

Dean of FME BUT Brno

ANSPRECHPARTNER CONTACT

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DATUM DATE

4th May 2022

Re: Dynamics of Microparticles Optically trapped in Vacuum (PhD dissertation)

Dear assessment committee,

Please find below my report on the above PhD thesis of Mgr. Vojtěch Svak.

The dissertation studies dynamics of particles confined by optical forces in vacuum. I find this work highly innovative and relevant for emerging trends in the area optical manipulation, and I am convinced that the author has fulfilled essential requirements to obtain a PhD degree: (i) he has studied the actual literature in sufficient extent and (ii) conducted unique and substantial research on a novel topic. Importantly, the work of the candidate contributed to two publications in prestigious scientific media, on which he claimed the first authorships.

Yet, it is clear, that the work has been conducted in very privileged environment, under generous funding and assistance from a very strong team, providing theoretical, programming and experimental expertise. Sadly, the efforts of the candidate to capitalise on this opportunity by producing adequately strong thesis seem rather minimal.

Generally, the thesis is full of grammar problems and typos, including the abstract and the acknowledgement. Many times, the same source is referred to under different numbers 2x or even 3x (e.g. [6], [53] and [56]).

The three-page long Introduction chapter says very little about the state of the discipline, it does not explain the most serious hurdles to be solved and gives little appreciation why are vacuum optical traps and studies of objects confined in this regime valuable.

The second chapter, which contains the author's main contributions to the work presented, is also very brief. Its name 'Experimental set-up' is rather awkward, given that section 2.2 is named 'Optical set-up' and most of its content describes principles of optical trapping (2.1) and methods (particle tracking, trap loading, etc.).

I had a lot of problems trying to understand the setup from one-page text of 2.2. Is the used single mode fibre (SMOF) polarisation maintaining and angle cleaved (in order to gain maximum power stability)? Why is lens L3 A-coated when it is in the NIR path? What is the difference between mirror M1 and DM1 (what is the logic behind the acronym)? Why is PP2 placed in front of the

mirror DM1? The polarisation will remain linear after the mirror only if vertical or horizontal is used, otherwise it becomes elliptical.

2.3.2 ends up describing a spherical aberration problem to be solved in the future, but without an explanation whether and how it affects the presented results.

Chapters 3 and 4 are essentially the above-mentioned publications, wrapped in few pages of semi-relevant additional text. In case of the 3rd chapter, a reader is promised a “derivation of trapped particle motion characteristics used in the paper” to follow the article, but the chapter ends together with the article. Has some text fell out?

Quite fortunately, there is chapter 5, which summarises a new way of force estimation from particle trajectories, applicable to non-conservative force fields. It indicates the candidate is indeed capable of methodical and didactic approach.

The thesis ends with 2 pages of Conclusions chapter, which briefly summarises the work, yet it gives the reader neither a good overview of how the health of the discipline improved through the candidate’s work nor provides any advice for the followers, pointing them to the most important problems to be addressed.

In summary, I recommend the thesis to be accepted as the basis for the candidate’s defence, although they rank near the very bottom of the quality interval where I deem such recommendation appropriate.

During the oral examination, the candidate shall answer the following questions:

- What influence has the spherical aberration identified in Chapter 2 on the position data?
- Next to the optical of forces, is there a way how one could estimate torques acting on a particle in a non-conservative field, using the recorded particle trajectories?

With the best regards,

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