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The Nanocluster Trap endstation at BESSY II

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Abstract: The Nanocluster Trap endstation at BESSY II combines a cryogenic linear radio-frequency ion trap with an applied magnetic field for x-ray magnetic circular dichroism studies of cold and size-selected trapped ions. Applications include atomic, molecular, and cluster ions as well as ionic complexes.

1 Introduction

With the Nanocluster Trap endstation, BESSY II hosts a unique experimental setup for x-ray magnetic circular dichroism (XMCD) spectroscopy of size selected and trapped cold ions (Hirsch et al., 2015; Langenberg et al., 2014; Niemeyer et al., 2012; Zamudio-Bayer, Hirsch, Langenberg, Kossick, et al., 2015; Zamudio-Bayer, Hirsch, Langenberg, Ławicki, et al., 2015; Zamudio-Bayer, Hirsch, Langenberg, Niemeyer, et al., 2015; Zamudio-Bayer et al., 2013). The setup consists of a cryogenic linear radio-frequency (RF) quadrupole ion trap inside a superconducting solenoid for XMCD spectroscopy of size-selected atomic, molecular, and cluster ions ions as well as ionic complexes. Nanocluster trap is jointly operated by Helmholtz-Zentrum Berlin, Uni Freiburg, TU Berlin, Kyushu University, and Toyota Technological Institute.

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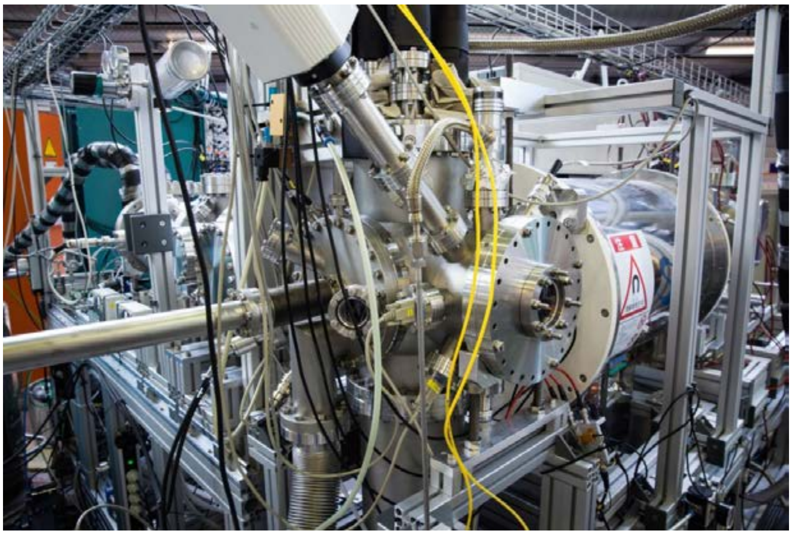

Figure 1: View of the Nanocluster Trap endstation.

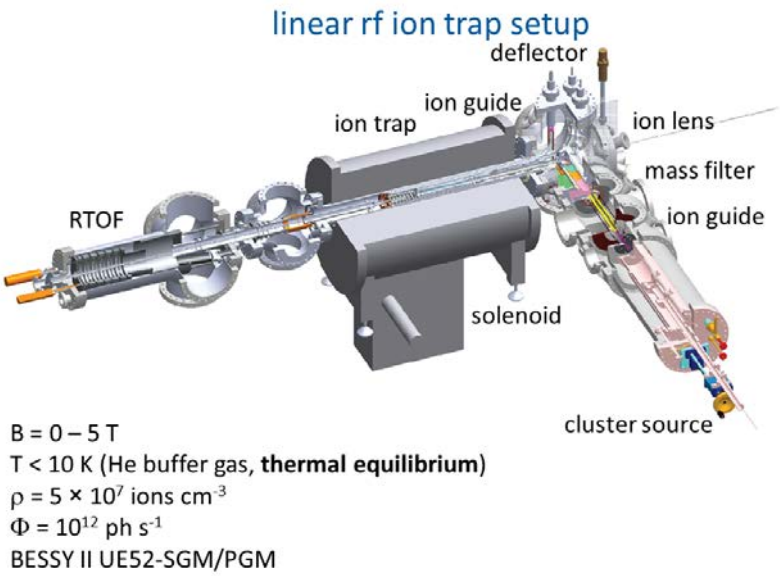

Figure 2: Schematic view of the Nanocluster Trap endstation with sample preparation (cluster source, ion guide/collision cell, and mass filter) and spectroscopy (ion trap, superconducting solenoid, and reflectron time-of-flight mass spectrometer) stages.

