For my research project, I am interested in learning more about mass spectrometry, how it makes use of electromagnetic traps and analyzers, and applications of this field with others, particularly nuclear physics. From the reading I have done so far, the general idea underlying mass spectrometry is the same for various techniques. Some sample being studied is introduced and is ionized. This ion source is passed onto some form of mass analyzer that makes use of electric and/or magnetic fields to filter the sample, and what is left after this analysis hits a detector. The analysis technique can be tuned for specific substances being detected and a mass spectrum for the sample. A few of the devices and techniques I have read about so far are the quadrupole mass spectrometer, the ion trap, and accelerator mass spectrometry.

Each method uses some aspect of electromagnetism in order to filter the sample. For example, the quadrupole mass spectrometer makes use of four hyperbolic, two on the x-axis and two on the z-axis, and applies a constant voltage and a radio frequency voltage with some specific frequency. From the equations of motion, there is a stable charge to mass ratio for our choice of separation, constant voltage, the amplitude of the rf voltage, and the rf voltage's frequency. Mass to charge analyzers like this can be used as parts of other methods, as well, such as in linear Accelerator Mass Spectrometry. Accelerator Mass Spectrometry could also make use of a cyclotron and tune its frequency to select a particular charge to mass ratio, which depends on the choice of the magnitude of the magnetic field.

The reason why this interests me is because it applies to a wide range of fields, one of which is nuclear physics. For instance, mass spectroscopy can be used to test for the ratio of different isotopes in a sample of given element. Another use for this in nuclear physics is finding

precision mass measurements for different nuclei. With this, current nuclear mass models which rely heavily on theory would be better informed by the data. The overview also mentioned the use of mass spectrometry for finding Q_{EC} values for superallowed transitions. It seems like these techniques is in use on the front line of nuclear physics research, an area of study that I am interested in, and so I want to use this project as a chance to learn more and better understand this topic.

Sources

- W. Paul. (1990). Electromagnetic Traps for Charged and Neutral Particles. *Rev. Mod. Phys., 62(3),* 531-540, *https://dx.doi.org/10.1103/RevModPhys.62.531*
- S. Maher, F. P. M. Jjunju, and S. Taylor. (2015). *Colloquium*: 100 years of mass spectrometry: Perspectives and future trends. *Rev. Mod. Phys., 87(1)*, 113-135, *https://dx.doi.org/10.1103/RevModPhys.87.113*
- D. Elmore and F.M. Phillips. (1987). Accelerator Mass Spectrometry for Measurement of Long-Lived Radioisotopes. *Science, 236(4801),* pp. 534-550, *https://dx.doi.org/10.1126/science.236.4801.543*
- R.A. Muller. (1977). Radioisotope Dating with a Cyclotron. *Science, 196(4289),* pp. 489-494, *https://dx.doi.org/10.1126/science.196.4289.489*