Experimental study of the MCF processes in solid H/D and H/T mixtures and in gaseous D/^{3}He mixture

V.M. Bystritsky[a] , M. Filipowicz[b], P. Knowles[c], F. Mulhauser[c,d] and J. Woźniak[e]

[a] *Laboratory of Nuclear Problems, Joint Institute for Nuclear Research, Dubna 141980, Russia*

[b] *Faculty of Fuels and Energy, AGH University of Science and Technology, PL-30059 Krakow, Poland*

[c] *Department of Physics, University of Fribourg, CH-1700 Fribourg, Switzerland*

[d] *Present address: University of Illinois at Urbana-Champaign, Urbana, Illinois 61801, USA*

[e] *Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, PL-30059 Krakow, Poland*

Methods and results of the two independent cycles of experiments performed at the meson factory TRIUMF (Canada) and PSI (Switzerland) and aimed at studying the μ-atomic and μ-molecular processes are reviewed. Application of the time-of-flight method and the solid hydrogen isotope mixture targets (H/D and H/T) at temperature 3K in the TRIUMF experiment allowed obtaining for the first time a number of very important parameters of the μ-atomic and μ-molecular processes occurring in these mixtures. The main results found by the analysis of the experimental data are the following: energy dependence of the $p\mu$, $d\mu$ and $t\mu$ scattering cross-sections on the H_2 molecules; discovery of anomalously high emission of ultracold $p\mu$-atoms ($E_{p\mu} < 2 \cdot 10^{-3}$ eV) from the solid hydrogen layer; experimental confirmation of the existence of the Ramsauer-Townsend effect in scattering of $d\mu$ and $t\mu$ - atoms in solid hydrogen and determination of its basic characteristic. The following results were obtained in PSI experiments with gaseous deuterium-helium targets. Nuclear fusion in $d\mu^3$He molecule was discovered for the first time. Effective rate of the nuclear fusion was measured for two different helium concentrations in the D/^{3}He mixtures. Energy dependence of the differential muon capture cross-sections by ^{3}He followed by emission of protons and deuterons was measured. Stopping power ratio of ^{3}He and deuterium atoms for muons slowed down in the D/^{3}He mixtures was measured. The other different μ-atomic and μ-molecular processes undergoing in deuterium-helium mixtures were also studied.