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Negative-ion/positive-ion coincidence spectroscopy with a novel spectrometer

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Synopsis A novel instrument for negative-ion/positive-ion coincidence spectroscopy (NIPICO) is presented. The instrument consists of a double TOF spectrometer with a common extraction region. Electrons are deflected by means of a magnetic field. We demonstrate detections of double (NIPICO) and triple (NIPIPICO) coincidences.

Core-excited states usually decay by emitting electrons or much less probably by emitting soft x-ray photons. The yield of negative ions typically increases at these resonances. Since negative ions only will be created in negative-ion/positive-ion pairs, these fragments can be detected in coincidence. A negative-ion/positive-ion coincidence technique (NIPICO) allows us to study how yields of different fragmentation channels vary when the photon energy is tuned to different resonances and associated kinetic energy releases.

We have designed a negative-ion time-of-flight spectrometer to be used together with a positive-ion time-of-flight spectrometer provided by the Gas Phase beamline at the Elettra storage ring [1]. The two spectrometers are mounted facing each other with a common interaction region. Ions and electrons are extracted by means of an electric field. The electrons are deflected by a magnetic field, similar to pioneering experiments by Schermann *et al* [2], in the negative spectrometer flight tube, reducing efficiently the detection of electron/negative-ion coincidences. The instrument could be operated either using a pulsed electric potential in the interaction region or using a constant field. In the latter case, the identities of the positive and negative ions are deduced from the unique time between the two ion detections.

As a first target for our instrument we chose the SF_6 molecule, known to produce negative ions at resonances close to the S 2p and F 1s edges [3,4]. Figure 1 shows a measurement at two resonances above and below the S 2p ionization edge. They were measured with a constant extraction field and show three main NIPICO channels S^-/F^+, F^-/F^+ and F^-/S^+. The pronounced doublet structure of the two former indicates a significant kinetic energy release in the corresponding dissociation channels. A change in branching ratios between the S^-/F^+ and F^-/F^+ coincidence channels is also seen. We have also detected several three-particle coincidence channels (NIPIPICO), such as $F^-/F^+/F^+$ and $F^-/S^+/F^+$.

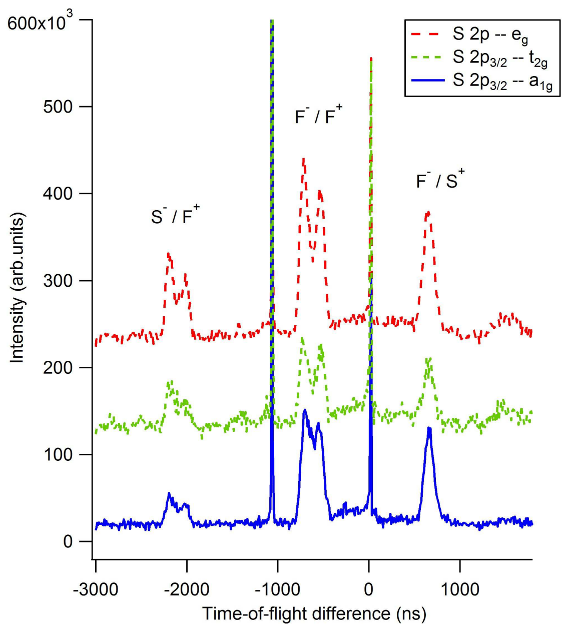

Figure 1. NIPICO spectrum for three resonances close to the S 2p IP. The t-scale indicates the differences between the positive ion TOF and the negative ion TOF. The main coincidence channels are indicated. The sharp peak at t = 0 arise either from cross-talk between the two detectors or fluorescence emission. The second sharp peak at t = -1100 is a computing artefact.

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