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# Optical Excitation Functions of ArII and $N_2^+$

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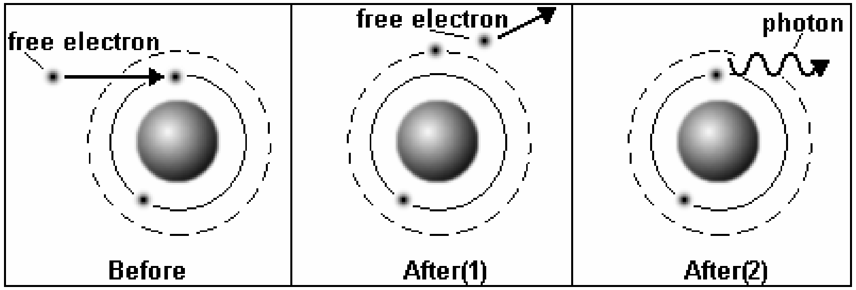
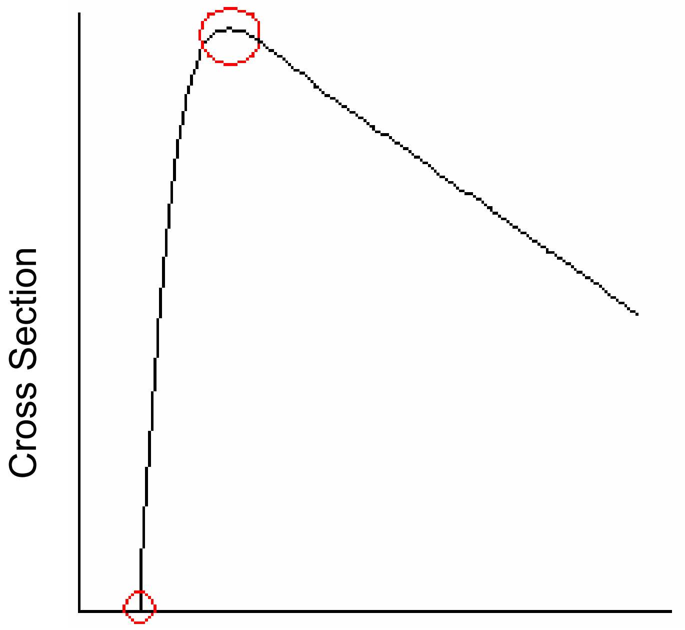
# Introduction

- A beam of electrons is shot into a chamber full of atoms in the gas phase
- Some beam electrons will collide with an atom; some of the electrons energy will be transferred to the atom
- The excited atom will release a photon
- Measure the light emitted as a function of electron energy



