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Attn.: Referee report – A. Kovalenko

The doctoral thesis submitted by Mr. Artem Kovalenko, entitled “*Laboratory Studies of Reactions of O^+ and N^+ Ions with Molecular Hydrogen and its Isotopologues, HD and D_2 , at Low Temperatures*” focuses on experimental studies of fundamental ion-molecule reactions. All the works have been carried out in the group of prof. J. Glošik and the subject, the technical aspects and the retrieved data fit well within the frame of *Physics of Plasmas and Ionised Media*.

The manuscript has ninety-seven pages of the original text (excl. TOC, Lists, Bibliography) and is supplemented with five author’s journal articles (four published, one under review). It is divided into six chapters, where first four chapters (approx. half of the total length) focus on the ion-molecule reactions, astrophysics and technical background necessary to understand and operate the experiment. The remaining half of the writing is devoted to presentation of experimental data.

Author extensively (145 bibliography entries) cites external sources, his own publications or the publications of the group. Figures, mostly in the technical part of the text, which has been adopted from various sources to illustrate the point, are appropriately marked as such. I have been provided with the reports from *Theses* and *TurnItIn* anti-plagiarist sw. Out of dozens matches, where vast majority under 1%, I have only seen two matches with score 3%, being presumably a paper of the same author and 13%, perhaps an internal document at *cuni.cz*. Closer look at the matches has not revealed block copies of the text, rather many occurrences of common phrases used in ion-molecule reaction texts and/or texts describing cold ion temperature traps. Albeit my lack of expertise in evaluation of plagiarism but along with the facts mentioned in this paragraph, I am of the opinion that author has been orderly diligent, while writing the manuscript in order to keep it original.



Concerning the language/ graphics/ expressions skills of the author, I would like to pitch only one point. The border between the figure captions and the main text is sometimes blurred so much, that the reading experience is severely hindered. The *ease of reading* is a very important part of any longer manuscript!

Author had conducted extensive experimental characterisation of O^+ and N^+ with H_2 (and/ or isotopologues HD, D_2) in a cryogenic 22 pole ion trap. Whereas these systems has been studied in the past, the presented work widened the temperature range, in which the reaction rate coefficient is experimentally determined. Such experiment, while not easy, are manageable and the author seems to have mastered the cryogenic rf trapping technique.

These experimentally determined temperature dependent reaction rate coefficients together with the branching ratios of the products are highly valuable for astrochemistry, mainly in complex astrochemical networks, where accurate inputs strengthen the resulting models. Therefore, dear Sir or Madame, I recommend the acceptance of this doctoral thesis.

Couple of questions/ discussion points for the author:

- p. 33.: “*output power antenna tuner that matches any transmitter or transceiver to virtually any antenna*” – is this really the case?
- p. 43.: Author states, that approx. 2 ms is enough to thermalise O^+ . Then on p. 86. Fig. 5.20 it is obvious, that all the “action” takes place in the first 10 ms. Were there attempts to experimentally investigate the “approx. 2 ms thesis”? What was the effective potential height during the experiments?
- p. 49–50.: Author states how he calculates the reaction rate coefficient. What I missed in the whole thesis, is the process used to connect the data to this model. Is bootstrapping, least-squares or some other method being used? Why? What is its effect on the reported uncertainties?
- p. 80.: Fig. 5.17 (similar to the previous point). Apparently, marked by solid/ dashed line (orange, red), only some exp. obtained data points have been included in the “fit”, while others have been excluded. The discussion/ reasoning behind this decision is missing (completely). With the provided data I agree with the conclusion of “*no barrier on the reaction path*” (p. 81., top), I am also looking forward for the “*further publication*” (p. 82., end)

Yours faithfully,

Dr. Pavol Jusko