4.3: Electric Sector/Double Focusing Mass Spectrometers

Electric Sector/Double Focusing Mass Spectrometers (1). An electric sector consists of two concentric curved plates. A voltage is applied across these plates to bend the ion beam as it travels through the analyzer. The voltage is set so that the beam follows the curve of the analyzer. The radius of the ion trajectory (r) depends up on the kinetic energy of the ion (V) and the potential field (E) applied across the plates.

$$r = \frac{2V}{E}$$

Equation $4.3.1$ shows that an electric sector will not separate ions accelerated to a uniform kinetic energy. The radius of the ion beam is indep endent of the ion's mass to charge ratio so the electric sector is not useful as a standalone mass analyzer.* An electric sector is, however, useful in series with a magnetic sector. The mass resolution of a magnetic sector is limited by the kinetic energy distribution (V) of the ion beam. This kinetic energy distribution results from variations in the acceleration of ions produced at different locations in the source and from the initial kinetic energy distribution of the molecules. An electric sector significantly imp roves the resolution of the magnetic sector by reducing the kinetic energy distribution of the ions**. These high resolutions experiments are discussed in the section on mass spectral interpretation. The effect of the electric sector is shown in Figure $4.3.1$ for a reverse geometry (BE) instrument with the magnetic sector (B) located before the electric sector (E).

*The electric sector is a kinetic energy analyzer. In the source region of the mass spectrometer all ions are accelerated to the same kinetic energy. Because they have the same kinetic energy, they are not separated by an electric sector. A magnetic sector will resolve different mass ions accelerated to a uniform kinetic energy because it separates ions based upon their momentum (See 4.2: Magnetic Sector).

**Ion optics are complex and interested readers are referred to the literature for more detail. The model presented here provides a framework for understanding many high resolution and tandem mass spectrometry experiments. The article by Nier (1) provides an excellent introduction, a historical perspective, and many references for the development and theory of these instruments.

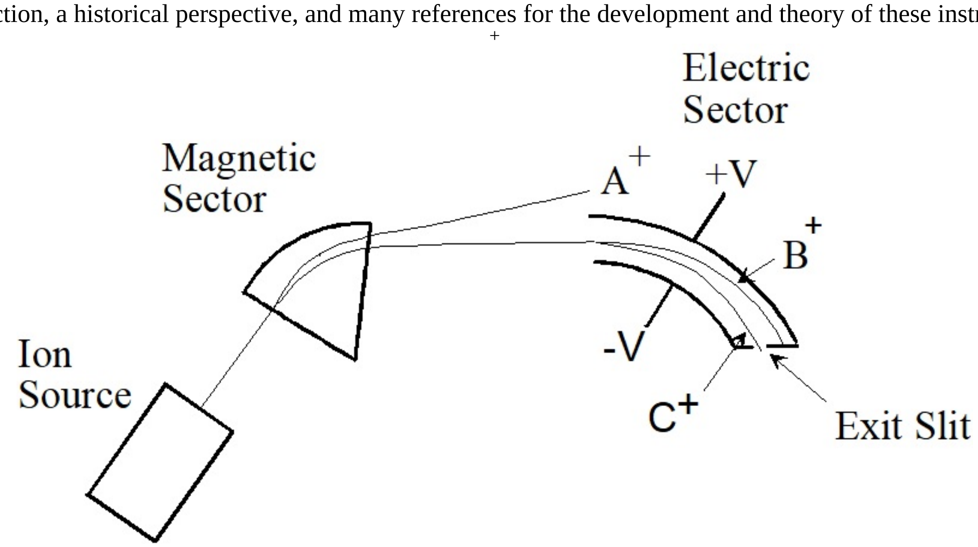

Figure \(\PageIndex{1}\): Reverse Geometry Double Focusing Mass Spectrometer. A^+ is a 100.00 *m/z* ion, B^+ is a 50.00 *m/z* ion and C^+ is a 50.01 *m/z* ion. A^+ is rejected by the magnetic sector because of it's greater momentum. B^+ and C^+ are not resolved by the magnetic sector because they have the same momentum. To have the same momentum, however, B^+ must have a more kinetic energy than C^+. As a result the electric sector separates these two ions.

References

1. Nier, A. J Am Soc Mass Spectrum **1991**, *2*, 447-452.
2. Hercules, D.M.; Day, R.J.; Balasanmugam, K.; Dang, T.A.; Li, C.P. Anal. Chem. **1982**, *54*, 280A-305A.

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