# Introduction

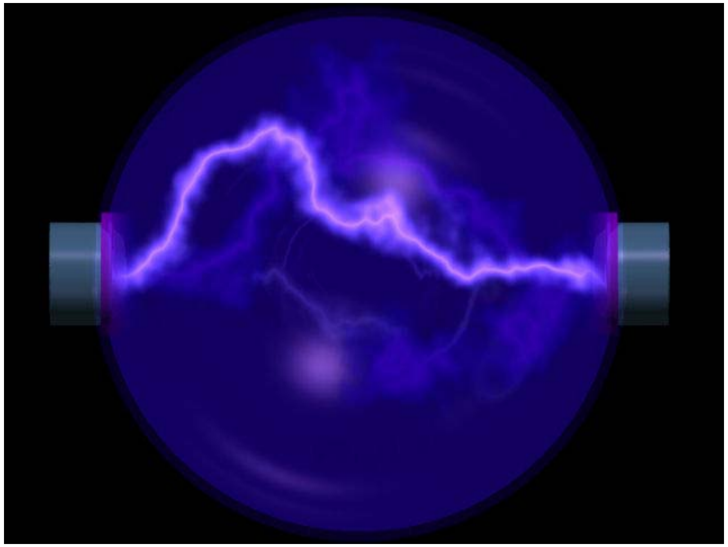



$$\sigma = \frac{N_\gamma}{kPI_{e^-}}$$

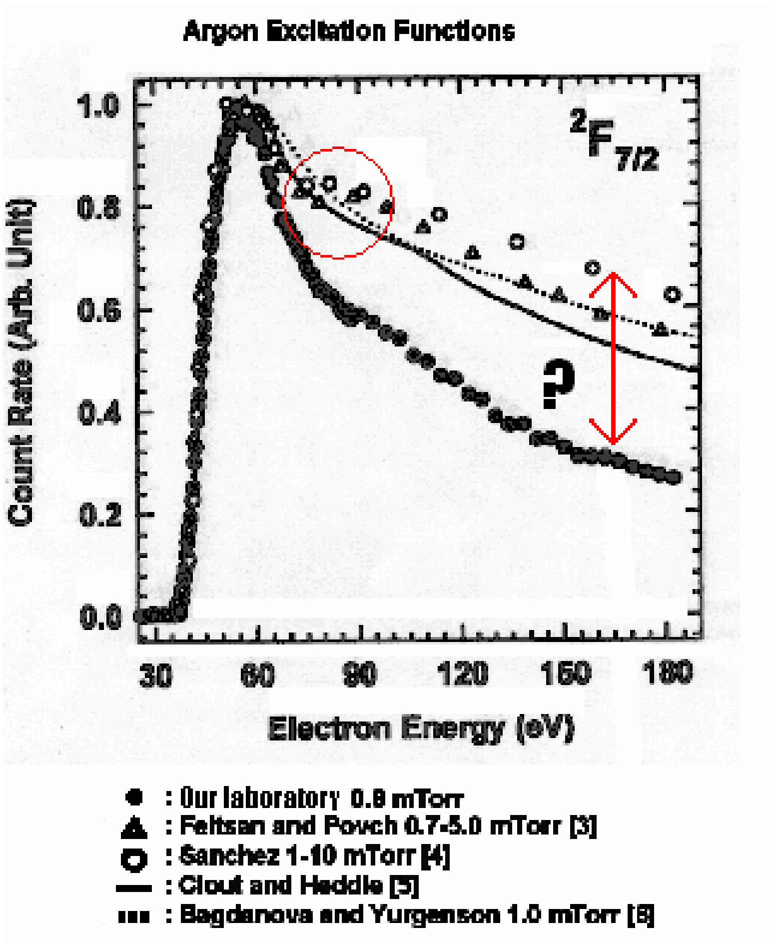
**σ** = total cross section of atom in question
$N_\gamma$ = number of photon detected by PMT
**k** = constant of proportionality, quantum efficiency of PMT, solid angle of optics
**P** = Pressure in collision cell
$I_{e-}$ = Current that has collision potential

# Applications

- Noble gas ion lasers
- Low-energy chemical vapor deposition in plasmas (computer chips)
- Astrophysical plasmas (aurora borealis)
- Atmospheric phenomena: interpreting optical emission from the earth's atmosphere



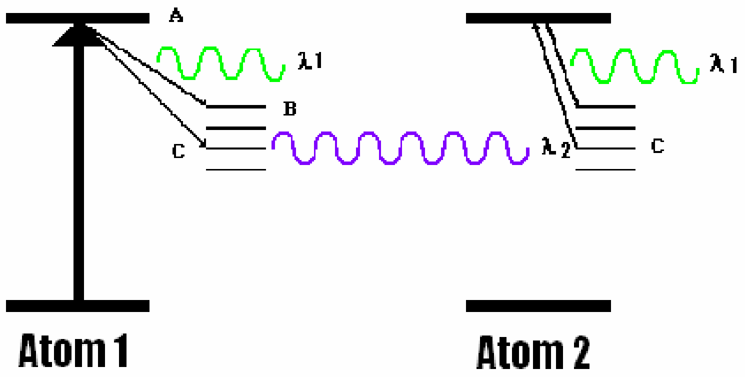
# Argon Data




**Argon 461nm:** Excitation function taken by our group compared with the data of other researchers. Our data looks different because it was taken at lower pressures. This reduces radiation trapping effects, as well as double collisions.

