Q 26: Poster – Precision Measurement, Metrology, and Quantum Effects

Time: Tuesday 14:00–16:00 Location: Tent

Q 26.1 Tue 14:00 Tent

Real-Space Dynamical Mean-Field Theory Analysis of the Disordered Bose-Hubbard Model — •Bastian Schindler, Renan da Silva Souza, and Walter Hofstetter — Goethe-Universität, Institut für Theoretische Physik, 60438 Frankfurt am Main, Germany

We numerically investigate the two-dimensional Bose-Hubbard model with local onsite disorder, where the competition between disorder and short-range interactions leads to the emergence of a Bose Glass (BG) phase between the Mott Insulator (MI) and superfluid (SF) phases [1]. In order to solve the inhomogeneous system we employ real-space bosonic dynamical mean-field theory [2] and include the stochastic nature of the system via an ensemble average over disorder realizations. To distinguish the MI from the BG phase we compare the Edwards-Anderson order parameter and the compressibility with the energy gap condition [3]. To find the insulator to SF transition we apply a percolation analysis to the condensate order parameter. In accordance with the theorem of inclusions [3] we always find an intermediate BG phase between the SF and MI. Analyzing the spectral function in the strong coupling regime reveals evidence for analytically predicted damped localized modes in the dispersion relation [4].

[1] M. P. A. Fisher et al., Physical Review B 40, 546 (1989)
[2] M. Snoek and W. Hofstetter, Quantum Gases (2013) https://doi.org/10.1142/9781848168121_0023
[3] V. Gurarie et al., Phys. Rev. B 80, 214519 (2009)
[4] R. S. Souza et al., New J. Phys. 25, 063015 (2013)

Q 26.2 Tue 14:00 Tent

Adiabatic Control of Photon Transport in Ring Geometries — •Milena Djatchkova[1], Igor Lesanovsky[1,2], and Beatriz Olmos Sanchez[1,2] — [1]Theoretische Physik, Universität Tübingen, Auf der Morgenstelle 14, 72076 Tübingen, Germany — [2]School of Physics and Astronomy and Centre for the Mathematics and Theoretical Physics of Quantum Non-Equilibrium Systems, The University of Nottingham, Nottingham, NG7 2RD, United Kingdom

Dense atomic ensembles couple collectively to the electromagnetic field. This gives rise to interesting effects, like the well-known super- and subradiant emission of light from the ensemble and exchange long-ranged interactions. Previous studies have demonstrated that, in a ring of atoms, a single photon can be trapped for times that largely exceed the lifetime of an isolated excitation by harnessing the presence of a subradiant manifold of states and the angular dependence of the induced dipole-dipole interactions (e.g. [1]). Here, we show that the photon can furthermore be transported in a dispersionless way across the ring by adiabatically altering the orientation of the atomic transition dipole moments (via, e.g., the direction of an external magnetic field). Moreover, we go beyond the single-photon case and model the dynamics of two rings, each containing a single photon. Our results reveal that, as the distance between the rings decreases, the photons can be brought to interact with each other, leaving as a trace a phase imprinting on the photonic wave functions. [1] M.Cech, I.Lesanovsky, and B.Olmos, Dispersionless subradiant photon storage in one-dimensional emitter chains, Phys. Rev. A108,L051702 (2023).

Q 26.3 Tue 14:00 Tent

Quantum non-demolition measurements in Ramsey interfermetry — •Maja Scharnagl and Klemens Hammerer — Institute for theoretical physics, Leibniz University Hanover, Germany

We investigate quantum non-demolition (QND) measurements and their application in Ramsey protocols. In doing so, we optimize the axes of signal imprint and measurement and compare the optimized sensitivity to the classical and quantum Fisher information. Moreover, we discuss the performance of the optimized Ramsey protocols in the clock simulator.

Q 26.4 Tue 14:00 Tent

Quantum dynamics of trapped atom interferometers in optical lattices — •Patrik Mönkeberg[1], Florian Fitzek[1,2], Naceur Gaaloul[2], and Klemens Hammerer[1] — [1]Insitut für Theoretische Physik, Leibniz Universität Hannover, Germany — [2]Institut für Quantenoptik, Leibniz Universität Hannover, Germany

Bloch oscillations of atoms in optical lattices offer a powerful technique to significantly enhance the sensitivity of atom interferometers by orders of magnitude. To fully exploit the potential of this method, an accurate theoretical description of losses and phases beyond current treatments is essential. In this work, we expand the theoretical framework introduced by [Fitzek et al., arXiv:2306.09399] to three dimensions. We introduce multiple approaches to treat the transversal motion of atoms trapped in an accelerated optical lattice and investigate the influence of transversal effects on the interferometer. We compare our model to state-of-the-art atom interferometers, mainly [Panda et al., arXiv:2210.07289].

Q 26.5 Tue 14:00 Tent

A high accuracy multi-ion clock with instability below $\times 10^{-16}/\sqrt{\tau}$ — •Ingrid Maria Richter[1], Shobhit Saheb Dey[1], Hartmut Nimrod Hausser[1], Jonas Keller[1], and Tanja E Mehlstäubler[1,2] — [1]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany — [2]Leibniz Universität Hannover, Hannover, Germany

Single-ion optical clocks represent some of the most accurate experiments and are applicable in research on high-precision spectroscopy, metrology and geodesy[1]. Although these systems have the potential to reach inaccuracies below 10^{-18}[2], their statistical uncertainty is fundamentally limited by quantum projection noise (QPN) and they require averaging times on the order of weeks to resolve frequencies at this limit.

This motivates our approach to develop a multi-ion system based on $^{115}In^+$ ions within Coulomb crystals sympathetically cooled by $^{172}Yb^+$ ions. Next to presenting a systematic frequency uncertainty of 2.5×10^{-18}[2] for single-ion operation, we show the scaling of clock instability with number of ions by a factor of $1/\sqrt{N_{\text{ion}}}$ below $1 \times 10^{-15}/\sqrt{\tau}$. Furthermore, we discuss plans for deploying a second cooling stage to reach the quantum-mechanical ground-state in order to reduce the thermal time dilation shift to below 2×10^{-19}.

