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Names and affiliations of applicants (* indicates experimentalists):

*Alojz Kodre, University of Ljubljana, FMF, Dept. of Physics, Slovenia
*Iztok Arčon, Faculty of Environmental Sciences, Nova Gorica, Slovenia
*Rok Prešeren, University of Ljubljana, FMF, Dept. of Physics, Slovenia
Marjan Hribar, University of Ljubljana, FMF, Dept. of Physics, Slovenia
Jana Padežnik-Gomilšek, University of Maribor, Slovenia

Report:

X-ray absorption spectra in the K-edge region of some elements between As and Rb were investigated for fingerprints of multielectron excitations (ME). The study of ME is of interest for atomic physics, providing data on the collective motion in the atom beyond the description by the self-consistent field models [I], as well as for the EXAFS analysis, providing the proper "atomic absorption background" of the EXAFS spectra [2]. Gaseous samples of Rb, SeO_2, As_2O_3 (vapors) and Kr, BrH, SeH_2, AsH_3 (gases) were used to avoid or minimize the masking of the tiny ME features by the EXAFS signal.

For each of the investigated elements, new information on ME has been extracted from the measured spectra. In Rb vapor as well as in Kr gas, measured for comparison, the high resolution and the low noise of the beamline provide the sharpness of detail superior to previous measurements [1,3], which can be essential in the identification of the multiple excited states. For As and Se, the spectrum of ME has been observed directly for the first time [4]: on [1 s3d] and [ls3p] absorption edges a substructure, most likely from multiplet splitting, has been resolved. The finding provides an additional, independent test of the theoretical models for ME.

Most notably, however, the fingerprints of the formation of [ls3s] excited state are resolved in the entire series of elements. The state is the deepest double excitation observed so far [5]: in contrast to the ME involving valence or subvalence electrons, the core character of this excitation is expected to result in a smooth Z dependence of the cross section whence the strength of the direct electron correlation can be reliably estimated.

References:

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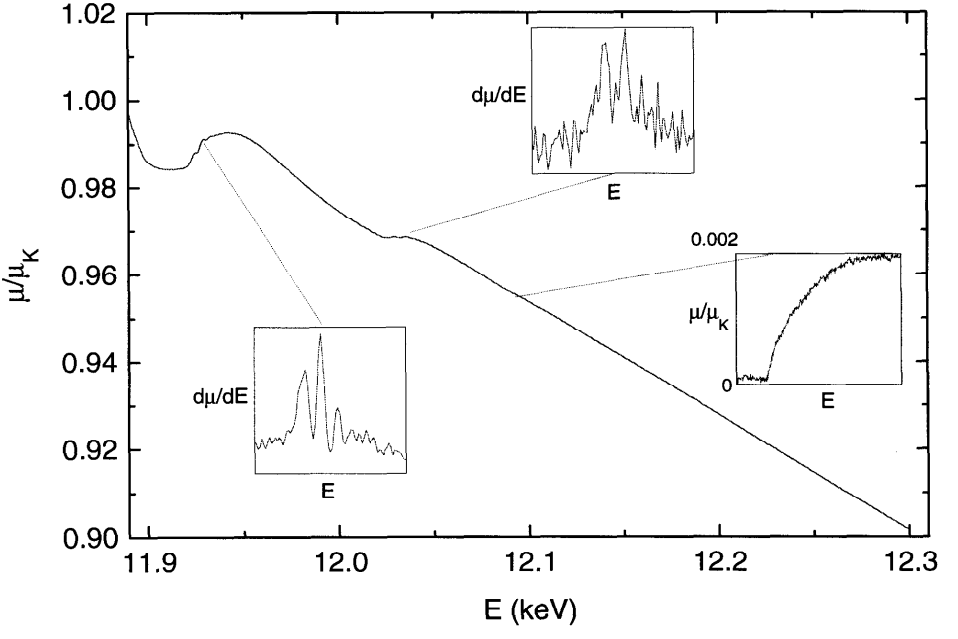

Fig. 1: ME in the absorption spectrum of AsH_3. The insets show the derivative of the spectrum to reveal the multiplet structure of the [1 s3d] and [1 s3p] edges, and the detail of the [1 s3s] excitation.