to control and improve ion packets for increased resolution, for example. The multi-ring segment configuration may additionally or alternatively provide the ability to control rf biasing on each ring segment, which may allow an increase in resolution, possibly causing a "resonant ejection" technique currently employed on cylindrical and quadrupole ion traps.

[0056] In one embodiment, one or more of the discrete ring segments is driven in accord with the following equation:

$$V_o = -(V_{dc} - V_{ac}\cos(\Omega t))$$

where Ω is a harmonic fraction of the resonant frequency of the ion trap, and may fall within the range of about 100 kHz and about 2 GHz.

[0057] Numerous operational methods may also be employed with one or more of the apparatus described above, including without limitation, double resonant ejection, variable pressure, variable buffer, etc. Moreover, ion traps within the scope of the present disclosure include those which do not have endcaps, such as one or both of the endcaps **130**, **140** shown in the example depicted in FIG. **1**. To continue with this example, embodiments in which one or more dedicated endcaps **130**, **140** do not exist may utilize the outer one(s) of the ring segments **110** in a manner similar to the function of the dedicated endcaps.

[0058] It should also be noted that the number of coaxially aligned ring segments is not limited to the examples depicted in FIGS. **1**, **2A-2D**, **3**, and **5**. That is, embodiments within the scope of the present disclosure may include any number of coaxially aligned ring segments, possibly ranging between 2 to 300 or more. One such embodiment is an ion trap that includes 10 discrete, coaxially aligned ring segments.

[0059] The foregoing outlines features of several embodiments so that those skilled in the art may better understand the aspects of the present disclosure. Those skilled in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the present disclosure, and that they may make various changes, substitutions and alterations herein without departing from the spirit and scope of the present disclosure.

What is claimed is:

1. An apparatus, comprising:
an ion trap, including:
an injection endcap having a first centrally located aperture;
an extraction endcap having a second centrally located aperture;
a plurality of ring electrode segments collectively positioned in substantially coaxial alignment between the injection and extraction endcaps; and
a plurality of insulators each interposing neighboring ones of the plurality of ring electrode segments.

2. The apparatus of claim **1** wherein the plurality of ring electrode segments is five ring electrode segments.

3. The apparatus of claim **1** wherein the plurality of ring electrode segments is ten ring electrode segments.

4. The apparatus of claim **1** further comprising a plurality of biasing means each configured to electrically bias a corresponding one of the plurality of ring electrode segments.

5. The apparatus of claim **1** wherein each of the plurality of ring electrode segments has an inner diameter ranging between about 100 μm and about 1 cm.

6. The apparatus of claim **1** wherein the plurality of ring electrode segments collectively define an internal volume of the ion trap, the internal volume having a substantially cylindrical shape having a length ranging between about 100 μm and about 1 cm.

7. A method of manufacturing a coaxially segmented ring ion trap, comprising:
forming a first ring electrode segment over a substrate;
forming a first insulator over the first ring electrode segment;
forming a second ring electrode segment over the first insulator;
forming a second insulator over the second ring electrode segment;
forming a third ring electrode segment over the second insulator;
forming a third insulator over the third ring electrode segment; and
forming a fourth ring electrode segment over the third insulator.

8. The method of claim **7** wherein:
forming the first ring electrode segment includes forming a first conductive layer including the first ring electrode segment and a first contact extending from the first ring electrode segment;
forming the second ring electrode segment includes forming a second conductive layer including the second ring electrode segment and a second contact extending from the second ring electrode segment;
forming the third ring electrode segment includes forming a third conductive layer including the third ring electrode segment and a third contact extending from the third ring electrode segment; and
forming the fourth ring electrode segment includes forming a fourth conductive layer including the fourth ring electrode segment and a fourth contact extending from the fourth ring electrode segment.

9. A mass spectrometer system, comprising:
an ion trap, including:
an injection endcap;
an extraction endcap;
a plurality of ring electrode segments collectively positioned in substantially coaxial alignment between the injection and extraction endcaps; and
a plurality of insulators each interposing neighboring ones of the plurality of ring electrode segments;
an ionization source;
a sample gas inlet; and
an ion detector.

10. The system of claim **9** wherein the plurality of ring electrode segments is five ring electrode segments.

11. The system of claim **9** wherein the plurality of ring electrode segments is ten ring electrode segments.

12. The system of claim **9** further comprising a plurality of biasing means each configured to electrically bias a corresponding one of the plurality of ring electrode segments.