

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 H_3^+ recombination measurements.