8th MT Student Retreat



Contribution ID: 35

Type: not specified

X-Ray Spectroscopy of U90+ using Metallic Magnetic Calorimeters

Wednesday 28 September 2022 14:00 (15 minutes)

Recent developments regarding metallic magnetic calorimeters (MMCs) have resulted in a new class of detectors for precision X-ray spectroscopy. One of them being the maXs series of detectors [1] (cryogenic microcalorimeter arrays for high resolution X-ray spectroscopy), which have been developed within the SPARC collaboration. They work as follows: The energy deposition of an incident X-ray photon leads to a measurable temperature rise of an absorber. At operation temperatures below 50 mK this leads to a change in the magnetisation of a paramagnetic sensor which can be measured by a superconducting quantum interference device (SQUID) [2]. MMC detectors combine a very high energy resolution (better than $100 \, \text{eV}$ FWHM at $100 \, \text{keV}$) comparable to crystal spectrometers, with the broad bandwidth acceptance of semiconductor detectors (0.1 – $100 \, \text{keV}$) [3].

These detectors are especially well suited for X-ray spectroscopy of highly charged ions. Helium-like ions, for example, are the simplest atomic multibody systems. Their study along the isoelectronic sequence provides a unique testing ground for the interplay of the effects of electron–electron correlation, relativity and quantum electrodynamics. However, for high-Z ions with nuclear charge Z > 54, where inner-shell transition energies reach up to 100 keV, there is currently no data available with high enough resolution and precision to challenge state-of-the-art theory [4]. We report on the first application of MMC detectors for high-resolution x-ray spectroscopy at the electron cooler of the low-energy storage ring CRYRING@ESR at GSI, Darmstadt. Within the presented experiment, the x-ray emission associated with radiative recombination of stored hydrogen-like uranium ions and cooler electrons was studied. Two maXs-100 detectors were placed at observation angles of 0° and 180° with respect to the ion beam axis. Special emphasis will be given to the achieved spectral resolution of better than 90 eV at x-ray energies close to 100 keV enabling for the first time to resolve the substructure of the K₁ and K₂ lines.

References

[1] C. Pies et al., J. Low Temp. Phys. 167, 269-279 (2012)

[2] D. Hengstler et al., Phys. Scr. 2015, 014054 (2015)

[4] P. Beiersdorfer and G.V. Brown, Phys. Rev. A 91, 032514 (2015).

Primary author: PFAEFFLEIN, Philip (Helmholtz Institute Jena)

Co-authors: ALLGEIER, Steffen (KIP, Heidelberg University); ANDELKOVIC, Zoran (GSI, Darmstadt); BERNITT, Sonja (Helmholtz Institute Jena); BOROVIK, Alexander (I.Physikalisches Institut, Gießen University); DUVAL, Louis (LKB, University Paris Sorbonne); FLEISCHMANN, Andreas (KIP, Heidelberg University); FORSTNER, Oliver (Helmholtz Institute Jena); FRIEDRICH, Marvin (KIP, Heidelberg University); GLORIUS, Jan (Andelkovic); GUM-BERIDZE, Alexandre (GSI, Darmstadt); HAHN, Christoph (Helmholtz Institute Jena); HENGSTLER, Daniel (KIP, Heidelberg University); HERDRICH, Marc Oliver (IOQ, Jena University); HERFURTH, Frank (GSI, Darmstadt); HIL-LENBRAND, Pierre-Michel (I.Physikalisches Institut, Gießen University); KALININ, Anton (GSI, Darmstadt); KIF-FER, Markus (IOQ, Jena University); KRÖGER, Felix Martin (IOQ, Jena University); LESTINSKY, Michael (GSI, Darmstadt); LÖHER, Bastian (GSI, Darmstadt); MENZ, Esther Babette (Helmholtz Institute Jena); OVER, Tobias (IOQ, Jena University); PETRIDIS, Nikolaos (GSI, Darmstadt); RINGLEB, Stefan (IOQ, Jena University); SIDHU, Ragandeep Singh (GSI, Darmstadt); SPILLMANN, Uwe (GSI, Darmstadt); TROTSENKO, Sergiy (GSI, Darmstadt); Prof. WARCZAK, Andrzej (Jagiellonian Univiversity, Krakow); WEBER, Günter (Helmholtz Institute Jena); ZHU, Binghui (Helmholtz Institute Jena); Prof. ENSS, Christian (KIP, Heidelberg University); Prof. STÖHLKER, Thomas (Helmholtz Institute Jena)

Presenter: PFAEFFLEIN, Philip (Helmholtz Institute Jena)

Session Classification: Afternoon session