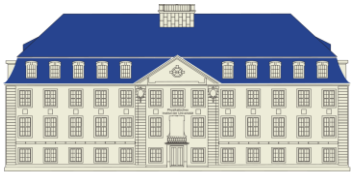
Institut für Angewandte Physik



Physikalisches Institut

UNIVERSITÄT BONN

RHEINISCHE FRIEDRICH-WILHELMS-UNIVERSITÄT BONN

COLLOQUIUM „OPTICS AND CONDENSED MATTER“

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Continuous lasing and pinning of the dressed cavity resonance with strongly-coupled ^{88}Sr atoms in a ring cavity

Superradiant lasers are a promising path towards realising a narrow-linewidth, high-precision and high-bandwidth active frequency reference [1]. They shift the phase memory from the optical cavity, which is subject to technical and thermal vibration noise, to an ultra-narrow optical atomic transition of an ensemble of cold atoms trapped inside the cavity. Our previous demonstration of pulsed superradiance on the mHz transition in ^{87}Sr [2,3] achieved a fractional Allan deviation of $6.7 \cdot 10^{-16}$ at 1s of averaging. Moving towards continuous-wave superradiance promises to further improve the short-term frequency stability by orders of magnitude. A key challenge in realizing a cw superradiant laser is the continuous supply of cold atoms into a cavity, while staying in the collective strong coupling regime.

We demonstrate continuous loading and transport of cold ^{88}Sr atoms inside a ring cavity, after several stages of laser cooling and slowing. We further describe the emergence of zones of collective continuous lasing of the atoms on the 7.5kHz transition, 7x narrower than the cavity linewidth, and pumped by the cooling lasers via inversion of the motional states. The lasing is supported by self-regulation of the number of atoms inside the cavity that pins the dressed cavity frequency to a fixed value over >2MHz of raw applied cavity frequency. In the process up to 80% of the original atoms are expelled from the cavity.

[1] D. Meiser et al., Phys. Rev. Lett. 102, 163601 (2009).
[2] M. A. Norcia et al., Science Advances 2, e1601231 (2016)
[3] M. A. Norcia et al., PRX 8, 021036 (2018)

November 7th, starting with discussion at 17:00 h, talk at 17:15 h, live IAP lecture hall or via Zoom
https://uni-bonn.zoom.us/j/98441612025?pwd=a01SSjlkY1Q3SDFhL09JQk1qc1V6dz09
Meeting-ID: 984 4161 2025
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