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ENHANCEMENT OF MASS RESOLUTION IN THE QUADRUPOLE ION TRAP VIA RESONANCE EJECTION

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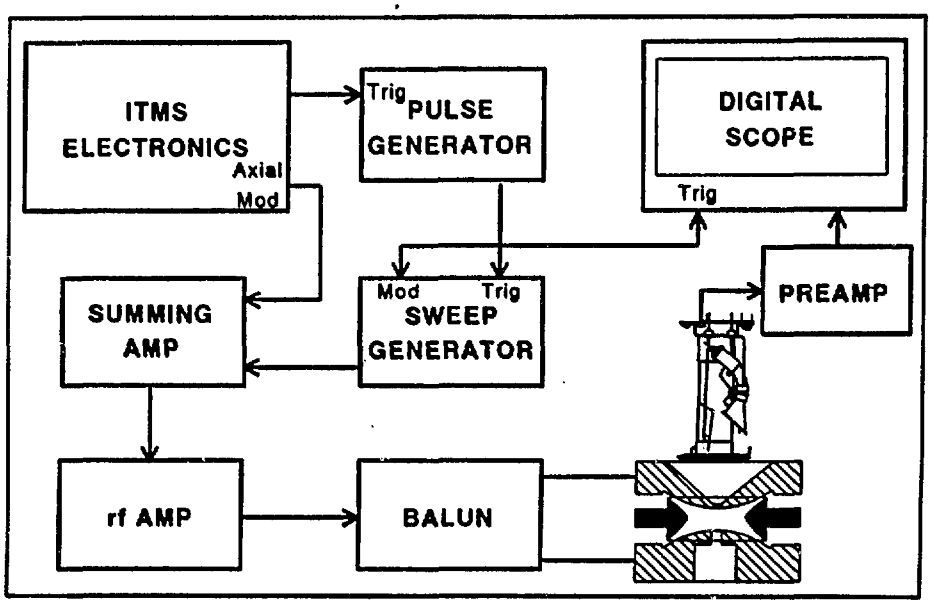
Some of the attributes of the quadrupole ion trap include high MS/MS efficiency, the capability for multiple stages of mass spectrometry (MS^n), high sensitivity, the capability for ion-molecule reactions, and relatively low cost. However, the Finnigan MAT ion trap mass spectrometer (ITMS) has unit mass resolution and a nominal upper mass/charge limit of only 650 when operated in the standard mass-selective instability method for acquiring mass spectra. Mass resolution up to ≈ 2500 can be achieved with the use of the axial modulation technique. Ions can also be ejected at a q_z value other than that corresponding to the mass-selective instability boundary by application of an auxiliary signal to the endcap electrodes. When the frequency of this signal is resonant with the secular frequency for a particular m/z, such ions can become kinetically excited and ejected from the trap via a process known as resonance ejection.

Last year, we demonstrated the capability to mass-selectively isolate or eject ions[1] over a wide mass range and to generate mass spectra of electrospray-generated ions by scanning the frequency of the resonance ejection signal applied to the end-cap electrodes[2]. A block diagram of the experimental modifications to the ITMS™ required for frequency-swept resonance ejection is shown in Figure 1. The mass resolution of the ion trap can be further enhanced by slowing the frequency scan rate and reducing the amplitude of the resonance ejection signal. EI mass spectral data acquired for the m/z 502 ion from perfluorotributylamine (PFTBA) acquired with axial modulation (Figure 2a) and frequency-swept resonance ejection (Figure 2b) are shown. The low resolution spectrum ($m/\Delta m = 1900$) was obtained at a scan rate of 5555 m/z per second, while the high resolution spectrum ($m/\Delta m = 45{,}000$) was acquired at 4 m/z per second. Although the amplitude of the m/z 502 signal from mass-selective instability is approximately fifty times greater than from resonance ejection, the corresponding peak width in time units is about fifty times less. Thus, the areas under the two peaks, which correspond to the total number of ions at m/z 502, are the same within experimental error. The mass resolution is shown in Figure 3 as a function of scan rate at m/z 502, q_z=0.85. The mass resolution is also a function of the q_z and m/z values for a particular ion as well as the frequency scan rate. Plots of the mass resolution versus these parameters are shown in Figure 4, for m/z 502, and in Figure 5, for q_z=0.85. Each data set was obtained at a sweep rate of 1.6 m/z per second.

Fig. 1



1. McLuckey, S.A.; Goeringer, D.E.; Glish, G.L. Proc. 38th ASMS Conf., 1990, 57.
2. Van Berkel, G.J.; McLuckey, S.A.; Glish, G.L. Proc. 38th ASMS Conf., 1990, 12.

