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Evaluation of scientific achievements of dr Mateusz Zawadzki

Dr Mateusz Zawadzki in date May 25th, 2021 applied to the Council of Scientific Excellence (Rada Doskonałości Naukowej) asking to open the procedure for the assigned of the degree of the habilitated doctor in the field of Natural Sciences (nauk ścisłych i przyrodniczych), discipline Physical Sciences (dyscyplina nauki fizyczne).

The achievement that the Candidate presented is entitled "Processes associated with collision of low-energy electrons on polyatomic molecules in the gas phase". I thoroughly studied the documentation presented, along with his overall scientific achievements.

The scientific background of the Candidate

Dr Mateusz Zawadzki graduated from the University of Strathclyde, Glagow, with the degree of Bachelor in Physics in 2005 (thesis entitled "Numerical analysis of fluorescence decays") and Master of Philosophy in Physics in 2006 ("Something cool – the journey to Bose-Einstein condensate"). His achieved the PhD at the same University in 2010, with the thesis entitled "Bose-Einstein condensate manipulation and interferometry").

Currently (from 2011) he is Adjunct at Division of Atomic, Molecular and Optical Physics, Gdańsk University of Technology.

He spent longer periods abroad:

- 2016-2017 at Heyrovsky Institute of Physical Chemistry, Czech Academy of Sciences,

- 2017-2019 as Fullbright fellow (and researcher) at California State University, Department of Physics, Fullerton

The habilitation achievement – main points

Dr Mateusz Zawadzki listed 7 papers in order to fulfill the requirement of art. 219 of Polish Law 20/07/2018 on Higher education and science.

Resuming this list shortly: four papers have experimental character and have been obtained in collaboration with the Heyrovsky Institute, one in collaboration with University of Siedlce, one a co-author with the leading researcher at CSU Fullerton and one individually (at Heyrovsky Institute). All these works concern the subject formulated in dr Zawadzki's request. Further, these works are complementary, therefore allowing to characterize widely processes of electron scattering on molecules in gas phase. The scientific reputations of the journals where these articles were published is generally acknowledged as high (J. Chem. Phys.) or very high (Phys. Rev. Lett., Physical Chemistry and Chemical Physics).

The achievements - details

The description given by dr Mateusz Zawadzki in the document entitled "Autoreferat.eng" allows to deduce that his knowledge on the subject of electron scattering in gases is thorough, deep and that he is able to present it a simple but still correct form.

The details given in the Introduction (par. 5.1) prove that the Candidate is aware of essential difficulties in experiments that he run and/or participated, like formation of the effusive gas beam, instrumental response function, specific constructions of the spectrometers, etc. The

description is exhaustive, anyhow concise and giving only essential points, important in specific experiments He run.

The choice of the papers is well aimed: to characterize different cross sections that constitute the phenomena of electron scattering on polyatomic molecules: elastic, ionization, electronic excitation, dissociative attachment. In the same manner different targets (HCOOH, C_3F_6O etc.) are reasonable chosen to give a complete overview of possible scattering phenomena, and at the same time also to characterize well these quite different molecules.

5.1 Dissociative electron attachment (DEA) in pyruvic acid [H3]

A particular research question of this study stayed in comparison of the effective rapture of the carboxylic bond and the formation of a de-hydrogeneated anion, with other molecules n which this process has been observed (benzoic acid, aminoacids etc.). The biological importance is strictly related to possible channels of DNA destruction/ modifications. The calculations (Rescigno et al.) of a similar process on formic acid suggest that the DEA undergoes via a resonant state, with an extra electron localized on the C=O bond.

Authors studied also other DEA channels, via shape and/or Feshbach resonances. The discussion is clear and exhaustive. Further, they observed dimerization of the pyruvic acid molecule, via DEA.

5.2. DEA in furan-containing molecules [H1]

One of scientific questions related to furan-containing acids is the proton migration in a double carboxyl-group bond. DEA in three acids of this type was studied in H1. The experiment was compared with authors' density functional calculations. Appearance of some dissociated fragments would indicate the proton (hydrogen, as Authors say) migration to/ from carboxyl group. The paper H1 is well written, giving graphical explanations, and discussing different working hypothesis.