[1] T. E. Mehlstäubler et al., *Rep. Prog. Phys.* **81**, 064401 (2018)
[2] S. M. Brewer et al., *Phys. Rev. Lett.* **123**, 033201 (2019)
[3] H. N. Hausser et al., arXiv:2402.16807 (2024)

Q 26.6 Tue 14:00 Tent

High accuracy multi-ion clock operation — •Shobhit S. Dey[1], Ingrid M. Richter[1], H. Nimrod Hausser[1], Jonas Keller[1], and Tanja E. Mehlstäubler[1,2] — [1]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany — [2]Leibniz Universität Hannover, Hannover, Germany

Optical clocks based on multiple trapped ions have the potential for maintaining the remarkably low systematic uncertainties obtained in present single-ion systems [1], while reducing statistical uncertainties [2]. We operate a clock based on mixed-species Coulomb crystals, with $^{115}In^+$ clock ions sympathetically cooled by $^{172}Yb^+$ ions. In operation with a single In^+ ion, at a systematic uncertainty of 2.5×10^{-18}, we have performed frequency comparisons – including the most accurate to date – with other optical clocks [3]. With an increased clock ion number N, the instability follows the expected $1/\sqrt{N}$ scaling.

In this contribution, we provide experimental details for the automated operation of mixed-species clocks. To obtain reproducible sympathetic cooling conditions, our system autonomously applies a sorting sequence, ensuring favorable positions of the cooling ions within the crystal. We also derive an instability limit for decay-based state preparation of multiple clock ions [4], which we have surpassed by addition of a quench laser.

[1] S. M. Brewer et al., *Phys. Rev. Lett.* **123**, 033201 (2019)
[2] J. Keller et al., *Phys. Rev. A* **99**, 013405 (2019)
[3] H. N. Hausser et al., arXiv:2402.16807 (2024)
[4] J. Keller et al., *J. Phys.: Conf. Ser.* **2889**, 012050 (2024)

Q 26.7 Tue 14:00 Tent

Theoretical Description of The Sequential Bragg Large Momentum Transfer — •Ashkan Alibabaei[1,2], Patrik Mönkeberg[2], Florian Fitzek[1,2], Naceur Gaaloul[1], and Klemens Hammerer[2] — [1]Leibniz University Hannover, Institut of Quantum Optics, Welfengarten 1, 30167 Hannover, Germany — [2]Leibniz University Hannover, Institute für Theoretical physics, Hannover, Germany

We present a comprehensive mathematical framework for the sequential Bragg technique as a method for large momentum transfer (LMT) atom interferometry, utilizing the Floquet formalism, and draw comparisons with the Bloch oscillation LMT approach. In this analysis, we identify a novel loss formalism arising from complex-valued eigenenergies, which we interpret as losses to the continuum. This framework establishes critical design criteria for optimizing the efficiency and accuracy of LMT techniques. To illustrate the practical implications of our findings, we apply them to a recent state-of-the-art experiment[Rodzinka, T., Dionis, E., Calmels, L. et al.].

Q 26.8 Tue 14:00 Tent

Towards x-ray quantum optics using periodically structured cavities — •Robert Horn and Jörg Evers — Max Planck Institute for Nuclear Physics, Heidelberg, Germany

Due to their narrow linewidth, Mössbauer nuclei, such as ^{57}Fe, have become an important platform for studying the nature of photons in the hard x-ray regime. These nuclei not only serve as potential nuclear clocks but also emerge as promising candidates for x-ray quantum dynamics. A typical environment for studying quantum optical effects in the linear x-ray regime is that of a thin-film cavity with embedded Mössbauer nuclei probed at grazing incidence. A recently developed ab initio approach using the electromagnetic Green's tensor provides a robust theoretical and numerically efficient framework for describing this setup.

In this project, we propose a modified setup that breaks the cavity's translational symmetry along the wave propagation direction by introducing a grating on the topmost layer. The aim is to investigate the emergence of additional scattering channels and to study photon correlations at varying incident angles.

Q 26.9 Tue 14:00 Tent

Shot-noise limited detection system for the INTENTAS project — •Viviane Wienzek[1] and The INTENTAS Team[1,2,3,4,5,6,7] — [1]Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover — [2]Leibniz Universität Hannover, Institut für Transport- und Automatisierungstechnik, 30823 Garbsen, Germany — [3]Institut für Quantenphysik and Center for Integrated Quantum Science and Technology (IQST), Universität Ulm, 89081 Ulm, Germany — [4]Ferdinand-Braun-Institut (FBH), 12489 Berlin, Germany — [5]Technische Universität Darmstadt, Fachbereich Physik, Institut für Angewandte Physik, 64289 Darmstadt, Germany — [6]Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institut für Satellitengeodäsie und Inertialsensorik (DLR-SI), 30167 Hannover, Germany — [7]Humboldt Universität zu Berlin, Berlin, 12489, Germany

The INTENTAS project aims to demonstrate sensitivity gains using squeezed Bose-Einstein condensates in microgravity. Set to operate in the Einstein-Elevator in Hannover, it will deploy rubidium (Rb) atoms to show that measurements below the Standard Quantum Limit (SQL) can be achieved under challenging conditions.

Detecting at or below the SQL imposes strict requirements on the detection system, particularly in terms of quantum efficiency and the reduction and rejection of stray light. This contribution will outline the design of the detection system for the INTENTAS project, presenting initial characterizations and results.

Q 26.10 Tue 14:00 Tent

Towards a transportable Al$^+$ optical clock — •Joost Hinrichs[1,2], Constantin Nauk[1,2], Gayatri Sasidharan[1,2], Vanessa Galbierz[1], Sofia Herbers[1], Benjamin Kraus[1], and Piet O. Schmidt[1,2] — [1]Physikalisch Technische Bundesanstalt, 38116 Braunschweig, Germany — [2]Leibniz University Hannover, 30167 Hannover, Germany

Optical atomic clocks are precise measurement tools, which achieve fractional frequency uncertainties on the order of 10^{-18} and below. We are setting up a transportable Al$^+$ clock to use this high accuracy for height measurements in relativistic geodesy and side-by-side clock comparisons, as a step to a future redefinition of the SI-Second.

Our fully rack integrated clock setup is based on the $^1S_0 \to ^3P_0$ transition in ^{27}Al$^+$. A co-trapped ^{40}Ca$^+$ ion allows state detection and cooling through quantum logic spectroscopy and sympathetic cooling. We present our progress on loading and Doppler cooling Ca$^+$, first spectroscopy measurements of the Ca$^+$ $^2S_{1/2} \to ^2D_{5/2}$ logic transition, and the characterization of our segmented trap. In addition, the clock hardware integrated in 19" racks is presented. It includes the laser systems, a physics package with a room temperature vacuum setup and a multilayer chip trap.