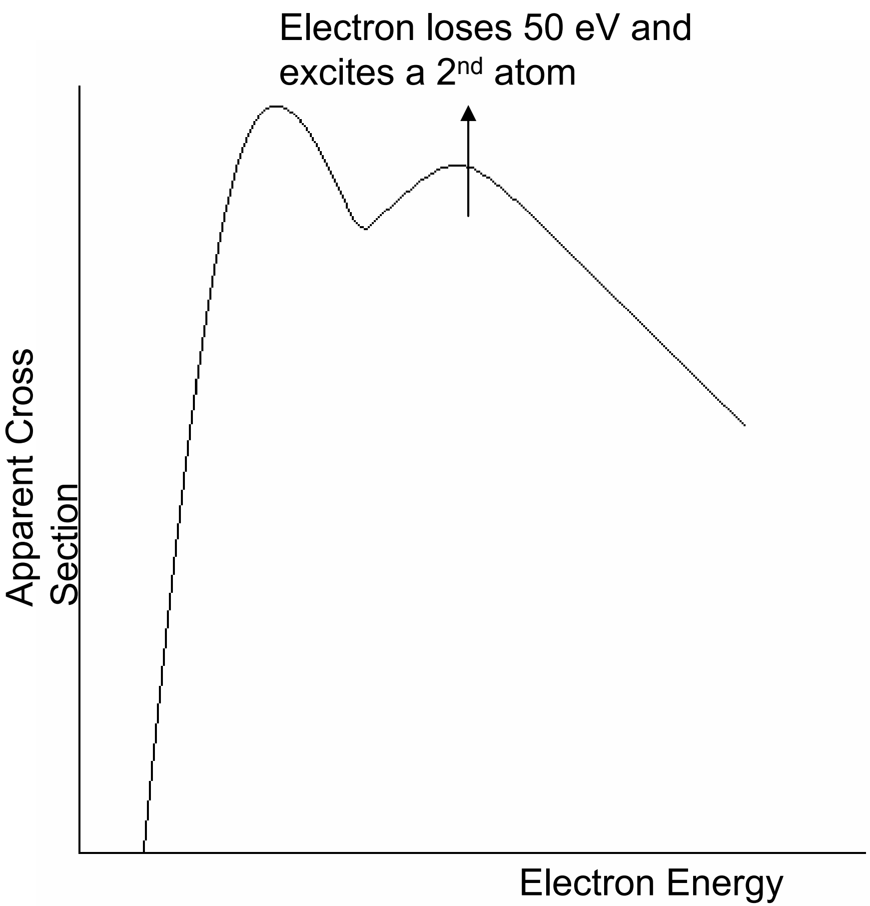
# Radiation Trapping

- Desired transition: A→B
- If excited atom decay A→C, and that photon comes into contact with an already excited atom, there is a new opportunity to produce the desired A→B transition

