• **Double K-shell photoionization.** The aim of the projects was to shed new light on the nature of electron-electron interactions in the double photoionization of many-body systems and in the radiative decay of K-shell double-hole states. Mechanisms and scaling laws of double ionization of the two innermost atomic electrons upon single-photon absorption in low-Z atoms and the corresponding two-electron ions were examined [1]. The role of many-electron correlations in the ground state and doubly ionized final states was addressed [2]. The first observation of two-electron one-photon transitions corresponding to a *simultaneous* two-electron jump of one 2s and one 2p electron to the K-shell core-holes and an emission of one photon, in single-photon K-shell double ionization was achieved [3]. In the perspective of XFEL based science the investigation of the nonlinear single and double K-shell electron ionization processes resulting from two-photon absorption (TPA) with XFEL ultrashort intense pulses in the hard X-ray regime was undertaken [4,5]. The study of hollow-atom formation, saturated absorption and nonlinear phenomena provided an important input for experiments in different fields and theoretical calculations.

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• **Investigation of fundamentals of X-ray matter interactions and decay processes** (such as multiple excitation and ionization [1], Radiative Auger effect, solid and chemical effects on X-ray spectra), and the determination of atomic Fundamental Parameters (FPs) [2,3] with the aim to obtain precise FPs to improve the FPs databases, for the development of numerical codes simulating X-ray matter interaction and for the analysis of novel materials. The FPs include energies and widths of X-ray transitions, absorption edge energies, transition probabilities, fluorescence yields, Auger and Coster-Kronig yields and MACs (Mass Absorption Coefficients). Transfer of know-how and expertise at the academic level and within collaborative projects including industrial partnerships.

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• **Contribution to the development of X-ray spectroscopy techniques and methodologies** such as high energy resolution XES (X-ray Emission Spectroscopy) [1], RXES (Resonant X-ray Emission Spectroscopy), XAS (X-ray Absorption Spectroscopy) [2], High-resolution GEXRF (Grazing Emission X-ray Fluorescence) and HEROS (High Energy Resolution Off-resonant Spectroscopy) [3]. Development of X-ray synchrotron radiation-based techniques, involving the design, construction and implementation of X-ray instrumentation, such as X-ray crystal spectrometers, X-ray optics and X-ray micro-tomography set-ups.

Dissemination of expertise through teaching activities and mentoring at the academic level and within collaborative projects.

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