Q 26.11 Tue 14:00 Tent

Laser stabilization for a compact inertial navigation system — •Philipp Barbey, Mouine Abidi, Xingrun Chen, Ashwin Rajagopalan, Ann Sabu, Polina Shelingovskaia, Matthias Gersemann, Dennis Schlippert, Ernst M. Rasel, and Sven Abend — Leibniz Universität Hannover - Institut für Quantenoptik, Hannover, Germany

The use of cold and ultracold atoms in light-pulse atom interferometry provides highly accurate measurements of inertial forces, with an emphasis on long-term stability. Especially inertial measurement systems for navigation are driving the development of advanced technologies. To deploy these sensors in practical field applications, significant progress is needed in creating compact and scalable technologies.

We present a new laser stabilization system for our atom interferometer, utilizing digital electronics based on the ARTIQ/Sinara experiment control framework. This system allows stabilization of our laser to a rubidium spectroscopy, while a frequency offset lock enables driving different transitions necessary for cooling and trapping atoms. This digital approach makes parameter adjustments easier, and the use of off-the-shelf components simplifies installation.

We acknowledge financial support by the DFG EXC2123 QuantumFrontiers - 390837967 and by the DLR with funds provided by BMWK under Grant No. DLR 50NA2106 (QGyro+).

Q 26.12 Tue 14:00 Tent

Multi-axis quantum gyroscope with multi loop atomic Sagnac interferometry — •Ann Sabu, Polina Shelingovskaia, Mouine Abidi, Philipp Barbey, Ashwin Rajagopalan, Xingrun Chen, Matthias Gersemann, Dennis Schlippert, Ernst M. Rasel, and Sven Abend — Institut für Quantenoptik - Leibniz Universität, Welfgarten 1, 30167 Hannover

Twin-lattice atom interferometry enables precise and highly sensitive rotation measurements through large-area Sagnac interferometry. Our goal is to develop a compact and transportable gyroscope capable of multi-axis inertial sensing. In the future, this gyroscope shall reach unprecedented Sagnac areas on the order of 100 cm^2 by employing multi-loop interferometry[1].

The multi-loop interferometer with extended free fall time will employ large momentum transfer utilizing Bose-Einstein condensates (BECs) of ^{87}Rb atoms. The system design, including the laser system for cooling and manipulation of the atomic ensemble is presented.

We acknowledge financial support by the DFG EXC2123 QuantumFrontiers - 390837967 and by the DLR with funds provided by BMWK under Grant No. DLR 50NA2106 (QGyro+).

[1]Schubert, C., Abend, S., Gersemann, M. et al. Multi-loop atomic Sagnac interferometry. Sci Rep 11, 16121 (2021). https://doi.org/10.1038/s41598-021-95334-7

Q 26.13 Tue 14:00 Tent

Realizing of multi-axis interial quantum sensor — •Xingrun Chen, Mouine Abidi, Philipp Barbey, Ashwin Rajagopalan, Ann Sabu, Matthias Gersemann, Ernst Rasel, and Sven Abend — Leibniz Universität Hannover, Institut für Quantenoptik,Germany

Atom interferometers utilizing Bose-Einstein condensates (BECs) as input state, produced by atom chips, have proven to exhibit exceptional capabilities in measuring rotations or accelerations, opening up the prospect of developing new quantum sensors to increase the sensitivity of inertial measurements. Integrating the three-axis quantum sensors with classical Inertial Measurement Units (IMUs), the emergence of hybrid quantum navigation presents a promising solution to mitigate drifts inherent in classical devices, irrespective of their limited band width and dynamic range. Collaborative efforts involve the exploration, of novel algorithms for the hybrid quantum sensor design, as well as the characterization of sensor dynamics and noise processes.

The quantum sensor initiative incorporates a specially designed fiber laser source operating at 1560nm, jointly with a commercial compact vacuum system. Furthermore, innovative optical configurations are em ployed to enhance the sensitivity of the quantum sensor. Ultimately, the finalized device is deployed on a gyro-stabilized platform.

Our current effort focuses on overcoming the main challenge of transitioning a sophisticated laboratory-based apparatus into a robust and compact unit for use in dynamic environments, such as reconstructing three-dimensional trajectories of GNSS.

Q 26.14 Tue 14:00 Tent

Absolute light-shift compensated twin-lattice atom interferometry — •Mikhail Cheredinov[1], Matthias Gersemann[1], Ekim

T. Hanimeli[2], Simon Kanthak[3], Sven Abend[1], Ernst M. Rasel[1], and the QUANTUS team[1,2,3,4,5,6] — [1]Institut für Quantenoptik, LU Hannover — [2]ZARM, Uni Bremen — [3]Institut für Physik, HU zu Berlin — [4]Institut für Quantenphysik, Uni Ulm — [5]Institut für Angewandte Physik, TU Darmstadt — [6]Institut für Physik, JGU Mainz

Twin-lattice atom interferometry is a method for forming symmetric interferometers with matter waves of large relative momentum spitting by using two counter-propagating optical lattices. This method utilizes double Bragg diffraction in combination with Bloch oscillations. It has the potential to enable highly sensitive inertial measurements. Until now, a limiting factor for this type of large momentum transfer has been the loss of contrast in the interferometer. Differential absolute light shifts arise due to diffraction effects of our Gaussian beam at apertures and other imperfections. By using a Flat-Top beam profile, such diffraction effects can be suppressed. Adding an oppositely detuned light field helps to cancel out remaining absolute light shifts. This contribution presents the recent results of this realization of a twin-lattice atom interferometer.

We acknowledge financial support by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy - EXC-2123 QuantumFrontiers - 390837967 and by DLR under grant no. DLR 50WM2450A (QUANTUS-VI).

Q 26.15 Tue 14:00 Tent

Sensing tilt in an optics lab — •Stefan Gessler, Jannik Zenner, and Simon Stellmer — Physikalisches Institut, Rheinische Friedrich-Wilhelms-Universität, Bonn, Germany

Precision measurements are often influenced by external parameters that need to be monitored by environmental sensors. One such disturbing factor can be the local tilt, induced by movement of the building and ground water dynamics. We report on the characterization and operation of a tiltmeter operating at resolution and stability in the nanorad regime.