2 Instrument application

The Nanocluster Trap endstation at BESSY II is used to investigate magnetic phenomena on the atomic scale. It is routinely used in combination with a magnetron cluster source. Magnetic spin and orbital moments of size-selected pure and mixed transition metal clusters, molecules, and complexes can be determined. The ion trap can also be combined with a variety of different ion sources (e.g., electrospray ionization (Egorov et al., 2015) or laser evaporation) because of a flexible interface to the first ion guide. Nanocluster Trap is currently being upgraded to even more flexible ion trapping schemes and even lower cryogenic ($T < 5$ K) ion temperature within BMBF project 05K13Vf2 hosted at Universität Freiburg.

3 Technical Data

Experiment in vacuum	Yes
Temperature range	5 - 300 K
Detector	High transmission reflectron time-of-flight mass spectrometer for ion yield spectroscopy
Manipulator	cryogenic linear quadrupole ion trap
Applied magnetic field	0 - 5 T
Mass range	10 - 4000 amu
Circularly polarized radiation	Yes

Table 1: Technical parameters of the Nanocluster Trap endstation.

References

Egorov, D., Sadia, B., Hoekstra, R., Ławicki, A., Hirsch, K., Zamudio-Bayer, V., … Schlathölter, T. (2015). An intense electrospray ionization source for soft X-ray photoionization of gas phase protein ions. *Journal of Physics: Conference Series*, *635*(11), 112083. http://dx.doi.org/1088/1742-6596/635/11/112083

Hirsch, K., Zamudio-Bayer, V., Langenberg, A., Niemeyer, M., Langbehn, B., Möller, T., … Lau, J. T. (2015). Magnetic Moments of Chromium-Doped Gold Clusters: The Anderson Impurity Model in Finite Systems. *Phys. Rev. Lett.*, *114*, 087202. http://dx.doi.org/10.1103/PhysRevLett.114.087202

Langenberg, A., Hirsch, K., Ławicki, A., Zamudio-Bayer, V., Niemeyer, M., Chmiela, P., … Lau, J. T. (2014). Spin and orbital magnetic moments of size-selected iron, cobalt, and nickel clusters. *Phys. Rev. B*, *90*, 184420. http://dx.doi.org/10.1103/PhysRevB.90.184420

Niemeyer, M., Hirsch, K., Zamudio-Bayer, V., Langenberg, A., Vogel, M., Kossick, M., … Lau, J. T. (2012). Spin Coupling and Orbital Angular Momentum Quenching in Free Iron Clusters. *Phys. Rev. Lett.*, *108*, 057201. http://dx.doi.org/10.1103/PhysRevLett.108.057201

Zamudio-Bayer, V., Hirsch, K., Langenberg, A., Kossick, M., Ławicki, A., Terasaki, A., … Lau, J. T. (2015). Direct observation of high-spin states in manganese dimer and trimer cations by x-ray magnetic circular dichroism spectroscopy in an ion trap. *The Journal of Chemical Physics*, *142*(23), 234301. http://dx.doi.org/10.1063/1.4922487

Zamudio-Bayer, V., Hirsch, K., Langenberg, A., Ławicki, A., Terasaki, A., v. Issendorff, B., & Lau, J. T. (2015). Electronic ground states of $Fe_2{}^+$ and $Co_2{}^+$ as determined by x-ray absorption and x-ray magnetic circular dichroism spectroscopy. *The Journal of Chemical Physics*, *143*(24), 244318. http://dx.doi.org/10.1063/1.4939078

Zamudio-Bayer, V., Hirsch, K., Langenberg, A., Niemeyer, M., Vogel, M., Ławicki, A., … von Issendorff, B. (2015). Maximum Spin Polarization in Chromium Dimer Cations as Demonstrated by X-ray Magnetic Circular Dichroism Spectroscopy. *Angewandte Chemie International Edition*, *54*(15), 4498–4501. http://dx.doi.org/10.1002/anie.201411018

Zamudio-Bayer, V., Leppert, L., Hirsch, K., Langenberg, A., Rittmann, J., Kossick, M., … Lau, J. T. (2013). Coordination-driven magnetic-to-nonmagnetic transition in manganese-doped silicon clusters. *Phys. Rev. B*, *88*, 115425. http://dx.doi.org/10.1103/PhysRevB.88.115425