ОТЗЫВ

члена диссертационного совета на диссертацию Абузалам Алаа Мохамед Ахмед на тему: «Процессы Пеннинговской ионизации в холодных ридберговских средах», представленную на соискание ученой степени кандидата физико-математических наук по научной специальности 01.04.08 – Физика плазмы.

Thesis for the degree of candidate of physical-mathematical science of Abouzalam Alaa Mohemed Ahmed on a subject - Penning Ionization Processes in Rydberg Cold Media, (Scientific specialization: 01.04.08 - Plasma Physics) are aimed at an interesting problem of modern plasma physics - investigation of Penning ionization processes in cold gas media of Rydberg alkali-metal atoms using the binary Smirnov-Katsuura model and an original modification of the semiclassical approach. These Penning processes in cold media play an important role in the formation of primary charged particles upon the evolution of cold Rydberg gas into cold plasma.

The thesis is written on 99 pages of the primary text, and in addition contains three appendices (17 pages together) with technical details. Thesis cite 104 sources of literature. The main results are published in 5 papers in internationally refereed journals and main results are reported during 7 conference appearances.

The main goal of this thesis is a systematic study of the peculiarities of Penning ionization processes in cold media in order to reveal their contribution to the formation of primary charged particles upon the evolution of cold Rydberg gas into cold plasma. To achieve this goal several problems have been solved. To the taste of the referee the most general, difficult and interesting one was the problem to obtaining universal semi-classical formulas for calculation of the dipole matrix elements for **bound-bound** and **bound–free** optical transitions in alkali metal atoms. It is known that full quantum mechanical solution of this problem could be quite complicated and laborious. Consequently the obtained semi-classical formulas could be useful for other problems in cold atom interaction physics as well.

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The analytical solution to this problem and obtained results demonstrate excellent mathematical skills of the defender and, I assume, is strongly related to the remarkable traditions and preferences of St Petersburg school of theoretical atomic physics. In a very positive sense it reflects a charming willingness and ability to invest the intellectual skills and careful mathematical technique in analytical calculations.

Despite of mathematically dense subject, the thesis is written in a rather easy to read manner and the number of paragraphs with grammatical roughnesses as well as typos are small.

Of courser there are no formal requirements, but what would be very helpful for this kind of texts, is to have list of mathematical notation and abbreviations at the beginning of text. Otherwise sometimes it is a bit complicated to keep track where all the quantities are introduced and to keep in mind their definition and meaning.

One thing that makes this thesis a bit unusual is the fact that the effect of the nontrivial dependence of Penning ionization efficiency on the size of coupling particles that is predicted in this study, has not be observed experimentally yet.

As the defender point out in the thesis, in the proposed model when calculating Penning ionization efficiency author assumes that quantum states of both Rydberg atoms are unpolarized. It means all the magnetic sublevels of particular angular momentum state are equally populated. On the other hand if Rydberg atoms are prepared, as it often is the case, in the process of laser excitation, atoms that will be used in an experiment can happen to be strongly polarized with unequal population of magnetic sublevels.

This leads to my first question to the defender

1. It seams to me that when one considers quantum interaction of atoms radial part of the problem is the most difficult one. The angular part of the problem based on much easier defined angular parts of wave-functions, usually is easier to solve. Quantum angular momentum theory is very well developed and St. Petersburg school of quantum atomic physics has contributed to it a lot. In this particular thesis angular part of the problem is left unconsidered. Would you tell your reasons not to touch angular part of the problem and elaborate a bit how complicated/easy it would be in the future studies to add polarization of atoms in the theoretical studies of Penning ionization problem. In my opinion it would make the experimental test of the model more easy.

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And a second question as well related to the accuracy, completeness and universality of the model

2. As I said earlier, full quantum mechanical calculation of the radial dipole interaction matrix elements for two alkali atoms is laborious, but possible. For that different approximations, numerical methods and computer routines are well developed. I would be happy to hear in a concise and compact way how quasi - classical method, developed in this study in accuracy relates to full quantum mechanical approach. When usage of the quasi-classical approach is possible and advisable.

In conclusion the thesis under review leaves a very positive impression. Finally in Russian.

Диссертация Абузалам Алаа Мохамед Ахмед на тему: «Процессы Пеннинговской ионизации в холодных ридберговских средах» соответствует основным требованиям, установленным Приказом от 01.09.2016 № 6821/1 «О порядке присуждения ученых степеней в Санкт-Петербургском государственном университете», соискатель Абузалам Алаа Мохамед Ахмед заслуживает присуждения ученой степени кандидата физико-математических наук по научной специальности 01.04.08 – Физика плазмы. Пункт 11 указанного Порядка диссертантом не нарушен.

Член диссертационного совета

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