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Thesis title : A preliminary study of fields in split-electrode ion traps

Abstract

Ion traps used in mass spectrometers are of two classes. One class consists of traps having three electrode geometries which have rotational symmetry about central axis. They are called axially symmetric ion traps. Paul trap, Cylindrical Ion Trap (CIT) are examples in this class. Other class of traps contain 2D electric field inside them which has same profile along the central axis due to translational symmetry. Linear Ion Trap (LIT) and Rectilinear Ion Trap (RIT) are examples in this class.

In the ideal hyperbolic geometries of Paul trap and LIT, electric field is a perfectly linear function of distance from the center of the trap. But when these ideal geometries are simplified into simpler geometries of the CIT and the RIT for ease in machining, linearity of field, which is a specialty of Paul trap and LIT is lost.

In this thesis, an effort is made to optimize the field within the traps by using split electrodes. The ring electrode of the CIT and both pairs of electrodes in the RIT are divided into more number of parts. Suitable voltages are applied on these parts to improve the linearity of the field.

This thesis contains six chapters. Chapter 1 contains a background information about mass spectrometry. Chapter 2 discusses the Boundary Element Method (BEM) used to calculate charge destribution and Nelder-Mead method used for optimization. It also shows the calculation of multipoles.

In Chapter 3, two new geometries namely split-electrode RIT and split-electrode CIT are considered with the objective of improving the linearity of electric field inside them. It is shown here that by applying certain external potential on various parts of split electrodes of these geometries, it is possible to improve the linearity of electric field inside them.

In Chapter 4, capacitor models of new geometries proposed in chapter 3 are discussed. The use of external capacitors as a replacement to external power supply is also discussed in this chapter.

In Chapter 5, study similar to that of Chapter 3 is carried out by splitting the geometries in more number of parts. The possibility of improved field profile is investigated by applying full potential to some of these parts and keeping other parts at ground potential.

In Chapter 6, concluding remarks are discussed.