Report of KU-UNIVIE Joint Grant Program

Section 1

Project title:		Thermodynamic bounds for levitated nanoparticles
Project coordinator (KU) **Name** **Position** **Faculty, department**		Dr. Andreas Dechant Senior Lecturer Statistical Physics and Dynamics Group, Department of Physics I, Graduate School of Science
Project coordinator (UNIVIE) **Name** **Position** **Faculty, department**		Dr. Nikolai Kiesel Associate Professor Quantum Optics, Quantum Nanophysics and Quantum Information Faculty of Physics
Period of project		From: 07/2023 To: 03/2024
Project location		KU: ☑ UNIVIE: ☑ Other:
Approx. number of participants	**For events**[*1] **(e.g. workshops, seminars, symposia)**	[KU] Faculty members: 1 Students: Others: [UNIVIE] Faculty members: 1 Students: 10 Others: Other institutions: *Please attach a participant list if possible. (the list will NOT be publicized)
	For other exchange activities (such as researcher visits and online meetings)[*2]	[KU] Faculty members: 1 Students: Others: 1 [UNIVIE] Faculty members: 3 Students: 3 Others: Other institutions: 4
If applicable: URL at which project outcomes can be viewed (e.g. workshop notifications/programs/reports, evidence of academic papers published or otherwise made available, etc.)		
If available: Photographs with captions		Attached image file: lecture-dechant.png Caption: Dr. Dechant giving a lecture on Stochastic Thermodynamics at UNIVIE on Feb. 14, 2024.

[*1] Please enter the number of participants for each event.
[*2] Please count each individual participant once only, even if they participate multiple times.

Section 2

Summary of the project (approx. 200 words)
The aim of the project is to establish a collaboration between experimental physicists at Vienna University and theoretical physicists at Kyoto University to investigate the thermodynamic limits of levitated nanoparticles. Optical levitation offers an unprecedented amount of control over the motion of small particles and over their interaction with the environment. Because of this, levitated nanoparticles are an excellent experimental platform to explore the fundamental constraints that physics imposes on their dynamics and the required cost for realizing a desired operation. In this project, we focus on a class of constraints called thermodynamic inequalities, which have emerged from theoretical research over recent years. So far, this research has mainly focused on the regime of strong damping, which is easier to address theoretically but is not relevant to optical levitation. Therefore, we want to investigate to what extent and how to generalize existing theoretical results to the experimentally relevant weak damping regime, and how to design and implement experiments that can approach the limits predicted by the theory. Finally, we also want to leverage the experimental platform to push into a regime where a theoretical treatment is not yet available, such as intermediate damping or the boundary between classical and quantum physics.