Q 26.16 Tue 14:00 Tent

General Relativistic Center-of-Mass Coordinates for Composite Quantum Particles — •Gregor Janson and Richard Lopp — Institut für Quantenphysik and Center for Integrated Quantum Science and Technology (IQST), Universität Ulm, Albert-Einstein-Allee 11, D-89069 Ulm, Germany

Recently, quantum clock interferometry has been proposed for tests of the Einstein equivalence principle. While most atom interferometric models include relativistic effects in an *ad hoc* manner, this work begins with the multi-particle nature of quantum-delocalizable atoms in curved spacetime and extends the special-relativistic concepts of center-of-mass (COM) and relative coordinates, which were previously studied for Minkowski spacetime only, to describe light-matter dynamics in curved spacetime. Specifically, for a local Schwarzschild observer at the Earth's surface using Fermi-Walker coordinates, we identify gravitational correction terms for the Poincaré symmetry generators. These corrections allow us to derive general relativistic COM and relative coordinates. Using these coordinates, we derive the Hamiltonian for a fully first-quantized two-particle atom interacting with an electromagnetic field in curved spacetime which naturally incorporates both special and general relativistic effects.

Q 26.17 Tue 14:00 Tent

Dimensional Reduction in Quantum Optics — •Jannik Ströhle and Richard Lopp — Institut für Quantenphysik and Center for Integrated Quantum Science and Technology (IQST), Universität Ulm, Albert-Einstein-Allee 11, D-89069 Ulm, Germany

One-dimensional quantum optical models usually rest on the intuition of large-scale separation or frozen dynamics associated with the different spatial dimensions, for example when studying quasi one-dimensional atomic dynamics, potentially resulting in the violation of (3+1)-dimensional Maxwell's theory.Our work provides a rigorous foundation for this approximation by means of the light-matter interaction. We show how the quantized electromagnetic field can be decomposed*exactly*into an infinite number of subfields living on a lower-dimensional subspace and containing the entirety of the spectrum when studying axially symmetric setups, such as with an optical fiber, a laser beam, or a waveguide. The dimensional reduction approximation then corresponds to a truncation in the number of such subfields that in turn, when considering the interaction with for instance an atom, corresponds to a modification to the atomic spatial profile. We explore under what conditions the standard approach is justified and when corrections are necessary in order to account for the dynamics due to the neglected spatial dimensions. In particular we examine what role vacuum fluctuations and structured laser modes play in the validity of the approximation.

Q 26.18 Tue 14:00 Tent

High-dimensional maximally entangled photon pairs in parametric down-conversion — •Richard Bernecker[1,2], Baghdasar Baghdasaryan[3], and Stephan Fritzsche[1,2] — [1]Institute for Theoretical Physics, Friedrich Schiller University Jena, 07743 Jena, Germany — [2]Helmholtz Institute Jena, Fröbelstieg 3, 07743 Jena, Germany — [3]Institute of Applied Physics, Friedrich Schiller University Jena, Albert-Einstein-Str. 6, 07745 Jena, Germany

Photon pairs generated through spontaneous parametric down-conversion constitute a well-established approach for creating entangled bipartite systems. Laguerre-Gaussian modes, which carry orbital angular momentum (OAM), are commonly used to engineer high-dimensional entangled quantum states within the spatial domain. For Hilbert spaces with dimension d>2, maximally entangled states (MESs) enhance the capacity and security of quantum communication protocols and increase the efficiency of quantum-computational tasks. However, directly generating MESs within well-defined high-dimensional subspaces of the infinite OAM basis remains challenging. In this work, we formalize how the spatial distribution of the pump beam and phase-matching conditions within the nonlinear crystal can be utilized to generate MESs without additional spatial filtering of OAM modes in a given subspace. We demonstrate our method with maximally entangled qutrits ($d = 3$) and ququints ($d = 5$).

Q 26.19 Tue 14:00 Tent

Software framework for decoherence-free control design in surface ion traps — •Eric Benjamin Kopp — Universität Innsbruck

We present details of the Generalized Control of Noiseless Subspaces (GCNS) framework, a MATLAB- and Java-based software library for computing decoherence-free control strategies for a broad class of open quantum model representations (e.g., Lindbladians, channel matrices, Kraus operators). The framework efficiently solves four constituent problems: *i*) identifying candidate subsystem codes in quantum noiseless subspaces (including decoherence-free subspaces), *ii*) determining model controllability subject to the requirement for zero information loss, *iii*) programmatically selecting control channels/resources from large candidate sets, and *iv*) generating control input signals for realizing arbitrary unitary gates acting on 1-6 logical qudits. The presentation includes results from the framework applied to a segmented surface ion trap model currently under development at the Universität Innsbruck.

Q 26.20 Tue 14:00 Tent

Setup for Laser Excitation of the ^{229}Th Nucleus in a Cryogenic Environment — •Florian Zacherl[1], Keerthan Subramanian[1], Nutan Kumari Sah[1], Srinivasa Pradeep Arasada[1], Valerii Andriushkov[2,3], Jonas Stricker[1,2], Yumiao Wang[1,4], Ke Zhang[1], Christoph E. Düllmann[1,2,3], Dmitry Budker[1,2,3,5], Thorsten Schumm[6], Ferdinand Schmidt-Kaler[1], and Lars von der Wense[1] — [1]Johannes Gutenberg University Mainz, Germany — [2]Helmholtz Institute Mainz, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [4]Fudan University, Shanghai, China — [5]University of California, Berkeley, USA — [6]Vienna University of Technology, Austria

The low isomeric energy level of only 8.4 eV in ^{229}Th places the transition wavelength in the vacuum-ultraviolet (VUV) and therefore provides the unique opportunity to excite it with optical lasers. The described setup aims to excite the nucleus of Th^{4+} ions in a $Th:CaF_2$ crystal with a continuous wave (CW) laser around 148 nm. The crystal is placed and excited in a cryogenic environment to reduce vibrations caused by phonons as well as to probe for variations in decay time at very low temperatures. Entering the cryogenic regime will also provide the possibility of better investigation of temperature dependent transition frequency shifts. The main part of the detection system of the radiative decay including a photomultiplier tube (PMT) is decoupled from the cryogenic area and placed in a separate chamber.

This work is supported by the BMBF Quantum Futur II Grant Project 'NuQuant' (FKZ 13N16295A).