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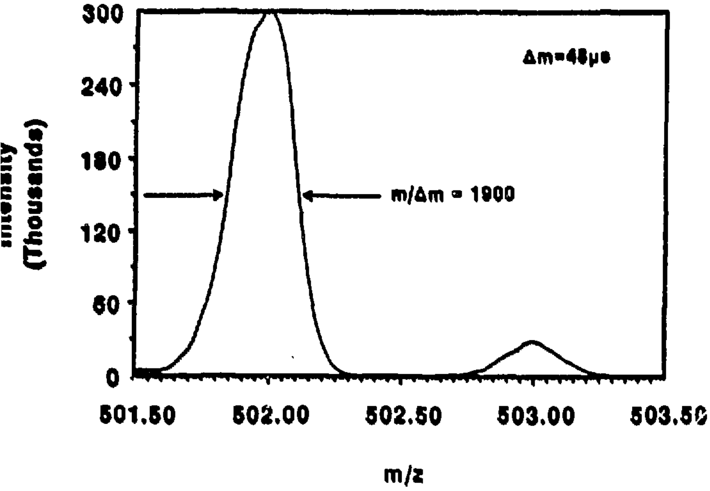

Fig. 2a

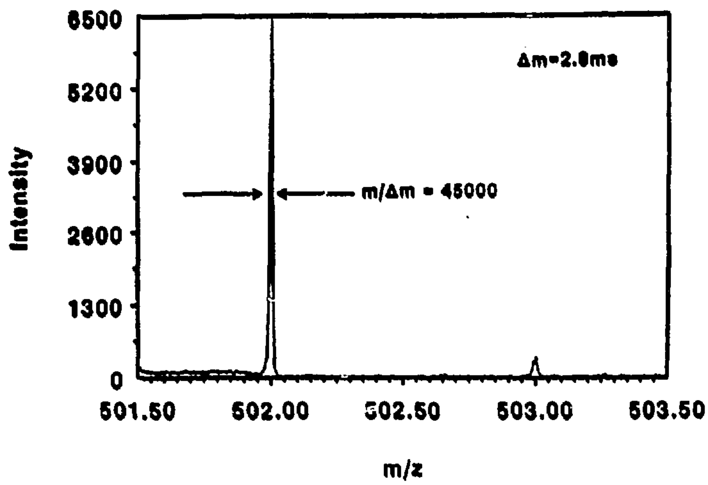

Fig. 2b

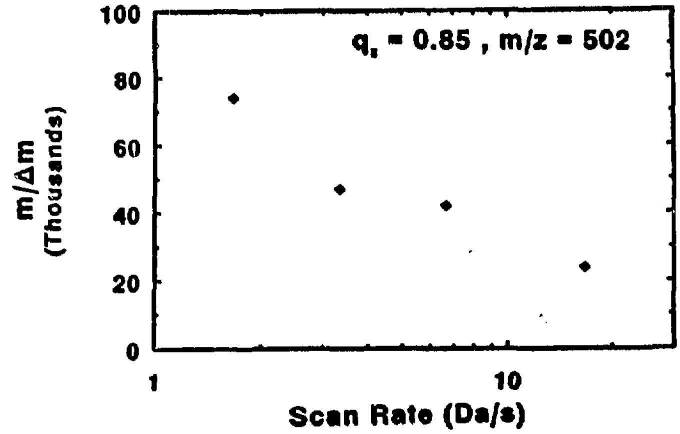

Fig. 3

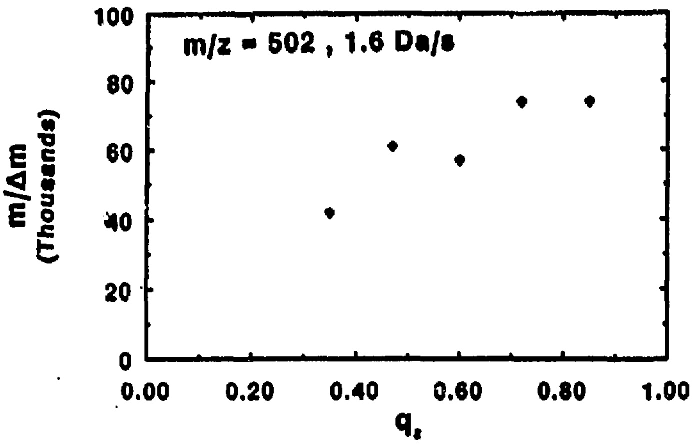

Fig. 4

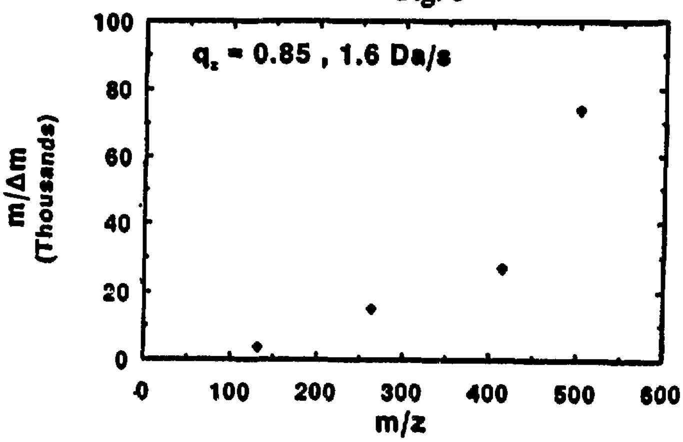

Fig. 5

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