**Synchrotron Radiation**

Synchrotron radiation is the light, i.e., photons emitted by accelerating electrons. A third-generation synchrotron produces highly-collimated photons, tunable from infrared to hard X-rays. The facility is used for a variety of scientific experiments from materials science to molecular physics.

**Research Objectives**

- Measure the photo-double ionization of water molecules
- Discuss and compare some theoretical modeling of water structure
- Understand radiation damage considering water is the main constituent of biosystems
- Learn atomic and vacuum physics, synchrotron radiation, and electron spectroscopy

**ELLETRA**

ELLETRA operates a third-generation synchrotron with 26 beamlines in Trieste, Italy. The synchrotron is capable of generating lights at wavelengths varying from infrared to hard X-rays. The facility is used for a variety of scientific experiments from materials science to molecular physics.

**Gas Phase Beamline**

The Gas Phase Photomission (GAPH) beamline is capable of delivering lights of wide energy range from 13.5 eV to more than 900 eV to gaseous systems. The Multi-coincidence chamber has 10 analyzers mounted along a circle with 30 degree increments. The analyzers allow only electrons at a certain energy level (and at a specific angle) to pass, and can detect the two electrons emitted by the photo-double ionization in coincidence.

**Photo-Double Ionization**

Photo-double ionization (PDI) is a process of emission of two electrons when one photon is absorbed by atoms or molecules. This is entirely due to electron-electron correlations beyond central potential model. The conservation of energy holds here.

**Method**

A ten-day measurement was conducted in ELLETRA synchrotron in Trieste, Italy in December, 2017. Electron spectroscopy was done to measure energy and angle resolved electrons in coincidence. The GAPH beamline was used to expose the gas H$_2$O molecules to photons in the 60 - 70 eV range and ionize them. The triple-differential emission cross-section was obtained from angular distribution, and it was compared with different theoretical models.

**Research Results**

On the left is the binding energy spectrum of the water dication comparison between the reference measurements done by Eland [1] (in red) and our measurements (in black). Our results follow the trend of increasing in the number of coincidence yield until around 41 eV but do not seem to follow the trend after about 45 eV of decreasing until the binding energy hits about 48 eV.

**Conclusions & Future Work**

The coincidence yield increases from 39 eV of binding energy and stays nearly as high until around 48 eV. This makes sense since four dication states (X3B1, 11A1, b1B1 and 21A1) are expected within the binding energy region 39-46 eV. Future work will involve uneven sharing of the energy between the two photo-electrons, which can be both direct and indirect.