Q 26.21 Tue 14:00 Tent

Modeling LMT Atom Interferometers Using Adiabatic Per-

turbation Theory — •Eric P. Glasbrenner, Richard Lopp, and Wolfgang P. Schleich — Institut für Quantenphysik and Center for Integrated Quantum Science and Technology (IQST), Universität Ulm, Albert-Einstein-Allee 11, D-89069 Ulm, Germany

Atom interferometers have become essential tools for high-precision sensing, with applications in gravimetry, rotation sensing and quantum clock interferometry. Initially developed to test fundamental principles of relativity and quantum mechanics, they are now advancing toward practical and commercial use, requiring compact, miniaturized setups. To enhance sensitivity, large-momentum transfer methods, such as double Bragg diffraction, sequential pulses, or Bloch oscillations (BO), are employed. However, accurately modeling the non-adiabatic effects influencing these methods remains challenging. We propose a semi-analytical approach based on adiabatic perturbation theory (APT), supported by numerical simulations, to describe light-pulse beam splitters and mirrors. This approach enables a unified treatment of Bragg diffraction and Bloch oscillations and allows for the analysis of a wide range of interferometer types. Using APT, we model imprinted phases, including non-adiabatic effects such as e.g. Landau-Zener tunneling, and identify the limits where APT fails for BO-based atom interferometers. APT versatility in modeling different interferometer types is further demonstrated and validated through detailed numerical simulations.

Q 26.22 Tue 14:00 Tent

A single-atom array strongly coupled to an optical cavity for quantum simulation — •Marcel Kern, Thomas Picot, Clément Raphin, Jakob Reichel, and Romain Long — Laboratoire Kastler-Brossel, Paris, France

Coupling certain materials to an optical cavity in the strong coupling regime can drastically change their chemical properties - a field of research known as polaritonic chemistry [1]. The underlying microscopic mechanisms are subject to intense research, where disorder and infinite long-range interactions are key in proposed theoretical models. One potential experimental implementation involves individually controllable, single, neutral atoms strongly coupled to an optical cavity, enabling an infinite and tunable interaction range, as well as frequency disorder via local light shifts.

In our group, high-finesse Fiber Fabry-Perot Cavities allow the operation in the strong coupling regime for a single emitter (Cooperativity ~ 100). Single ^{87}Rb atoms are trapped in an array of optical tweezers, providing individual detectability and control over their coupling parameters. The states of the atoms can be either detected one by one via cavity transmission or at once via background-free fluorescence spectroscopy. With this platform, the transport properties in long-range interacting spin chains can be explored, relevant for polaritonic chemistry, and generally for studying quantum entanglement propagation.

[1] T. W. Ebbesen, et al. - Chemical Reviews *2023* 123(21)

Q 26.23 Tue 14:00 Tent

Entanglement and coherence in the resonance fluorescence of a two-level quantum emitter — •Gabriele Maron, Xinxin Hu, Luke Masters, Arno Rauschenbeutel, and Jürgen Volz — Department of Physics, Humboldt-Universität zu Berlin, Newtonstraße 15, 12489 Berlin

The resonance fluorescence of a single two-level emitter is a fundamental phenomenon in quantum optics and is a key resource for photonic quantum technologies. It is well-known that the scattered field consists of a stream of photons that shows antibunched statistics. However, as we recently experimentally showed [1], this behaviour can be viewed as a quantum interference effect between two distinct two-photon components of the scattered light, commonly referred to as coherent and incoherent, which interfere perfectly destructively. Furthermore, it turns out that the incoherently scattered component consists of energy-time entangled photon pairs. Here, the properties of these two-photon components are the subject of further investigation. In particular, we study their interference behaviour in order to analyse the coherence and indistinguishability of photons emitted at different times. Our results demonstrate a high degree of coherence between the emitted photon pairs, which opens up new pathways for the realization of sources of entangled photon pairs based on resonance fluorescence from a single two-level emitter.

[1] Masters et al, Nat. Photon. 17, 972-976 (2023)

Q 26.24 Tue 14:00 Tent

Towards a Chip-Scale Quantum Gravimeter — •Julian Lemburg[1], Joseph Muchovo[1], Kai-Christian Bruns[1], Vivek Chandra[1], Sam Ondracek[1], Hendrik Heine[1], Waldemar Herr[2], Christian Schubert[2], and Ernst M. Rasel[1] — [1]Leibniz Universität Hannover, Institut für Quantenoptik — [2]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Satellitengeodäsie und Inertialsensorik (SI)

In the field of gravimetry, atom interferometry offers the perspective of a highly powerful tool for measuring gravity, with an expected residual uncertainty on the order of nm/s^2. To enable in-field or space-borne experiments, the development of compact, lightweight devices with low power consumption is crucial. We address these challenges by using atom chips for a rapid production of Bose-Einstein condensates, which enable high contrast, the implementation of large momentum transfer processes, and control of systematic effects in atom interferometry. To date, atom chips have either been equipped with a grating to simplify the optical setup for the magneto-optical trap (requiring only a single input beam) or with a mirror designed for atom interferometry. In our approach, we aim to integrate both functionalities.

In this poster, we present our concept and initial results of the optical characterization using test chips that combine the features of a grating and a mirror. These chips pave the way for performing both laser cooling and atom interferometry using a single optical beam.

Q 26.25 Tue 14:00 Tent

Towards a two-photon E1-M1 clock transition excitation in ^{174}Yb — •Mario Montero[1], Ali Lezeik[2], Dominik Koester[2], Klaus Zipfel[2], Ernst M. Rasel[2], Christian Schubert[1], and Dennis Schlippert[2] — [1]Institut für Satellitengeodäsie und Inertialsensorik, Deutsches Zentrum für Luft und Raumfahrt, Hannover, Deutschland — [2]Institut für Quantenoptik, Leibniz Universität Hannover, Hannover, Deutschland

Atom interferometry experiments measuring gravitational redshift require access to long-lived internal states, such as the $^1S_0 \rightarrow\ ^3P_0$ optical transition in group II atoms. An E1-M1 two-photon excitation directly access the clock state from the ground state by coupling to a far detuned intermediate state through a pair of electric and magnetic dipole allowed transitions [1]. This avoids state mixing, enhancing the excited state's lifetime. Moreover, using counter-propagating photons with degenerate frequencies eliminates first-order Doppler effects.

