FAKULTÄT für PHYSIK
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PHYSIK-DEPARTMENT
TECHNISCHE UNIVERSITÄT MÜNCHEN
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Garchinger Maier-Leibnitz-Kolloquium

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Online via ZOOM:

https://lmu-munich.zoom.us/j/98457332925?pwd=TWc3V1JkSHpyOTBPQVlMelhuNnZ1dz09

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Cold highly charged ions for fundamental physics studies from the visible to the x-ray domain

Hidden behind the outer electronic shells, a highly charged ion (HCI) builds the core of every atom. In most of the universe, this stripped core is the natural form of baryonic matter; protons and highly charged ions (HCI) overwhelm neutral matter in the ionized gas filling the intergalactic space. In astrophysical environments, HCI govern the radiative transfer in stellar cores, they even survive at closest distances to the event horizon of black holes while still emitting valuable spectroscopic signatures of those harsh environments. On the theoretical side, relativistic, quantum electrodynamic, and nuclear size effects are enormously magnified in HCI, while their electronic structure becomes simpler. A great variety of isoelectronic sequences enables the systematic study of such fundamental effects in the laboratory. In recent proposals, the insensitivity of HCI to external perturbations and the existence of highly forbidden optical transitions in many isoelectronic sequences were found to make HCI ideal candidates for optical frequency metrology references in ultrastable clocks [1]. Several systems have been proposed for the investigation of the time variation of fundamental constants, e. g., Ir 17+ and Pr 9+ [2], where orbital level crossings are present. Experiments with cold HCI [3], frequency-metrology techniques [4] and extreme ultraviolet frequency combs [5] are already underway in the PTB-MPIK collaboration. An experiment in a Penning trap has demonstrated the existence of extreme metastability in the soft x-ray domain [6] through a mass measurement of a 200-eV excited state, a fact that enables atomic clocks beyond the optical. The talk will present a general introduction to HCI and recent experimental results.

[1] M. G. Kozlov et al., Rev. Mod. Phys. 90, 045005 (2018)
[2] H. Bekker et al., Nature Communications 10, 5651 (2020)
[3] L. Schmöger, et al., Science 347, 1233 (2015)
[4] P. Micke et al., Nature 578, 60 (2020)
[5] J. Nauta et al., Optics Express 29, 2624 (2021)

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