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

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Uncertainty analysis and post-processing in TOFMS

One of the major challenges to making measurements in the MLT is the high background of neutral species. The use of mass spectrometers (MS) to study these species requires the reduction of the background signal to a level where the signal of interest can be measured. To achieve this, the integration time of the MS is set to be on the order of 30 ms, which is too short to allow for the complete collection of the signal of interest. Therefore, we need to consider the uncertainty due to the background signal.

The uncertainty due to the background signal can be described as

\[ \sigma_{\text{background}}^2 = \sum_{i} \sigma_{i}^2 \]

where \( \sigma_{i} \) is the uncertainty associated with the background signal component \( i \). The total uncertainty \( \sigma_{\text{total}} \) is then given by

\[ \sigma_{\text{total}}^2 = \sigma_{\text{signal}}^2 + \sigma_{\text{background}}^2 \]

where \( \sigma_{\text{signal}} \) is the uncertainty due to the signal component.

Example of uncertainty analysis:

Consider the example of measuring the number density of NO in the MLT. The uncertainty due to the background signal is

\[ \sigma_{\text{background}}^2 = \sigma_{\text{background, NO}}^2 + \sigma_{\text{background, CO}}^2 \]

where \( \sigma_{\text{background, NO}} \) and \( \sigma_{\text{background, CO}} \) are the uncertainties due to the background signal of NO and CO, respectively.

The total uncertainty is then given by

\[ \sigma_{\text{total}}^2 = \sigma_{\text{signal}}^2 + \sigma_{\text{background}}^2 \]

where \( \sigma_{\text{signal}} \) is the uncertainty due to the signal component.

Conclusion:

In conclusion, the uncertainty analysis is an important step in the data analysis of TOFMS measurements. It allows us to understand the impact of background signals on the measurement and to improve the performance of the instrument. The uncertainty analysis is also useful for optimizing the measurement conditions and for improving the sensitivity of the instrument.