We report the progress of our experimental setup to drive the clock transition. We prepare an ultra-cold atomic ensemble of ^{174}Yb through a dual-stage magneto-optical trap sequence, followed by evaporative cooling in a crossed optical dipole trap [2]. To excite the transition, we utilize a high-power (10 W), narrow-linewidth 1156 nm laser system referenced to a high-finesse cavity and a frequency comb.

We discuss further applications of the two-photon Doppler-free excitation as a beam splitting method for quantum clock interferometry experiments.

[1]PRA **90**, 012523 (2014). [2]J.Phys.B **54**, 035301 (2021).

Q 26.26 Tue 14:00 Tent

Cooling and diffraction of atoms with a multi-purpose laser system — •Ekim Taylan Hanimeli[1], Simon Kanthak[2], Matthias Gersemann[3], Mikhail Cheredinov[3], Sven Herrmann[1], Claus Lämmerzahl[1], Sven Abend[3], Ernst M. Rasel[3], and the QUANTUS team[1,2,3,4,5,6] — [1]ZARM, Universität Bremen — [2]Institut für Physik, HU Berlin — [3]Institut für Quantenoptik, LU Hannover — [4]Universität Ulm — [5]Technische Universität Darmstadt — [6]Johannes Gutenberg-Universität Mainz

As part of the QUANTUS project, we are working to advance matter-wave interferometry techniques. One of the avenues we investigate is the application of Bragg and Raman diffractions in a single experimental sequence, allowing independent manipulation of the internal and external states of atoms, enabling techniques such as blow-away pulses or the use of clock states.

This contribution presents results obtained with a compact fiber laser system that enables these diffraction techniques, and provides optical cooling and detection. We have achieved stable and efficient double Bragg and double Raman beamsplitters, as well as blow away sequences. We were also able to utilize the capability for Raman pulses for gray molasses cooling.

The project is supported by the German Space Agency DLR with funds provided by the Federal Ministry for Economic Affairs and Climate Action (BMWK) under grant number DLR 50 WM 2450C (QUANTUS-VI).

Q 26.27 Tue 14:00 Tent

Utilizing Bose-Einstein condensates for atom interferometry

in the transportable Quantum Gravimeter QG-1 — •Smit Kanawade[1], Pablo Nuñez von Voigt[1], Nina Heine[1], Waldemar Herr[2], Jürgen Müller[3], and Ernst M. Rasel[1] — [1]Leibniz Universität Hannover, Institut für Quantenoptik, Hannover, Germany — [2]Deutsches Zentrum für Luft und Raumfahrt, Institut für Satellitengeodäsie und Inertialsensorik, Hannover, Germany — [3]Leibniz Universität Hannover, Institut für Erdmessung, Hannover, Germany

Atom interferometers have demonstrated unprecedented sensitivity and stability for sensing inertial quantities in complex lab-based environments. The Quantum Gravimeter (QG-1) aims to transfer this ability to a transportable device for performing long-term geodetic measurements of the acceleration due to gravity with sub-nm/s^2 uncertainty. The reduced SWaP (size, weight, and power) of the sensor is realized using atom chip technology for efficient source preparation of delta-kick collimated ^{87}Rb Bose-Einstein condensate. Using a lensed cloud with a low expansion rate allows spatially resolving absorption imaging compared to cold atom sensors, which have to rely on fluorescence imaging for detection. The atom chip provides precise control over the release of the probe cloud, and together with the spatial information of the condensate's center of mass motion from absorption imaging, it can help minimize the residual horizontal velocity. This provides a better understanding and control of the systematic effects, such as Coriolis bias and characterization of wavefront aberrations.

Q 26.28 Tue 14:00 Tent

Transportable highly stable laser system for an Al$^+$/Ca$^+$ quantum logic clock — •Gayatri R. Sasidharan[1], Benjamin Kraus[1], Sofia Herbers[1], Fabian Dawel[1,2], Constantin Nauk[1,2], Joost Hinrichs[1,2], Vanessa Galbierz[1], Pascal Engelhardt[1,2], and Piet O. Schmidt[1,2] — [1]Physikalisch-Technische Bundesanstalt, 38116 Braunchweig, Germany — [2]Leibniz Universität Hannover, Institut für Quantenoptik, 30167 Hannover, Germany

Optical clocks offers fractional frequency uncertainties down to 10^{-18}, making them suitable candidates for applications ranging from dark matter research, redefinition of the SI second to geodesy. With these applications in mind, we develop a transportable clock based on Al$^+$. The cooling and detection transitions of the clock ion species ^{27}Al$^+$ are not directly accessible and therefore a co-trapped Ca$^+$ ion is used for sympathetic cooling and state readout through quantum logic spectroscopy. We present our extensive infrastructure of highly stable laser systems build to address clock and logic transitions precisely on ^{27}Al$^+$ and ^{40}Ca$^+$ respectively [1],[2]. This involves locking laser to stable cavities maintained at 10^{-9} mbar pressure levels, stability comparison setups using frequency comb and optical path length stabilization units. We also report on finesse and photo thermal measurements of our dual wavelength coated logic cavity.

[1] B. Kraus, PhD thesis, Leibniz Universität Hannover (2024).
[2] Fabian Dawel, et al., Opt. Express 32, 7276-7288 (2024).

Q 26.29 Tue 14:00 Tent

Scalable Multi-Loop Cold Atom Rotation Sensor — •Sandra Rühmann, Holger Ahlers, Christian Deppner, Waldemar Herr, and Christian Schubert — Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institut für Satellitengeodäsie und Inertialsensorik, Hannover

Matter-wave interferometry with cold atoms offers a competitive tool for absolute measurements of acceleration and rotation. The sensitivity of atom-interferometric gyroscopes depends on the area enclosed by the interferometer. In this contribution, we present a concept for a rotation sensor, utilizing a multi-loop interferometer geometry to achieve a scalable area while maintaining a compact setup. It enables rotation measurements of a single axis on ground and can be extended to measure rotations along all three spatial axes in microgravity, for potential applications in space missions, Earth observation, and navigation systems.

Q 26.30 Tue 14:00 Tent

Commissioning of the Very Long Baseline Atom Interferometry facility — •Guillermo Alejandro Pèrez Lobato, Vishu Gupta, Kai C. Grensemann, Klaus Zipfel, Ernst M. Rasel, and Dennis Schlippert — Leibniz Universität Hannover, Institut für Quantenoptik

The Very Long Baseline Atom Interferometry (VLBAI) facility in Hannover opens the possibility of testing questions in fundamental physics e.g. macroscopic delocalization of wavefunctions and constraining fundamental decoherence mechanisms. The 10 m baseline enables free fall times of up to $2T = 2.4$ s and therefore large sensitivity scale factors $k_{eff}T^2$. The use of this equipment imposes a series of technical demands that need to be achieved such as obtaining an ultracold sample of atoms with the number of atoms in the order of one million, with sub-nanokelvin temperatures.

