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# Complutense University of Madrid



## Markus Müller

Postdoctoral researcher at the  
Department of Theoretical Physics I

**Quantum Information Processing  
and Quantum Control in Atomic  
Many-Body Systems**



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# Research areas of interest

The diagram shows energy levels  $|g\rangle$  and  $|r\rangle$  with a detuning  $\Delta$  and a Rabi frequency  $\Omega$ . To the right, a vertical stack of particles is shown with red and blue spheres and black circles. Below, a 3D lattice of particles is shown with blue spheres and red arrows indicating interactions. A small inset shows two states  $|0\rangle$  and  $|1\rangle$ .

**Multi-particle entanglement**  
**Efficient quantum gates**

The diagram illustrates topological quantum codes and phases. It features a torus (donut shape) on the left, a 2D lattice of particles with red and blue regions in the middle, and a 3D lattice of particles with red and blue regions on the right. A large white arrow points from the 2D lattice to the 3D lattice. The 2D lattice has nodes labeled 1 through 7.

**Topological Q. Codes & Phases**  
**Fault-Tolerant Q. Computing**

The diagram shows a system  $S$  (blue circle) inside an environment  $E$  (red circle). To the right, the equation  $\partial_t \rho = -i [H, \rho] + \mathcal{L}[\rho]$  is shown, with a red double-headed arrow pointing to the  $\mathcal{L}[\rho]$  term.

**Q. Control of open systems**  
**Reservoir engineering**  
**Driven-dissipative phase transitions**



# Qualifications and Capabilities

AMO physics expertise, in particular:

Trapped Ions, Rydberg Ions and Atoms

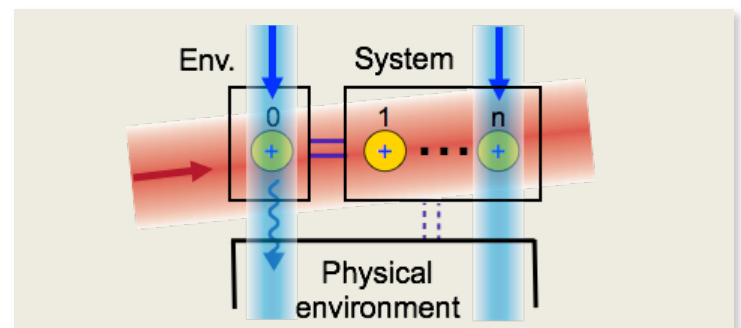
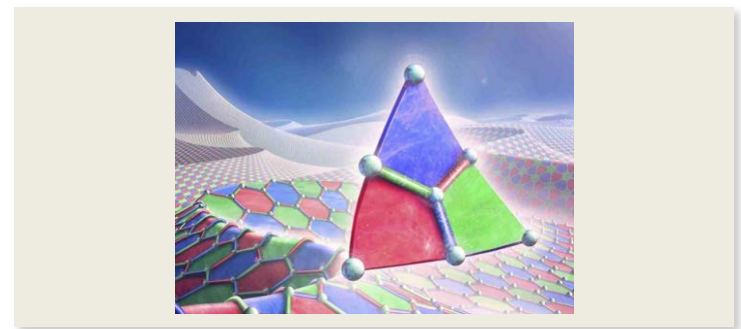
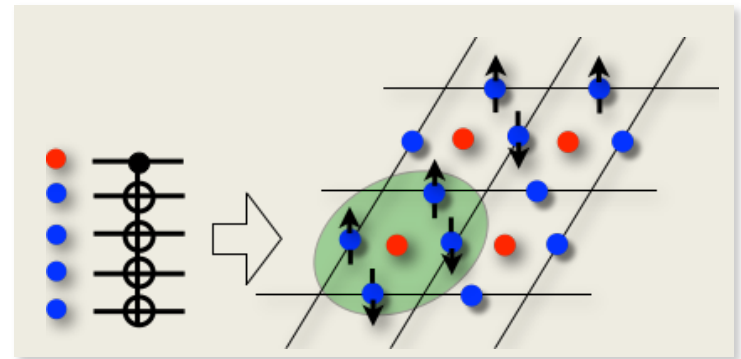
Mesoscopic Rydberg gate, PRL **102**, 170502 (2009)  
Rydberg quantum simulator, Nat. Phys. **6**, 382 (2010)

Realistic and experimentally feasible QIP implementation concepts

Q. Computations on a Topologically Encoded Qubit  
D. Nigg\*, MM\*, et al., Science **345**, 302 (2014)

Quantum control of open quantum systems

An open-system quantum simulator with trapped ions  
J. T. Barreiro\*, MM\* et al., Nature **470**, 486, (2011)  
Open-system quantum simulation with atoms and ions  
MM\*, S. Diehl\* et al., Adv. AMO Phys. **61**, 1 (2012)





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## Contact Information

- Name: Markus Müller
- Title: PhD (Physics)
- Organization: Universidad Complutense  
Dept. of Theoretical Physics  
Madrid, Spain
- Email address: [mueller@ucm.es](mailto:mueller@ucm.es)
- Phone number: 0034 91 394 4569