An Axial Time-of-flight Mass Spectrometer for Upper Atmospheric Measurements

Addison E. Everett
Utah State University

W. Sanderson
Space Dynamics Laboratory

D. Allen
Utah State University

J. Dyer
Space Dynamics Laboratory

B. Smith
Space Dynamics Laboratory

M. Watson
Space Dynamics Laboratory

See next page for additional authors

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An axial time-of-flight mass spectrometer for upper atmospheric measurements

E. A. Everett, Jr., W. Henderson, D. Allen, Jr., E. Byrne, B. Smith, M. Watson, C. J. Mertens, C. A. Syers

Utah State University (Logan, UT); Spacelabs Dynamics Laboratory (North Logan, UT); NASA Langley Research Center (Hampton, VA)

Abstract

This work presents a 4-channel, 200-kHz axial time-of-flight (TOF) Mass Spectrometer (MS) for use in sounding rocket missions to the mesosphere/lower thermosphere. The MSNumber Density Uncertainty (5 km Integration) for each channel is \( \sigma \approx 0.001 \) (with two of \( \sigma \approx 0.1 \)) and it optimizes mass resolution, sensitivity, and count rate in TOF-MS. Predicted performance for multiple molecules, ions, and sources is robust for upper atmospheric measurements. The MS has been designed to capture undisturbed transmission fraction of some important molecules in the mesosphere/lower thermosphere.

Introduction

The semi-annual 26–28 km geomagnetic storms have been shown to be the major contributor to geomagnetic storm energy dissipation. The energetic solar wind particles from a coronal mass ejection enter the Earth’s magnetosphere, and are accelerated by the geomagnetic field. The energy deposition depends on geomagnetic access. Additionally, the location of the ionospheric storms is very sensitive to atmospheric density variations. In order to model and predict the ionospheric storms, it is necessary to have a better understanding of the ionosphere and its interaction with the solar wind. This work presents a 4-channel, 200-kHz axial time-of-flight (TOF) Mass Spectrometer (MS) for use in sounding rocket missions to the mesosphere/lower thermosphere. The MSNumber Density Uncertainty (5 km Integration) for each channel is \( \sigma \approx 0.001 \) (with two of \( \sigma \approx 0.1 \)) and it optimizes mass resolution, sensitivity, and count rate in TOF-MS. Predicted performance for multiple molecules, ions, and sources is robust for upper atmospheric measurements. The MS has been designed to capture undisturbed transmission fraction of some important molecules in the mesosphere/lower thermosphere.

Mass spectrometry in the upper atmosphere

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Rock-STEAD mass spectrometer

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Conclusions

The MSNumber Density Uncertainty (5 km Integration) for each channel is \( \sigma \approx 0.001 \) (with two of \( \sigma \approx 0.1 \)) and it optimizes mass resolution, sensitivity, and count rate in TOF-MS. Predicted performance for multiple molecules, ions, and sources is robust for upper atmospheric measurements. The MS has been designed to capture undisturbed transmission fraction of some important molecules in the mesosphere/lower thermosphere.

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