This contribution focuses on the progress towards achieving highly delocalized matter waves, including the manipulation of rubidium atoms utilizing purely optical potentials for matter wave lensing. We discuss the performance requirements of the atom source in the various parameters of interest such as number of atoms, temperatures required, and others that are imposed by the manipulation and control methods used for the measurement process. The methods utilized include the use of lensing and dipole trap launches with painted optical dipole traps, and the coherent manipulation of atomic wave functions by Bragg beam splitting processes.

Q 26.31 Tue 14:00 Tent

Absolute Aero Quanten-Gravimetrie (AeroQGrav) — •Patrick Rössler, Knut Stolzenberg, Ernst Rasel, and Dennis Schlippert — Leibniz Universität Hannover - Institut für Quantenoptik

To map the Earth's gravitational field on a large scale, satellites are used for this purpose. This comes with the down-side of a spatial resolution of several km. To improve the spatial resolution, we utilize an airplane as a platform for combining inertial and positional sensors at lower altitudes. Within a measuring duration of 5 s we are aiming for a spatial resolution of 0.3 to 0.5 km, by the implementation of a cold atom quantum gravimeter with the sensitivity of 1 μm/s^2 and correlate it with GNSS antennas, a terrestrial laser scanner and a laser velocity meter. The work shown here gives an overview of all the necessary electronics to merge the aforementioned sensors and the read-out scheme to operate the quantum gravimeter using sensor fusion in the noisy environment of an airplane.

Q 26.32 Tue 14:00 Tent

Numerical simulations and differential wavefront analysis for a Ramsey-Bordé interferometry based optical clock — •Levi Wihan[1], Oliver Fartmann[1], Amir Mahdian[1], Vladimir Schkolnik[1], Ingmari Tietje[1], and Markus Krutzik[1,2] — [1]Humboldt-Universität, Inst. f. Physik, Newtonstr. 15, 12489 Berlin — [2]Ferdinand-Braun-Institut (FBH), Gustav-Kirchhoff-Straße 4, 12489 Berlin

We develop a compact optical atomic clock based on Ramsey-Bordé interferometry (RBI) with a thermal strontium beam. This atomic beam clock leverages the narrow $^1S_0 \rightarrow ^3P_1$ intercombination line at 689 nm, offering enhanced stability compared to vapour cell clocks and greater simplicity than cold atom clocks, making it well-suited for field applications and clock networks. Given RBI's sensitivity to the wavefront of the interrogating laser, we investigated the impact of wavefront aberrations by adapting a numerical RBI model to include Gaussian beam effects, traditionally neglected in plane-wave approximations. The model guided the optimization of key beam parameters such as waist size and position. To mitigate wavefront aberrations in the portable setup, which is in development, wavefront analysis of the used optical elements is necessary. Therefore, we developed a workflow using a Shack-Hartmann wavefront sensor which is independent of the beam's position on the detector. Using differential wavefront analysis we identify sources of aberrations, which helps to ensure consistent beam quality throughout the interferometer.

Q 26.33 Tue 14:00 Tent

Quantum Monte-Carlo study of the bond- and site-diluted transverse-field Ising model — •Calvin Krämer, Max Hörmann, and Kai Phillip Schmidt — Lehrstuhl für Theoretische Physik V, Staudtstraße 7, Universität Erlangen-Nürnberg, D-91058 Erlangen, Germany

We study the transverse-field Ising model on a square lattice with bond- and site-dilution at $T = 0$ by quantum Monte Carlo simulations. By tuning the transverse field h and the dilution p, the phase diagram of both models is explored. Finite-size scaling of the order parameter and averaged Binder ratios is employed to determine the positions of critical points and the critical exponents β and ν along the critical lines and at the multi-critical point. Dynamical properties in the vicinity of the quantum critical point are analyzed through the local susceptibility. We complement these findings by stochastic analytical continuation [1] of imaginary-time Green's functions, providing momentum-resolved insights into the behavior of excitations.

[1] Anders W. Sandvik, Phys. Rev. B 57, 10287

Q 26.34 Tue 14:00 Tent

Strongly coupled Yb atoms in a high-finesse cavity: lasing and spectral dynamics — •Saran Shaju[1], Dmitriy Sholokhov[1], Ke Li[1], Simon B. Jäger[2], and Jürgen Eschner[1] — [1]Universität des Saarlandes, Experimentalphysik, 66123 Saarbrücken, Germany — [2]Physikalisches Institut, University of Bonn, Nussallee 12, 53115 Bonn, Germany

We report on the investigation of optical gain and lasing emission from an ensemble of a few thousand Yb atoms which are magneto-optically trapped using the $^1S_0$ – $^1P_1$ transition at 399 nm, inside a 5 cm-long high-finesse cavity. By optically pumping the atoms on the $^1S_0$ – $^3P_1$ intercombination transition at 556 nm, continuous-wave lasing on the same transition is observed [1]. We have analyzed this two-photon lasing process using heterodyne detection techniques and formulated an empirical modeled based on Bloch equations [2]. Employing magneto-optical trapping solely on the intercombination line results in a colder, denser atomic ensemble, facilitating the collective strong coupling regime in cavity QED. In this setting, we observe additional light scattering from the side-pumped atoms, outside the lasing regime. We investigate experimentally and theoretically these atom number-dependent dynamics that emerge from the strong nonlinear interactions.

[1] H. Gothe et al., Phys. Rev. A 99, 013415 (2019).
[2] D. Sholokhov et al., arXiv:2404.16765 (2024).

Q 26.35 Tue 14:00 Tent

An open-fiber cavity system for quantum dot spectroscopy — •Moritz Meinecke, Peter Gschwandtner, Sven Höfling, and Tobias Huber-Loyola — Technische Physik, Physikalisches Institut Würzburg, 97074 Würzburg, Germany

Single-photon sources are an essential resource for quantum communication and quantum computing. Semiconductor quantum dots have been proven to be a great platform for delivering single photons on demand. Embedding quantum dots in so-called open cavities, improves the device performance due to a higher extraction efficiency of the single-photons stream. Overall efficiencies of > 70 % have been shown in such type of cavities.

