

This work is focused on laboratory studies of ion chemistry at conditions relevant for astrophysics. The three main outcomes of the thesis are: (1) The experimental study of the reaction rate coefficient of the associative detachment reaction  $\text{H}^- + \text{H} \rightarrow \text{H}_2 + \text{e}^-$ ; measurement of the thermal rate coefficient at the temperatures in the range 10-135 K is described. (2) The design of a novel apparatus for detecting the electrons produced in the RF trap and measuring their energy; numerical simulations and preliminary experimental results are presented. (3) The development of a model of the electron cooling in the afterglow plasma and the application of the model in the analysis of the  $\text{H}_3^+$  recombination measurements.