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Institut für Experimentalphysik
Univ.-Prof. Dr. Tracy E. Northup

Prof. dr hab. Ireneusz Grabowski
Chairman of the Board of Disciplines of Physical Sciences
Institute of Physics
Nicolaus Copernicus University
5/7 Grudziądzka Street
87-100 Toruń
Poland

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Assessment of Dr. Eng. Łukasz Kłosowski's application for the degree of habilitated doctor

Dear Prof. Grabowski,

At the request of the Board of Disciplines of Physical Sciences, I have examined the application materials submitted by Dr. Eng. Łukasz Kłosowski for the degree of habilitated doctor. Based on these materials, which document significant independent scientific work carried out by Dr. Kłosowski in the years since obtaining his doctorate, I am convinced that he is well qualified for the degree.

Dr. Kłosowski obtained his Ph.D. in 2008 at Nicolaus Copernicus University in Toruń and has remained at the university since then, first as an assistant and then as an assistant professor. During this time, he undertook two research stays abroad, the first at the University of Innsbruck in 2010-11, in three visits (four months in total) to Prof. Rainer Blatt's group, and the second at the University of Aarhus in 2011-12, as a postdoctoral fellow in Prof. Michael Drewsen's group. I should mention that I was a postdoctoral fellow in Prof. Blatt's group during the time of Dr. Kłosowski's visit but did not work with him directly. Upon returning from Denmark, Dr. Kłosowski applied for and received funding to carry out experimental research on trapped ions, reviving an earlier direction of research in Toruń that was part of a cooperation with the Poznań University of Technology. In the years since then, he has steadily built up experimental, theoretical, and numerical research efforts on collisions and resonance phenomena in ion traps.

Five publications (six including the Supplementary Information for the *Nature* paper) have been submitted as part of the application. The first is a 2014 *Nature* paper on the buffer-gas cooling of the rotational degrees of freedom of molecular ions to record low temperatures. The research was a collaboration between the Drewsen group and Prof. Crespo López-Urrutia's group at the Max-Planck Institute for Nuclear Physics in Heidelberg, and Prof. Drewsen's letter attests to the significant role of Dr. Kłosowski, in particular, in the characterization of the ions' rotational temperature. This landmark achievement has potential applications for quantum information processing, for physical chemistry, and even for understanding energy-transport phenomena in biological molecules.

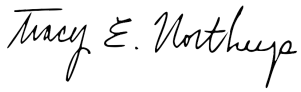
The next four publications are first-author publications that represent the first research results from the experimental setup that Dr. Kłosowski has constructed in Toruń. The 2018 *Journal of Mass Spectrometry* paper characterizes nonlinear resonances that occur for the particular trap geometry that he and his colleagues are using. Another 2018 paper, which appeared in the *Journal of Electron Spectroscopy and Related Phenomena*, presents a feasibility study on the electron gun that has been implemented in the setup for the creation of molecular ions, while a third paper from the same year in *Physics of Plasmas* examines energy transfer processes between the electron beam from this gun and trapped calcium ions. Finally, a 2020 publication in *AIP Advances* analyzes the scattering of electrons from the beam by the trapped ions. In his list of scientific achievements, Dr. Kłosowski has clearly documented his leading contributions to all of these results. These papers are technical in nature and oriented towards specialists in the field: they will help those specialists to construct and evaluate similar experimental setups, and their analyses lay the groundwork for future experiments with the apparatus under consideration.

All five publications appear in established international peer-reviewed journals. It can take several years to build up the kind of experimental setup that Dr. Kłosowski is using, and it is commendable that during this process, he has been able to obtain new research results through the careful characterization of this setup; these results have also been presented at several conferences. In his summary of professional accomplishments, he outlines the next research steps that are planned. These steps build naturally upon his recent work and also address questions of broad interest for the trapped-ion community, such as the sympathetic cooling of light ions, which may have applications in antimatter research. Here I would like to emphasize that Dr. Kłosowski is well connected to a network of European trapped-ion researchers, through his past collaborations but also through his current leadership on the European COST Action "Trapped Ions: Progress in Classical and Quantum Applications," as the coordinator for short-term scientific missions and as a Management Committee member. (I am also a Management Committee member.) One can expect that he will be able to take advantage of these connections as his group's ion-trap research continues to advance, on one hand, as the basis for new collaborations and scientific exchange that will boost his research, and on the other hand, as a means to disseminate the results of his work.

During the research efforts discussed above, Dr. Kłosowski has supervised diploma and PhD students on various experimental topics, and he has obtained extensive teaching experience in physics and engineering courses over more than a decade, in particular, in laboratory courses and exercises. This appears to be a strong foundation and preparation for taking on a senior role in supervision and university lecturing.

Taken as a whole, the scientific portfolio that Dr. Kłosowski has assembled since obtaining his Ph.D. is that of an independent researcher with broad experience in research, teaching, and service to the scientific community. Specifically, his research achievements have made a significant contribution to the development of the discipline of physical sciences, including a landmark demonstration of cooling molecular ions during his research stay in Denmark as well as the construction of a new trapped-ion setup in Toruń that in the past few years has delivered its first four experimental results. Based on this portfolio, I recommend him without reservation for the degree of habilitated doctor.

Sincerely yours,



Tracy E. Northup

Universität Innsbruck, Technikerstraße 25 / 4, 6020 Innsbruck, Austria
Phone: +43 512 507 52463 · E-Mail: tracy.northup@uibk.ac.at