# Trapped ion collision with MOT atoms and cold molecules

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We have developed an experimental technique that measures the collision rate coefficient of trapped ions with cold trapped atoms[1] using atomic fluorescence as a probe. In such systems, the traditional framework of projectile, target and scattering events is not convenient as each ion can undergo multiple scattering. The rate of collision between the ions and the atoms is therefore detected by the changes in atom populations.

Here we show that when ions and atoms are simultaneously trapped, collisions between the relatively energetic ions ($Rb^+$) and the MOT atoms (Rb) result in MOT atom loss. A simple rate equation model shows that the evolution of the atom number in the MOT, during photo-ionization[2] of the Rb atoms and in the presence of $Rb^+$ ions is,

$$\frac{dN_{MOT}}{dt} = L - (\gamma_{ml} + \gamma_{pi} + \gamma_{ia})N_{MOT}$$

where $L$ = MOT loading rate, $\gamma_{ml}$= natural loss rate of MOT atoms, $\gamma_{pi}$ = loss rate of MOT atoms due to photo-ionization, and $\gamma_{ia}$=loss rate of MOT atoms due to ion-atom interaction.

The $\gamma_{ia}$ is then used to determine the ion atom collision rate coefficient $k_{ia}$, by the relationship

$$k_{ia} = \frac{V_{IT}}{N_I^0}\gamma_{ia}(I_{pi} \to \infty)$$

where, $V_{IT}$ = trapping volume of the ion trap, $N_I^0$ = the maximum number of trappable ions, and $I_{pi}$ = intensity of ionizing light. These expressions are derived within a consistent formalism and making reasonable approximations we arrive at a value of $k_{ia} = 9.5(\pm 2.9) \times 10^{-14} cm^3/s$. This value compares very well with the corresponding theoretically estimated value[3]. Finally the study is extended to trapped ion collisions with cold $Rb_2$ molecules formed by photo-association.

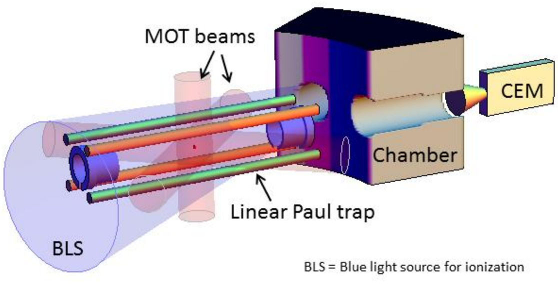


Fig.1. Chamber schematic diagram of the experimental set-up is illustrated.

References:
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