Study of dμd and pμd Fusion in D_2 and HD Mixtures

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The experiment was introduced last year as a new investigation of muon catalyzed fusion with greatly increased absolute precision [1]. The main improvements, developed in Gatchina, include a redesigned high pressure ionization chamber with a sensitive reaction volume of 15 cm^3 and a energy resolution of $\sim$ 50 keV FWHM, a temperature control system operating with ± 0.1 K stability, and a chemical gas treatment apparatus producing ultra clean samples of HD molecules with concentrations of $c_{\mathrm{HD}} \sim 94\,\%$ [2]. In two experimental runs we collected fusion data over a temperature range from 28 K to 350 K at gas densities from 3 %–8 % of liquid H_2.

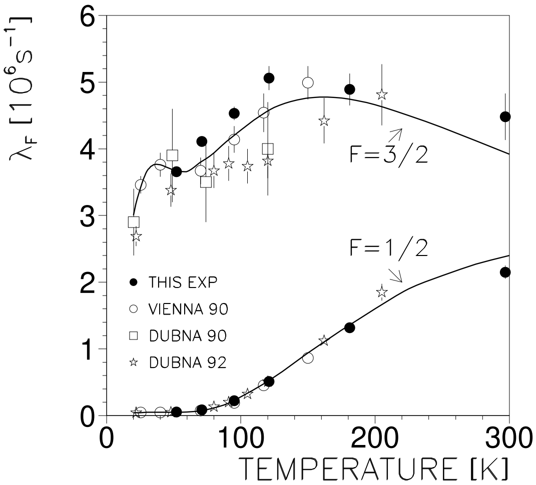

Fig. 1: new and old dμd formation rates λ_F in D_2 versus temperature (from ref. [3]).

Preliminary results of the 1994 run were presented at the international μCF-95 conference in Dubna [3]. Figure 1 shows the temperature dependence of spin separated dμd formation rates in D_2, λ_F, characteristic for the resonant formation mechanism. Previous measurements and the theory curves are also shown for comparison. Our new data will determine the dd fusion rate and the dμd resonance energy to very high precision allowing rigorous tests of the theory.

Figure 2 displays the new data about the μd spin flip rate $\lambda_{3/2,1/2}$. The curves represent the theoretical expectations, (a) from the inelastic scattering process only (dashed line), (b) the same including the term of resonant dμd formation followed by backdecay (full line), see ref. [4]. The HD data point at 50 K (star) is significantly lower than the D_2 results (full circles). It provides first direct experimental evidence that the resonant spin flip term (absent in HD molecules) really exists in D_2 at the predicted intensity. Thus, inelastic scattering μd + d will need more theoretical attention to get the theory in accord with the experimental observations.

This experiment will be continued in 1996, primarily with more detailed investigations of the so far poorly known μCF processes with HD molecules.

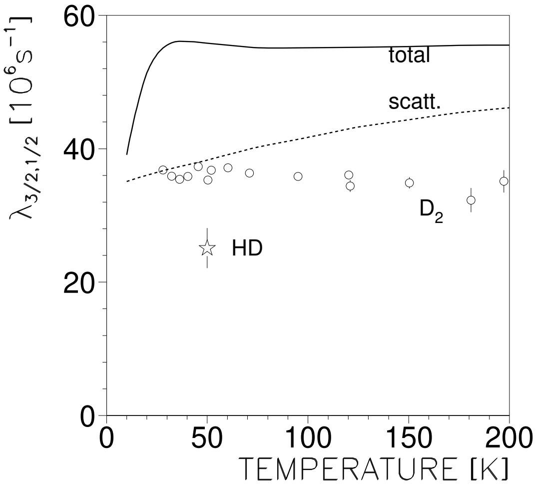

Fig. 2: new results on μd spin flip rates $\lambda_{3/2,1/2}$ versus temperature in D_2 (circles) and HD gas (star).

References

[1] PSI Annual Report 1994 /Annex I, p. 43.
[2] G.G. Semenchuk et al., Proc. μCF-95, Dubna, to be published in Hyp. Int. (1996).
[3] C. Petitjean et al., Proc. μCF-95, Dubna, preprint PSI-PR-95-22 (Aug. 1995).
[4] A. Scrinzi et al., Phys. Rev. **A47** (1993) 4691 and references cited therein.