



CRC 1227  
Designed Quantum States of Matter



## GUEST LECTURE

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(Guest of Dr. N. Gaaloul and Prof. Dr. K. Hammerer)

Leibniz Universität Hannover  
**DQ-mat Colloquium**  
**Tuesday 21 November 2023, 3.00 pm**  
**Room 317, Callinstr. 36**  
**Building 3406**

### **"A Causal Framework for Non-Linear Quantum Mechanics"**

We add non-linear and state-dependent terms to quantum field theory. We show that the resulting low-energy theory, non-linear quantum mechanics, is causal, preserves probability and permits a consistent description of the process of measurement. We explore the consequences of such terms and show that non-linear quantum effects can be observed in macroscopic systems even in the presence of de-coherence. We find that current experimental bounds on these non-linearities are weak and propose several experimental methods to significantly probe these effects. We also expose a fundamental vulnerability of any non-linear modification of quantum mechanics - these modifications are highly sensitive to cosmic history and their locally exploitable effects can dynamically disappear if the observed universe has a tiny overlap with the overall quantum state of the universe, as is predicted in conventional inflationary cosmology. We identify observables that persist in this case and discuss opportunities to detect them in cosmic ray experiments, tests of strong field general relativity and current probes of the equation of state of the universe. Non-linear quantum mechanics also enables novel gravitational phenomena and may open new directions to solve the black hole information problem and uncover the theory underlying quantum field theory and gravitation.

**All DQ-mat members and all interested are cordially invited to attend.**