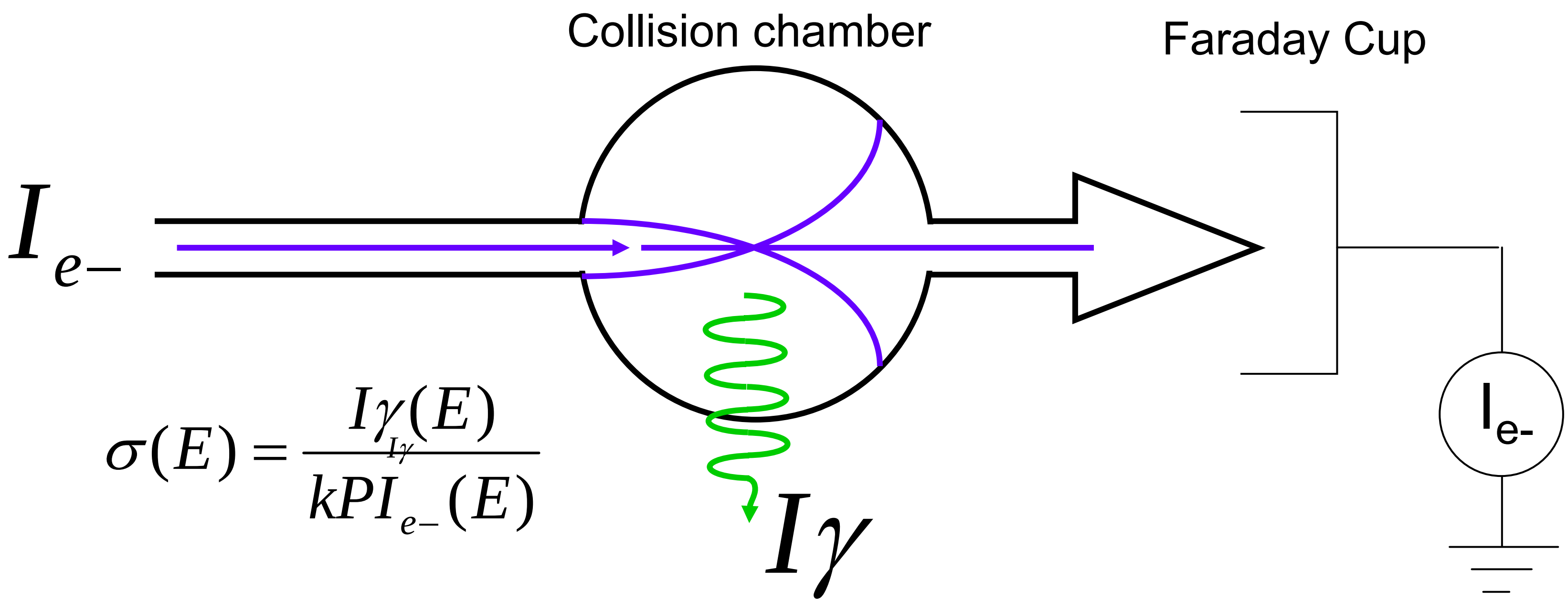


# Double Collisions

- At very high electron energies, a single electron can excite one atom and still have enough energy to excite a second atom with an even greater probability
- The peak for the single ionization cross section occurs between 45 and 50 eV, the secondary feature should be double that



