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ARTEMIS: Toward Measurement of Magnetic Moments in Heavy, Highly Charged Ions

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In ARTEMIS[1] laser-microwave double-resonance spectroscopy[2] will be used to measure the intrinsic magnetic moments of both electrons and nuclei in heavy, highly charged ions (HCIs). The extreme field strength of the nearby nucleus in such heavy HCIs enhances the effect of bound-state QED and nuclear interactions with the orbiting electron. Figure 1 shows the level scheme for hydrogen-like bismuth and the transitions used for the measurement.

The ARTEMIS Penning trap (Figure 2) has two sections: the spectroscopy trap (ST) and creation trap (CT). The ST uses a half-open design for optical and ion access[3]. On the closed side spectroscopic access is provided by a transparent endcap electrode with a conductive indium-tin-oxide coating. This provides ≈ 2 sr conical access to the trap center for irradiation and detection of fluorescence light but maintains a well-defined trap potential. On the open side HCIs can be injected from the adjacent CT, where they can be created *in situ* via electron impact ionization or captured from an external source. The cryogenic fast-opening valve allows injection of ions from the HITRAP facility while maintaining ultra-low residual gas pressure in the trap region. Temperatures as low as 8.5 K and lifetimes greater than 22 days have been observed for O^{4+} since the beamline was connected. Stored ions are monitored non-destructively by their induced image currents, which also brings the ions into thermal equilibrium with the cryogenic environment [4]. Attempts at ion injection from the SPARC EBIT are currently underway. Simulation driven design of a bunching pulsed drift tube and position sensitive, non-destructive charge counter that will improve the injection tunability and transmission will also be presented.

[1] Ebrahimi, M. S. et al. *Resistive Cooling of Highly Charged Ions in a Penning Trap to a Fluidlike State. Physical Review A 98, no. 2 (2018). doi: 10.1103/physreva.98.023423.*
*[2] Quint, W. et al.*Laser-microwave double-resonance technique for g-factor measurements in highly charged ions. Physical Review A 78, no. 3 (2008). doi: 10.1103/physreva.78.032517
[3] von Lindenfels, D. et al. Hyperfine Interact (2014) 227(197). doi: 10.1007/s10751-013-0961-z
[4] *Resistive cooling of highly charged ions in a Penning trap to a fluid-like state*, M.S. Ebrahimi, Z. Guo, M. Wiesel, G. Birkl, W. Quint and M. Vogel, Phys. Rev. A 98, 023423 (2018)

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