5.3 DEA in benzoic acid was measured at University of Siedlce, on the apparatus constructed at Freie Universtaet Berlin. The Candidate gave in "Autoreferat" exhaustive discussion of the features seen in DEA, also with the help of density functional calculations.

5.6 DEA in HNCO: [H4] is a joint experimental-theoretical paper (PRL, 2018) paper in which a distinction between σ or π-orbital resonances is discussed. The contribution of the Candidate to the theory presented in this paper was probably not decisive, but the very scientific quest is of a basic importance, and the quality of experimental results make this work particularly significant. [H5] is a paper on DEA in a molecule of technological interest, C_3F_6O. Measurements were done in collaboration with ETH Zurich.

[H6] is a single-author paper giving total and partial ionization cross sections for formic acid. The Candidate used two complementary set-ups; he tested them on CO_2 and SF_6. The two methods gave congruent results; in agreement also with semi-empirical models. This was the first measurement of ionization cross sections in the formic acid.

[H7] reports measurements of differential cross sections for elastic scattering on acetonitrile, performed at Fullerton University. Such cross sections allow to complete the overall picture of electron scattering on a target, also via theoretical calculations, complementary between chemical and physical aspects of scattering.

The overall impression from the seven works chosen as the Achievement is the dr Mateusz Zawadzki understands well the subject of physical and chemical phenomena related to low-energy scattering on polyatomic molecules. The "Autoreferat" is thoroughly and clearly written. The only regret is that the Candidate did not supply with the documentation the texts of achievements claimed, as they constitute a formal basis for the procedure chosen by the Candidate.

Other works

The Candidate is a co-author of other 28 scientific papers (27 after the PhD degree, apart from seven papers listed as "the achievement"). These works were obtained, essentially, in three laboratories (Technical University Gdańsk, Heyrovsky Institute and Fullerton University). The subjects covered are, respectively, total cross sections for electron scattering on molecules (8 papers), dissociative electron attachment (7 papers), elastic scattering and electronic excitations (11 papers). As in the case of "the achievement", these papers were published in high-quality journals. The spectrum of subjects covered, and the discussion given in "Autoreferat" prove the Candidate's deep knowledge of electron interactions in gases.

The Candidate presented numerous conference contributions, Those, at broad international fora, date to periods of Candidate's permanence in Glasgow, Prague and California.

The Candidate's Hirsh's index was 8 at the moment of presenting documents. The Candidate gave also the "scores" of point as assigned by Polish Ministry. What is meaningful, is the international reputation of journals in which he published and the variety of their main thematic – interdisciplinary and not related only to electron scattering.

Worth stressing is vast range of scientific collaborations in Candidate's works. They include apart from his "host" institutions also an Ion accelerator in France, University of Potsdam, two universities in Brazil and ETH Zurich.

A positive feature of the "Autoreferat" is its review character, rather than the listing of the seven papers. In this mode the "Autoreferat" resembles a kind of mini-monograph, defining the state of art, open problems and perspectives, so it may be useful not only for the scope of the habilitation procedure. However, a resume' comparing different partial cross sections studied by the Candidate would be very useful.

Conclusions

Dr Mateusz Zawadzki chose 7 works out of some 40 published in international journals with his authorship or co-authorship. He worked for longer periods in four laboratories, in UK, Poland, Czech Republic and USA, obtaining significant results in all of them. He acted within frames of different international funding schemes, including those of the EU and USA.

The spectrum of subjects covered (and details of all these papers) prove that his professional experience in Physics is broad and the knowledge in Physical Sciences deep.

Achievements of dr Mateusz Zawadzki, in my opinion, fulfill the requirement of the Polish Law on High education and science 10/07/2018 to assign the scientific degree of habilitated Doctor ("doktor habilitowany") and the usual expectations at the international level for an equivalent position. I recommend to proceed with the assignment of the degree of "Doktor habilitowany" to dr Mateusz Zawadzki, in the discipline He claimed.

Prof. dr hab. inż. Grzegorz Karwasz

Sopot, 19.12.2021