The Electrostatic Ion Beam Trap: A prospective instrument for *in-situ* composition analysis of planetary atmospheres and space plasma

Koushik Saha[1]

[1]Department of Physics, Indian Institute of Technology Dharwad, Dharwad - 540008

*Corresponding Author E-mail: (koushik.saha@iitdh.ac.in)

The identification and knowledge about the energy distribution of a population of neutral/charged atomic/molecular species is crucial to obtain information about the properties of planetary atmospheres and surfaces, solar winds and its interaction with planetary atmospheres. *In-situ* analysis yielding the chemical composition of a planetary atmosphere and surface holds clues to its formation process and its subsequent evolution. A major thrust area in space exploration activities has been the development of various mass spectrometer payloads that can perform *in-situ* measurements of planetary bodies and space plasma [1,2,3]. Here, the potential of a unique experimental set-up, the Electrostatic Ion Beam Trap (EIBT), as a mass spectrometer, is presented, that can be a prospective payload for future space missions for *in-situ* composition analysis of planetary atmospheres and space plasma.

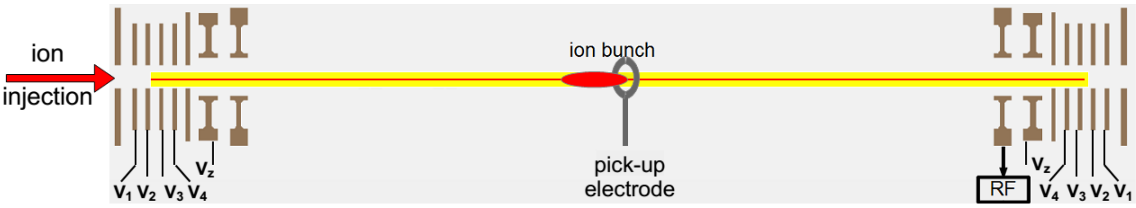

Figure: Schematic of the simulated Electrostatic Ion Beam Trap.

The EIBT is a unique trapping/storage device that uses purely electrostatic fields to trap any cationic or anionic species in a compact volume [4]. Ions are trapped in an oscillatory motion longitudinally between a pair of identical sets of mirror electrodes carrying certain DC voltages and placed opposite to each other. The trap is tuned so that all ions with a certain kinetic energy to charge ratio can be trapped, and, as in all purely electrostatic devices, the trapping is independent of the ion mass. Ionic species with the same mass-to-charge have the same frequency with which they oscillate while trapped in the EIBT and it is by measuring this frequency under specific trapping conditions, the mass-to-charge ratio of the ionic species can be identified. The capabilities of the EIBT as a high resolution mass spectrometer ($\Delta m/m \sim 10^{-5}$) have been demonstrated in the laboratory [5]. Traditionally, the EIBT have been mostly used in the laboratory to study the dynamics of ionic species inside the trap [6] or for studying the photo-physics of ionic species of astrophysical relevance [7]. Owing to its compact design, relatively simple operational aspects and possibility of miniaturization, the EIBT can prove to be an ideal candidate for mass spectrometric studies for future space missions.

References:

[1] J. Kissel *et al.*, (1986) *Nature, 321, 280.*
[2] J. Kissel *et al.*, (2007) *Space Science Reviews, 128, 823.*
[3] A. Bhardwaj *et al.*, (2015) *Geoscience Letters, 2, 10.*
[4] L. H. Andersen *et al.*, (2004) *J. Phys. B, 37, R57.*
[5] D. Strasser *et al.*, (2002) *Phys. Rev. Lett. 89, 283204.*
[6] R. K. Gangwar *et al.*, (2017) *Phys. Rev. Lett. 119,103202.*
[7] K. Saha *et al.*, (2018) *Nature Communications 9, 912.*