therein and other uses will occur to those skilled in the art which are encompassed within the spirit of the invention or defined by the scope of the claims.

What is claimed is:

1. An apparatus for separating and analyzing ions, comprising:

an ionization source to generate ions,

an ion drift cell coupled to said ionization source, in which the ions are separated according to their mobility and which comprises electrodes for transporting and focusing the ions, said focusing comprises a superposition of periodic field focusing and hyperbolic field focusing; and,

a detector coupled to said ion drift cell to detect the ions.

2. The apparatus of claim 1 wherein said detector is a mass spectrometer.

3. The apparatus of claim 2 wherein said mass spectrometer is coupled to said ion drift cell by a microchannel aperture plate comprising a bundle of capillaries.

4. The apparatus of claim 3 wherein a voltage is applied across said microchannel aperture plate.

5. The apparatus of claim 3 wherein said capillaries are of increasing diameter, having the larger diameter capillaries facing the mobility drift cell.

6. The apparatus of claim 2 further comprising a radio frequency focusing interface between said drift cell and said ion detector.

7. The apparatus of claim 6 wherein said radio frequency focusing interface comprises a combination of a radio frequency electric field and a direct current electric field

8. The apparatus of claim 2 wherein said mass spectrometer is a time-of-flight mass spectrometer having a flight tube positioned orthogonally with respect to the ion drift cell axis.

9. The apparatus of claim 2 further comprising means for fragmenting ions, said means for fragmenting being coupled to said ion drift cell to receive ions therefrom, and positioned prior to said mass spectrometer.

10. The apparatus of claim 9 wherein said means for fragmenting ions comprises collisions of said ions with gas particles.

11. The apparatus of claim 10 wherein said collisions occur in the expanding gas flow during the transmission of ions from said drift cell to said mass spectrometer.

12. The apparatus of claim 11 wherein the collision energy of said collisions may be increased by accelerating the ions in an electrical field within said expanding gas flow.

13. The apparatus of claim 9 wherein said means for fragmenting ions comprises electron impact fragmentation.

14. The apparatus of claim 9 wherein said means for fragmenting ions comprises surface induced dissociation.

15. The apparatus of claim 9 further comprising a radio frequency quadrupole.

16. The apparatus of claim 1 wherein said electrodes are comprised of regions of conical shape.

17. The apparatus of claim 1 wherein said electrodes comprise thick plate electrodes possessing a central hole wherein said central hole has a conical shape.

18. The apparatus of claim 1 wherein said electrodes have unequal potential differences applied between them.

19. The apparatus of claim 1 wherein said electrodes comprise electrodes with unequal hole diameters.

20. The apparatus of claim 1 wherein said electrodes comprise electrodes having unequal spacing between them.

21. The apparatus of claim 1 wherein said electrodes comprise cup-shaped electrodes.

22. The apparatus of claim 1 wherein said ion drift cell comprises a stack of electrodes with insulating material between those electrodes.

23. The apparatus of claim 22 further comprising seal rings in said stack in order to seal said drift section.

24. The apparatus of claim 22 further comprising positioning rings in order to position said electrodes along the axis of said drift chamber.

25. The apparatus of claim 22 further comprising a positioning tube in order to position said electrodes along the axis of said drift chamber.

26. The apparatus of claim 25 wherein said positioning tube also seals said drift chamber.

27. The apparatus of claim 1 wherein said ionization source to generate ions comprises:

an ionizing beam; and,

a sample holder with a surface to accommodate a sample to receive said ionizing beam.

28. The apparatus of claim 27 further comprising one or more mirrors positioned to redirect said ionizing beam onto said surface so that said ionizing beam can enter from behind said surface.

29. The apparatus of claim 27 further comprising one or more mirrors positioned to redirect said ionizing beam onto said surface so that said ionizing beam can enter said drift chamber essentially orthogonally to its axis.

30. The apparatus of claim 27 wherein said sample holder comprises a sample holder allowing sequential exposure of several samples to the ionizing beam.

31. The apparatus of claim 30 wherein said sample holder comprises a rotatable sample holder.

32. The apparatus of claim 30 wherein said sample holder is positioned orthogonally to an ion mobility drift cell.

33. The apparatus of claim 30 wherein said sequential exposure of said samples comprises the use of a moving belt to carry said samples to the position of said ionizing beam.

34. The apparatus of claim 1 where said electrodes each accommodate several openings in order to transport and focus several parallel beams of ions.

35. An apparatus for transporting ions, comprising:

an ion drift cell, which comprises electrodes for transporting and focusing the ions, said focusing consisting of a superposition of periodic field focusing and hyperbolic field focusing.

36. An apparatus for transporting ions, comprising:

an ion drift cell, which comprises electrodes for transporting and focusing the ions, said focusing consisting of a combination of periodic field focusing and hyperbolic field focusing.

37. An apparatus for separating and analyzing ions, comprising:

an ionization source to generate ions,

an ion drift cell coupled to said ionization source, in which the ions are separated according to their mobility and which comprises electrodes for focusing the ions, wherein said focusing comprises hyperbolic field focusing; and,