# Normalization Problems

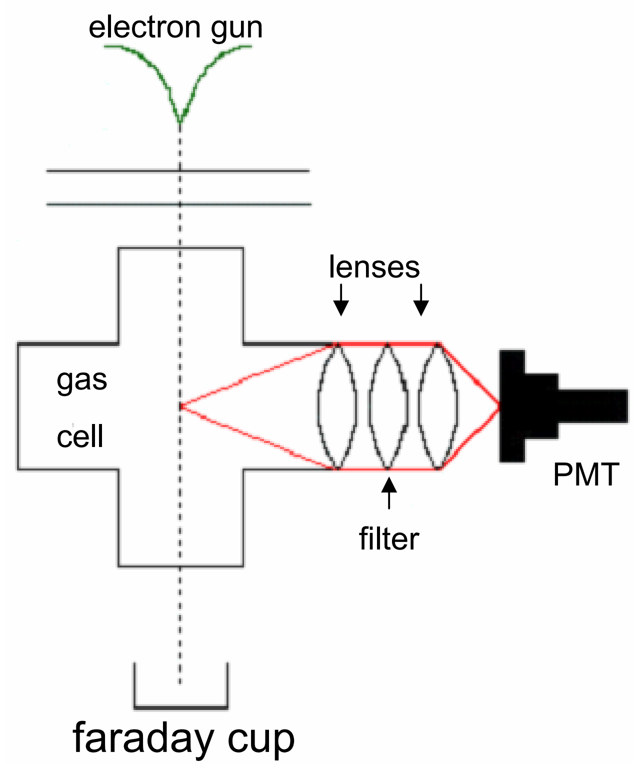



$$\sigma(E) = \frac{I\gamma(E)}{kPI_{e-}(E)}$$

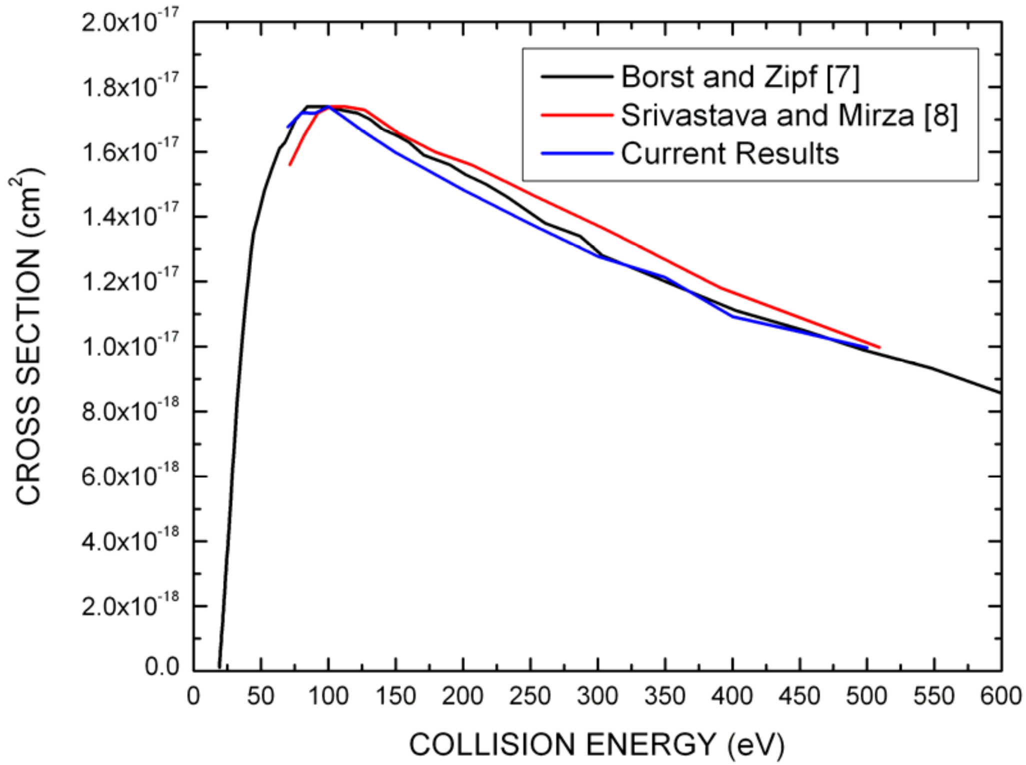
Geometry of old apparatus. Due to anomalous focusing effects, not all electrons that produced photons that are detected are recorded down stream in the Faraday Cup. The means that the detected current , Ie- and the detected photon counting rate, Iγ, are not necessarily proportional, leading to error in the measured optical excitation cross section,σ.

# Apparatus

- Diffusion Pump on 6” Conflat 6-way cross
- Entire chamber flooded with gas at constant pressure
- Electron gun uses little or no focusing to ensure that the beam is parallel in the interaction region
- Photomultiplier tube as well as optical train are focused on the center of the beam



