

Development of a VUV-VIS-spectropolarimeter for target characterisation

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The interaction of highly charged ions with atomic or molecular gases and free electrons has been thoroughly studied in the past by means of x-ray and particle spectroscopy. In these experiments, processes like radiative electron capture and dielectronic recombination have been investigated and compared to theory. The calculations, however, have been performed by averaging over all possible channels involving different electronic states of neutral atoms and ions, and then comparing the results with the experiments.

Advantages of Fluorescence Spectrometry

Dispersed fluorescence spectrometry, however, offers the possibility to detect state-specific fluorescence transitions in the projectile or target atoms. In coincidence with x-ray or particle spectrometry, this allows the investigation and testing of different processes during or following the interaction. The technique may also be used in experiments on radiative electron capture, the time-reversed process of photoionization, where an electron is captured from the continuum to a bound state while emitting a photon to be detected, or on dielectronic recombination, when the capture of a free electron leads to the excitation of another electron in the ion. The involved states can be identified by subsequent dipole transitions. Also, time-dependent fluorescence measurements have been shown to pose a monitor for longitudinal beam profiles. In order to evaluate the applicability of the technique, a pilot experiment for fluorescence spectrometry has been carried out at the GSI.

Experimental setup

The experiment has been carried out at the gas target of the ESR storage ring at the GSI, where a jet of neutral Xe atoms crossed a beam of Xe^{52+} and Xe^{54+} ions at 200 MeV/u. For the fluorescence measurements, a Seya-Namioka-type spectrometer has been used as depicted in fig. 1. The dispersive element is an optical grating with a concave radius of 1 m and a line density of 600 l/mm, the opening angle between entrance and exit arm is 70.15° , which is characteristic for this type of spectrometer. The detector is a commercial 1" micro-channel-plate detector from Quantar Technology that uses an S-20 Bialkali photocathode and a resistive anode for position encoding. In this tentative experiment, a view port with a borosilicate viewport was in the path of the fluorescence, restricting the lowest observable wavelength to 200 nm.

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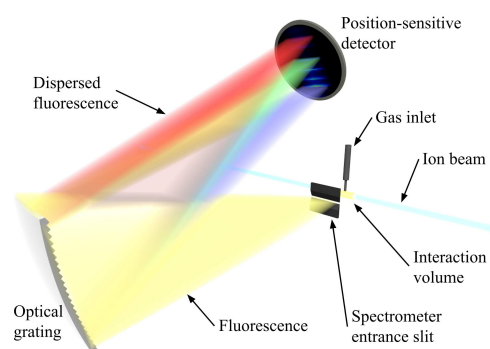


Figure 1: Scheme of the used spectrometer setup. Fluorescence light from the interaction volume passes through the entrance slit of the spectrometer and is dispersed by a spherical reflection grating that projects the dispersed fluorescence onto the surface of a position-sensitive detector. This enables the measurement of a certain fluorescence wavelength range. The width of which depends on the line density of the grating and the size of the detector.

First results

The wavelength range from 200 nm to 650 nm has been scanned and a number of individual fluorescence lines could be measured, most likely stemming from Xe^{2+} and Xe^{3+} ions in the gas target, as shown in fig. 2. A conclusive evaluation is in progress. The experiment showed that the application of fluorescence spectrometry at heavy-ion storage rings is feasible. For future experiments, an optimised spectrometer for the use at CRYRING@ESR is planned.

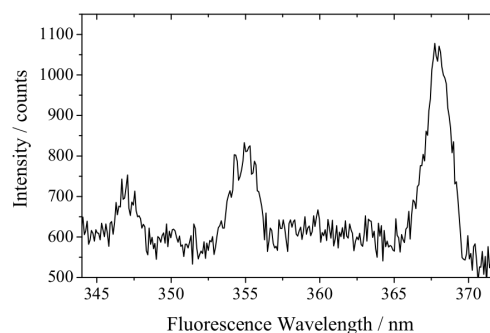


Figure 2: Example for the measured fluorescence spectrum from the Xe gas target, excited by Xe^{54+} ions at 200 MeV/u.