Gdańsk, 11.02.2022

Dr. hab. Jan Franz, prof. PG
Division of Computational Chemical Physics
Faculty of Applied Physics and Mathematics
Gdańsk University of Technology
ul. Narutowicza 11/12, 80-233 Gdańsk, Poland
Tel : +48 58 347 2889
Email: janfranz@pg.edu.pl

Assessment of research and teaching achievements of Dr. Marek Pietrow
for awarding the academic degree of habilitated doctor

1. General thoughts

Dr Marek Pietrow obtained his master's and doctoral degree from UMCS. The title of his master's thesis "Models of loose granular media" and of the doctoral dissertation "The formation of positronium in hydrocarbons and their derivatives" quite well reflect the scope of interests of the candidate. During his doctoral studies he was on two short internships in France (10 days) and Russia (1 week). He obtained his doctoral degree in 2008. Since 2008 he is working as an assistant professor at the Institute of Physics at UMCS in Lublin. In 2018 he was manager of a project at the Helmholtz-Zentrum in Dresden-Rossendorf in Germany. The candidate has spent most of his scientific career in Lublin. This is not necessarily a disadvantage, because it enabled Dr. Pietrow to build up a strong commitment to projects within the local community. A perfect example for this is his development of the Waxo device to test the quality of beeswax. For me it is very impressive to bring the research into practical applications, which in this case can have positive impact on the economy and environment.

2. Assessment of the habilitation dissertation

The habilitation thesis has the title "Influence of e^+ - e^- pair interaction with matter in the vicinity of free volume of condensed medium on the formation of positronium atom". I have read the English version of the thesis. The thesis is a pleasure to read. However, it contains a number of typographical errors and some sentences are difficult to understand. The number of references in the autoreferat could be larger to make it easier to put the work of the author into context. However, this is only a minor point, since sufficient references are given in the author's papers.

The thesis lists 11 manuscripts as scientific achievements, two of them have been published before obtaining the doctoral degree. For manuscript [A1] the author has been unable to present reference statements from all co-authors. The manuscript is written by 8 authors and from the statements of the other authors one can deduct that the statement of Dr. Pietrow about his contributions are correct. Dr. Pietrow is the lead author and corresponding author of all nine manuscripts, which have been published after his doctorate. He is the sole author of two manuscripts ([A3] and [A4]). Two of the manuscripts ([A6] and [A8]) are published in the journal Material Science Forum. The author does not give any points for this journal from the Ministry scored journal list (MNiSW). This should not be considered as a negative issue. The website Mostwiedzy.pl (see

JF

https://mostwiedzy.pl/en/magazine/materials-science-forum,22419-1) shows 8 points for the period 2008 – 2010 and 20 points for the MNiSW list published in 2019. Furthermore these two manuscripts are well written and could have been published in a higher ranked journal. Most of the papers have been published in good journals (Phys. Chem. Chem. Phys, J. Chem. Phys., J. Phys. Chem. Solids, Radiat. Phys. Chem., Phys. Lett. A). The paper [A2] was selected as a HOT PCCP article by the editors.

The common topic of the papers is the investigation of the interaction of the e^+ - e^- pair in condesed media. The positron and electron are treated as individual particles. A focus of the research is the formation of positronium in sites of free volume in molecular crystals made from alkanes.

The largest part of the thesis is devoted to the investigation of electron traps in alkanes. He and his team cleverly devised experiments using PALS to study the effect of doping and different morphology on the depth of the electron traps and the location of the trapping sites (papers [A1,A5,A6,A8,A9,B1,B2]).
In paper [A4] the author is using the coupled dipole method to calculate the energy of an electron or positron in the free volume of molecular crystals made from alkanes. The paper also discusses the effects of the morphology of alkane crystals on the depth of the traps.
In paper [A7] the decoherence of the e^+ - e^- pair in positronium is investigated. As a results the authors present modified formulas for the decomposition and analysis of PALS spectra.
In paper [A3] the author is using the theory of excitons to model the formation of positronium in condensed matter. The author proposes that a photon can be emitted during the formation process of positronium. This idea is further investigated in paper [A2]. In this paper the results of experiments, performed in collaboration with the Helmholtz-Zentrum in Dresden-Rossendorf, are presented.

In all five research topics Dr. Pietrow was the main initiator. The research tasks performed by the author include the development of theoretical models and the implementation of computer software for the numerical solution. Dr. Pietrow was also involved in the performance of experiments and of the analysis of experimental results. He has also written software for the purpose of analyzing the experimental results. This shows the wide range of his skills, which is also visible from his other scientific achievements and his teaching achievements. His approach to treat the positron and the electron in the positronium as independent particles is novel. Taking into account that the Tao-Eldrup model is very popular in the field of PALS studies, it requires bravery and creativity to introduce a new approach.

3. Assessment of scientific achievements

In addition to the manuscripts, which are presented in the habilitation thesis, Dr. Pietrow has co-authored 15 papers, eight of them have been published after obtaining his PhD. He delivered 10 presentations at conferences. The majority of these publications is dealing with applications of the PALS method. He wrote several articles about complex systems and cellular automata, which he published on the arxiv-server. In addition he applied to three Polish patents and three international patents at WIPO.