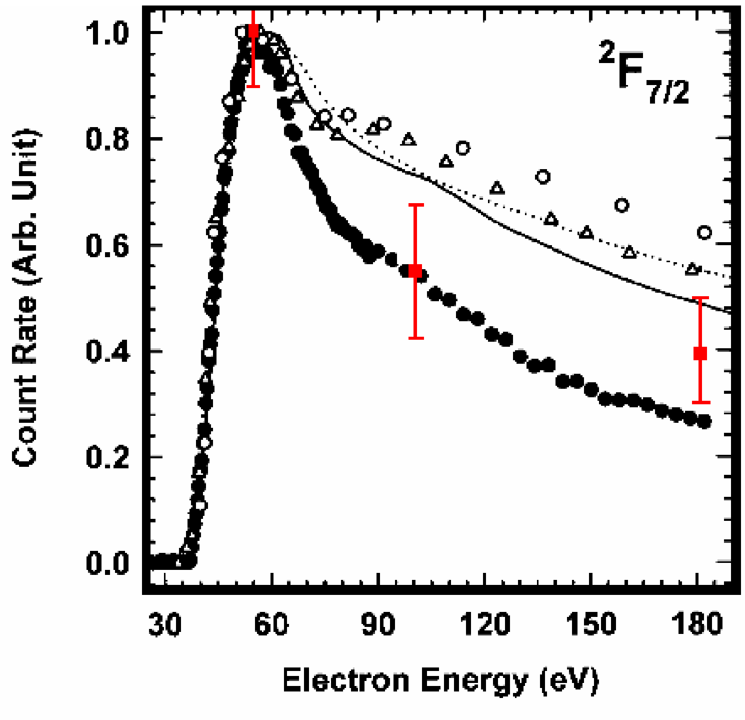
# $N_2^+$ Results



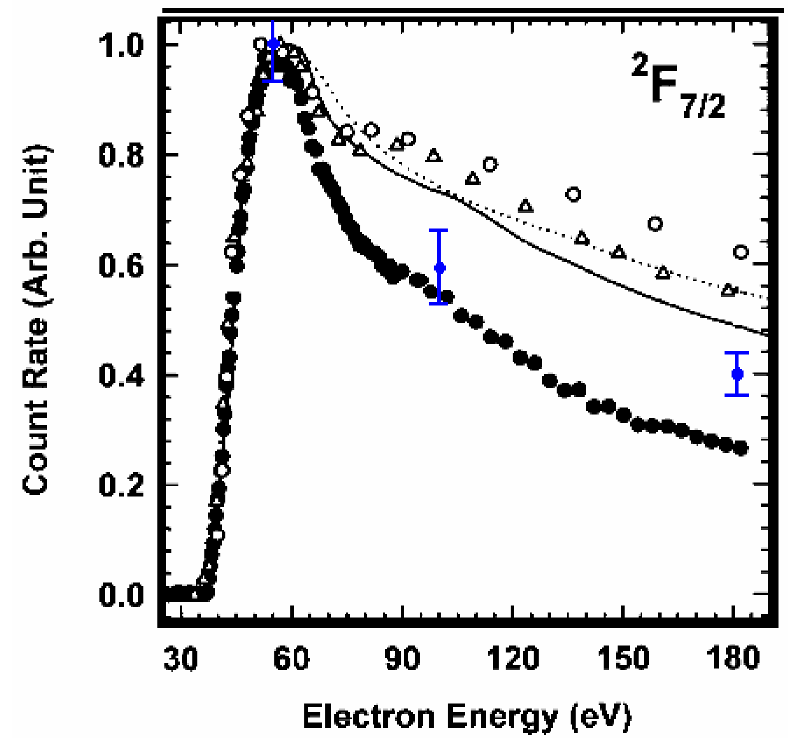

Current results of the $B^2\Sigma_u^+$ - $X^2\Sigma_g^+$ 391.4 nm transition in $N_2^+$ compared with previously obtained results.

# Argon Data

- 0.4 mTorr




- 0.8 mTorr




● : Our laboratory 0.8 mTorr
▲ : Feltsan and Povch 0.7-5.0 mTorr [3]
○ : Sanchez 1-10 mTorr [4]
— : Clout and Heddle [5]
▪▪▪ : Bagdanova and Yurgenson 1.0 mTorr [6]

# Conclusion

- Preliminary data would indicate that previous publications for ArII 461nm transition are inaccurate due to pressure effects
  - Radiation trapping
  - Double collisions
- Data taken on our old apparatus seemed to have incorrect normalization
- Next step will be to take data at more than three points

# References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