

Spectator Auger decays of *cis*-1,1,2,2,3,4-hexafluorocyclobutane in the F 1s region

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Synopsis Spectator Auger spectra of gaseous *cis*-1,1,2,2,3,4-hexafluorocyclobutane have been recorded in the F 1s region as a function of photon energy. The peaks are all shifted to higher electron kinetic energies, as compared to those in the normal Auger spectra. The shift values are different from peak to peak. Such spectator shifts are analyzed with a simple model which contains a term value and an effective nuclear charge. The values obtained are 1.41–1.53, depending on the peaks.

Spectator shifts in resonant Auger spectra are defined as the energy shifts of spectator Auger bands relative to the corresponding normal Auger bands. The physical interpretation of the shift is given by the spectator electron partially screening the core-hole from an outgoing Auger electron [1]. This work is motivated by the results of our recent study [2] that the F KVV Auger peaks of *cis*-1,1,2,2,3,4-hexafluorocyclobutane (HFCB, *cis*-c-C₄H₂F₆) seem to change linearly with the photon energy. In order to get more insight into the spectator shift, the resonant and normal Auger spectra have been recorded across the F 1s threshold as a function of photon energy with a higher electron energy resolution.

The experiments were conducted on the soft X-ray beamline, BL6U, in the UVSOR facility, IMS, Japan. A main chamber was equipped with a gas cell and a high-resolution hemispherical electron analyzer (MBS A-1). The gaseous HFCB sample was introduced in the cell so as to keep the pressure in the main chamber at 2.0×10^{-4} Pa during the measurements. The electron spectra were acquired in the photon energy region of 682.0–702.0 eV with a constant photon energy step of 0.5 eV.

The two-dimensional map of resonant and normal Auger spectra is displayed in Figure 1a. The spectra have been plotted after subtraction of the contribution from photoelectrons, of which spectrum was measured at 684.0 eV. The normal Auger spectrum recorded at $h\nu = 702.0$ eV is shown in the panel c. It has an intense band around 646 eV (labeled N1) and weaker bands at 627 and 619 eV (labeled N2). A very weak band N3 can be seen at about 601 eV.

These bands forms islands in the 2D map, which all bend toward higher kinetic energies below the photon energy of 694.4 eV.

A simple model is made up to evaluate the physical quantities of the spectator shifts. The model contains a term value and an effective nuclear charge resulting from the screening by the spectator electron. The obtained values of the effective nuclear charge are 1.41–1.53 depending on the peaks. This proves the validity of the model because the value should be in the range 1–2 in the resonant Auger case.

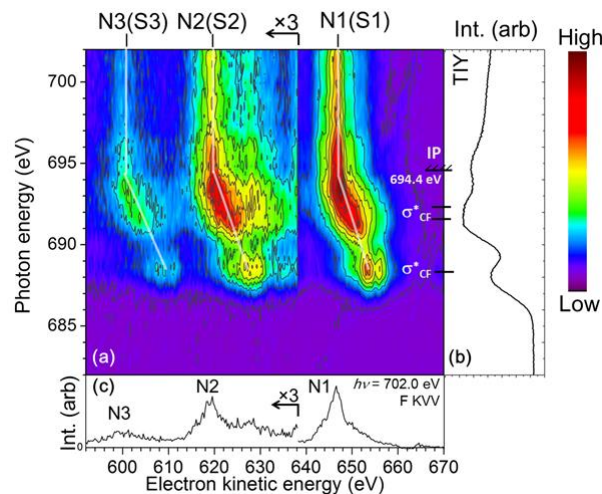


Figure 1. Two-dimensional map of resonant and normal Auger spectra of HFCB acquired across the F 1s threshold. White lines are drawn as a guide for eyes.

References

- [1] A. Nilsson *et al.* 2010 *J. Electron Spectrosc. Relat. Phenom.* **177** 99
- [2] S. Ishikawa *et al.* 2015 *UVSOR Activity Report* **42** 121

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