In total he has 26 publications in peer-reviewed journals. His publications have been cited 101 times (without self-citations 75). His Hirsch index is 7. These bibliometric factors are relatively low for a scientist with his seniority. In my opinion this in not a problem. One has to consider, that Dr. Pietrow's work is in a field, that is not in the mainstream of science. The majority of his publications are tackling problems of fundamental scientific questions, which are very important for the progress of the field, but which attract only a small number of readers (and therefore a small number of citations).

Furthermore it is still the exception that researchers at universities develop applications, which can be patented and applied in the real world. This kind of achievement is not fairly measured by bibliometric factors. Therefore the sum of the scientific achievements of Dr. Pietrow should be considered as very good.

4. Assessment of teaching activity

Dr. Pietrow supervised three bachelor's theses at UMCS. The topics of the theses are very close to the research interest of the author. In my opinion this makes the theses more interesting and introduces the students in a first-hands approach into scientific research.

Dr. Pietrow is originator and coordinator of the project ***FlatWorld*** – *a Rubiks cube like puzzle that you can create yourself*. His team includes employees as well as students from other faculties. The project has a great potential to motivate young people to build up an interest in computer science and to introduce them to algorithmic thinking.

He is also originator of an interdisciplinary project, which investigates the propagation of sound in meadows. This project is performed together with two students. A publication (in Physical Review E) with summarizes the achievements of the project is in progress.

Dr. Pietrow conducted a large number of classes (seminars, laboratories and lectures) on a large variety of topics, which include Mathematics, Physics, Chemistry and Computer Science. In total more than 30 different classes are mentioned in his list of teaching achievements. Furthermore Dr. Pietrow led classes for projects, which were co-financed by the European Union.

From the amount of teaching activity one can conclude that Dr. Pietrow is experienced in teaching a wide area of subjects. This experience also allows him to teach interdisciplinary subjects as well as specialized subjects to different diverse groups of audiences. He coordinated two ambitious educational projects, which further shows his energy and creativity in popularization of science.

5. Assessment of organizational activity

Dr. Pietrow has been co-organizator of eight conferences. For two of these conferences he also has been guest editor of the corresponding special issues (Nukleonika and Acta Physica Polonica A).

He was the principal investigator of the project Innovation Incubator 2.0 for *Construction of the device for testing beeswax adulteration*. The project team developed the Waxo device and has applied for three patents at the Patent Office of the Republic of Poland and three patents at the World Intellectual Property Organization (WIPO). Results from the project has been published in one peer-reviewed publication (Apidologie, 2021). The project has produced a larger amount of attention in various media. The authors received several awards (INTARG 2020, INTARG 2021, gold medal at Euroinvent 2020, Award from the Rector of UMCS). There is a big chance that the Waxo device will be certified (technological readiness level 9) and commercialized. The Waxo device can help in improving the quality of wax used in bee colonies. This can result in better conditions in bee colonies and higher productivity of honey.

Dr. Pietrow was involved in the project ***FlatWorld*** – *a Rubiks cube like puzzle that you can create yourself* as the coordinator of the project.

Dr. Pietrow was the principal investigator of the project *Detection of near-visible light produced in the process of positronium formation* (project no. 18201279-ST) at the at the Helmholtz Zentrum Dresden Rossendorf. Results form the project have been published in manuscript [A2] (Phys. Chem. Chem. Phys., 2021).

From 2014 to 2016 Dr. Pietrow was contractor in the project *Study of the structure and properties of composite materials and multicomponent organic materials by positron spectroscopy* (NCN, Sonata-5, grant 2013/09/D/ST2/03712) and from 2008 to 2010 in the project *Structure and defects of simple hydrocarbon solid phases and positron annihilation (influence of temperature, pressure, light and radiation)* (MNiSW, grant N 202 181 31/3928). Many of his publications from this periods of time can be connected to these two projects.

In summary Dr. Pietrow shows a high involvement in organization of scientific conferences and in a variety of projects. All of his project have been successful and delivered a good number of publications. Two of the projects (the Waxo device and the FlatWorld project) have applications outside the academic world and are very nice examples for the dissemination of scientific results.

6. Summary

I consider that the most important results of the candidate are the development of a model for traps for electrons and positrons in the free volume of condensed materials and the application of the excitonic model to the formation of positronium.
The teaching and organizational activities of Dr. Pietrow are outstanding. In my opinion the highlight is the development of the Waxo device to investigate the quality of beeswax.

Therefore, I conclude that the habilitation achievement entitled "Influence of e^+ - e^- pair interaction with matter in the vicinity of free volume of condensed medium on the formation of positronium atom" as well as the remaining achievements and scientific activity of Dr. Marek Pietrow meets the relevant statutory requirements and I support the application for the award of Dr. Marek Pietrow with the degree of habilitated doctor in physical sciences.

W związku z tym stwierdzam, że osiągnięcie habilitacyjne pt. "Badanie wpływu oddziaływania pary e^+ - e^- z materią w okolicy wolnych objętości w ośrodku skondensowanym na tworzenie atomu pozytu" a także pozostały dorobek i aktywność naukowa dr Marek Pietrow spełnia odnośne wymagania ustawowe i popieram wniosek o nadanie dr Marek Pietrow stopnia doktora habilitowanego nauk fizycznych.