ICP-MS WITH QUADRUPOLES OPERATED IN HIGHER STABILITY ZONES

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Quadrupole mass filters separate ions on the basis of path stability. Ion trajectories are classified as stable if the amplitude of ion motion remains less than the field radius, r_0, (the distance from the centre to a rod) and "unstable" if the amplitude increases until an ion strikes an electrode. The stability is described in terms of the Mathieu parameters a and q given by $a = \frac{8eU}{m\omega^2 r_0^2}$ and $q = \frac{4eV}{m\omega^2 r_0^2}$ where e is the ion charge, U and V the dc and rf voltages between poles, ω the angular rf frequency and m the ion mass. For a given ion mass to charge ratio, a given quadrupole size (r_0) and given frequency, a is a measure of the dc voltage applied to the rods and q a measure of the rf voltage. Combinations of a and q that give stable motion form regions shown on a stability diagram. There is an infinite number of stability regions. Almost all commercial quadrupoles operate in the first stability region near (a,q)=(0.24,0.7). With quadrupole operation in the stability region near (a,q)=(3,3) it is possible to achieve remarkably high abundance sensitivity, $>10^7$ or more, 0.2 m/e from a peak maximum. It is also possible to reach a resolution of 4000 with 3 eV Co^+ ions. The region near (a,q)=(0.03,7.55) allows achieving a resolution of 9000 (FWHM) with 20 eV Co^+ ions and unit resolution on ions of at least 1000 eV. First results from the region near (a,q)=(0, 21.3) show that a resolution of 4000 can be obtained with 1000 eV $^{39}K^+$ ions. Extrapolation of these data for the (0, 21.3) region suggests that unit resolution will be possible for 40,000 eV K^+ ions. The implications of these results for ICP-MS will be described.