Laser ablation techniques made it possible to imprint a curved mirror into the tip of a fiber, enabling to design fiber-based Fabry-Pérot cavities. The advantage of fiber-based cavities is the support of smaller mode volumes compared to conventional Fabry-Pérot cavities based on bulk optical mirrors. A small mode volume allows easier exploitation of the Purcell effect to increase the source brightness. Here, we present our design of a single photon source based on InAs quantum dots embedded in a fiber-based Fabry-Pérot cavity.

Q 26.36 Tue 14:00 Tent

Quantum Monte Carlo simulations of generalized Dicke-Ising models — •Anja Langheld, Max Hörmann, and Kai Phillip Schmidt — Department Physik, Staudtstraße 7, Friedrich-Alexander Universität Erlangen-Nürnberg, D-91058 Erlangen, Germany

Recently, we introduced a wormhole algorithm for the paradigmatic Dicke-Ising model to gain quantitative insights on effects of light-matter interactions on correlated quantum matter [1]. This method enabled us to determine the quantum phase diagram for ferro- and antiferromagnetic interactions on the chain and square lattice alongside the criticality of its second order quantum phase transitions. The continuous superradiant phase transitions are in the same universality class as the Dicke model, leading to a well-known peculiar finite-size scaling which can be understood in terms of scaling above the upper critical dimension.

Going one step further we now introduce new ingredients to the matter Hamiltonian like geometric frustration, long-range interactions and disorder to study the interplay between a variety of correlated matter phenomena and light-matter interactions.

[1] A. Langheld et al., arXiv:2409.15082

Q 26.37 Tue 14:00 Tent

Setup of a laser system for Th ions cooling and spectroscopy in a Paul Trap — •Yumiao Wang[1,2], Valerii Andriushkov[3,4], Keerthan Subramanian[1], Ke Zhang[1], Florian Zacherl[1], Nutan Kumari Sah[1], Jonas Stricker[1,3], Srinivasa Pradeep Arasada[1], Christoph E. Düllmann[1,3,4], Dmitry Budker[1,3,4,5], Ferdinand Schmidt-Kaler[1], and Lars von der Wense[1] — [1]University of Mainz, Germany — [2]Fudan University, China — [3]Helmholtz Institute Mainz, Germany — [4]GSI Helmholtz Centre for Heavy Ion Research, Germany — [5]University of California, USA

The ^{229m}Th isomeric state, with its low excitation energy, offers the potential for highly precise nuclear optical clocks, aiding in dark matter detection and measuring physical constants. Recent experiments have shown direct excitation and de-excitation of the ^{229m}Th nuclear transition in Th-doped crystals using VUV lasers and frequency combs, though excitation in a Paul trap has not yet been achieved. We aim to excite the nuclear transition in $^{229}Th^{3+}$ ions, sympathetically cooled with Ca+ in a Paul trap, and detect it via a double-resonance scheme, where nuclear spin changes affect electronic levels through hyperfine interaction. Progress towards setting up the Paul trap and laser systems to probe the Th^{3+} electronic shell, along with future precision measurement possibilities for the octupole moment of the ground and isomeric states, will be presented.

This work is supported by the DFG Project 'TACTICa' (grant no. 495729045) and the BMBF Quantum Futur II Grant Project 'NuQuant' (FKZ 13N16295A).

Q 26.38 Tue 14:00 Tent

Stabilization of a tunable coherence laser system for scattered light suppression — •Lennart Manthey, Daniel Voigt, and Oliver Gerberding — Institut für Experimentalphysik, Universität Hamburg, 22761 Hamburg, Germany

Scattered light limits the sensitivity of laser interferometric ground based gravitational wave detectors. To suppress this noise, we test tunable coherence which uses pseudo-random-noise (PRN) phase modulations. We showed suppression levels of 40dB for 170kHz scatter frequency in Michelson interferometers are possible. To achieve better results at lower measurement frequencies of 3Hz to 10kHz a stabilization of the laser amplitude and frequency is needed. The amplitude stabilization uses a photodiode connected in a control loop to actuate the diode voltage of the laser. The frequency stabilization uses an ultra-stable cavity to lock the frequency on its length. We present the status of our noise level of the amplitude and frequency and its effects on the scattered light suppression.

Q 26.39 Tue 14:00 Tent

Developing compact displacement sensors using Deep Frequency Modulation Interferometry (DFMI) — •Lea Carlotta Hügel, Leander Weickhardt, and Oliver Gerberding — Institut für Experimentalphysik, Universität Hamburg, 22761 Hamburg, Germany

Gravitational-wave detectors are currently, especially at low frequencies, limited by the noise of displacement sensors. Therefore, building high-precision displacement sensors is crucial for improving future gravitational wave detectors.

The displacement sensing technique, presented here, is called Deep Frequency Modulation Interferometry (DFMI). DFMI is a laser interferometry technique in which the frequency of the laser is rapidly modulated by a sine wave. DFMI is practical for more precise sensors because low-frequency signals are projected to higher frequencies, where they are not affected by higher readout noise in their original frequency region. To improve future implementations, identifying and evaluating the performance limits of DFMI, is the first step. An effect that can spoil the overall readout performance of DFM is the excitation of higher harmonics in the laser frequency modulation. This can e.g. be caused by non-linearities in the frequency actuation. DFMI is also limited by readout noise. By combining resonant enhancement and DFMI the overall sensitivity can be improved to a few $fm/\sqrt{Hz}$.

By looking at the latest status of our experiments, addressing these two problems, an interesting inside to the field of high precision displacement sensors can be gained.

Q 26.40 Tue 14:00 Tent

Study of Adsorption Kinetics with the Zero Range Process — •Mark Paal[1], Henry Martin[1], and Matteo Colangeli[2] — [1]Kwame Nkrumah University of Science and Technology — [2]University of L'Aquila

The Zero Range Process (ZRP) stands as a pivotal model in nonequilibrium statistical mechanics, offering profound insights into the macroscopic behaviour of systems driven away from equilibrium. This process, exemplifying driven diffusive systems on a lattice, unveils intricate phenomena including phase separation, transitions, and long-range correlations. In this study, we explore adsorption and desorption kinetics in confined geometries hoping it can provide insights into the behaviour of interacting particles. A discrete hopping model, such as the zero-range process, can be used to investigate these kinetics even on a one-dimensional lattice.