Short Term Visit to Innsbruck from the University of Birmingham
Dr. Chris Mayhew (Birmingham)
10 days: 24th June – 4th July

The programme of research carried out during this visit was done in collaboration with Prof. Paul Scheier, who supervised the project, and Dr. Stefan Feil, who kindly worked with me on a daily basis on the apparatus.

During this trip a series of PFCs of importance to technological plasmas were investigated using two types of electron beam apparatus. One was CELIA - a trochoidal electron monochromator instrument shown opposite.

The second was VG ZAB-2SEQ – a two sector field mass spectrometer show opposite. These two instruments complemented each other, with CELIA being the best instrument to investigate the zero energy resonances and the VG ZAB for resonances from 0.5 eV and above. Furthermore, following suggestions from Professor Scheier the VG ZAB was used to obtain autodetachment rates and was also used to investigate unimolecular decay. This extended the original project proposal. The visit was very successful. Although we could not complete all the measurements in the time allocated to me, Dr. Feil kindly began the study on one of the molecules before I arrived, and then we worked together to complete studies on the other three originally proposed. The systems studies were:

- c-C_4F_8 (prior to this study there has been many swarm experiments, some scattering experiments but little evidence of beam work)
- 2-C_4F_8 (first electron beam study made by us)
- 1, 3 C_4F_6 (prior to this study only swarm and scattering studies only have been obtained)
- C_5F_8 (prior to this study only swarm studies to date have been reported)

The analysis of the data is currently being worked on both here in Birmingham and in Innsbruck. We anticipate that a paper will result from this work before the end of the year.

Additional Work

During the visit, I took the opportunity to work on a research paper relating to work done during my previous ESF visit to Innsbruck:

Vacuum Ultraviolet and Electron Impact Dissociative Ionization Studies of SF_5Cl

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This was completed during the visit and we anticipate that the paper will be submitted to International Journal of Mass Spectrometry by the end of July 2006. The abstract of the paper is as follows:

A complementary study of the interaction of SF_5Cl in the gas phase with vacuum-UV photons and low-energy electrons from the onset of ionisation, *ca*. 12 eV, to 20 eV is presented. The photon-induced experiments have used tunable vacuum-UV radiation from a synchrotron and threshold photoelectron photoion coincidence spectroscopy for product ion detection, the electron-induced experiments a trochoidal electron monochromator and a quadrupole mass spectrometer. The strengths and limitations of both experiments are contrasted, the main difference being the absence of state selectivity in the electron-induced study. The parent cation is not observed in either study, suggesting that its ground electronic state is repulsive following Franck-Condon vertical excitation. The fragment cations SF_5^+, SF_4Cl^+, SF_4^+ and SF_3^+ have been observed in both studies, with reasonable agreement in their threshold appearance energies. Using a variant of threshold photoelectron photoion coincidence spectroscopy applicable when the ground state of the parent cation is repulsive, the first dissociative ionisation energy of SF_5Cl is determined to be 12.3 ± 0.2 eV, leading to a value for the adiabatic ionisation energy for the SF_5 radical of 9.92 ± 0.28 eV. The electron-induced experiment is sensitive to ion-pair production, and onsets for F^+ and Cl^+ production have been observed which are only possible energetically if the accompanying fragments are the anions SF_4Cl^- and SF_5^-, respectively. A lower limit for the electron affinity of the SF_4Cl radical of 4.88 eV is determined, a value confirmed by *ab initio* calculations. The electron-induced experiment is very sensitive to gas impurities, and the effects of minute quantities of SF_4, FCl, Cl_2 and possibly SF_2 in the gas sample are observed.