formation in the same ddμ-state is also possible. But in this case the emitted Auger electron of the D2 molecule can carry away the released energy only for dμ-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 ddμ formation process described above for μCF 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 μCF in HD mixtures [4], non-resonant ddμ formation by non-thermalized dμ-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 dμ atoms.

References

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