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Referee report for evaluation of doctoral thesis:

Mgr. Serhiy Rednyk: “Reactions of astrophysically important positive ions with molecules and atoms at low temperatures”

The doctoral thesis of Mgr. Serhiy Rednyk concerns several experimental investigations of reactions of ions with both atomic and molecular hydrogen at temperatures relevant to interstellar clouds and media, respectively. The experimental work was carried out under the supervision of prof. Juraj Glosík, where experiments using 22-pole ion trap apparatus have a long tradition. The high scientific standard of the group itself guarantees quality of the presented work. The thesis of S. Rednyk brings the work of the group further and can be divided into three main topics:

1. Study of reactions leading to the creation of ammonia
2. Energetic balance study of the reaction of NH^+ with atomic hydrogen
3. Reactions of double charged carbon cation C^{2+} with atomic hydrogen

The work itself is divided into 6 chapters followed by a brief summary. In Introduction, state of the art about ammonia and its presence and role in space are mentioned. In the second chapter, 22-pole ion trap apparatus, which was used for all the experiments is described, including detailed description of the modifications to the H-source accommodator. The third chapter contains brief overview of ammonia formation in space. The introduced reaction chain of NH^+ with H_2 up to NH_3^+ with H_2 is studied in the fourth chapter. The fifth chapter is dedicated to the study of energetic balance of the reaction $\text{NH}^+ + \text{H}_2 \rightarrow \text{N}^+ + \text{H}_2$. In the sixth chapter, first results of the reaction of C^{2+} with H_2 are introduced and their relevance to the CH^+ formation in interstellar space is discussed.

The thesis is written in Czech and there are very frequent mistakes and typos throughout the text. Choice of the Czech for the thesis is unusual and it is a pity that the work itself will have limited impact on scientific community. The results are well documented in figures. The literature survey used in the work is well documented with plenty of references. The author often refers also to the other work published by the former and present members of the group.

The main drawback of the work is its formal standard. It is very difficult to distinguish between different parts of the text. Enumerating of pictures, their description and references are written in the same font as the main text, which makes the reading rather problematic and uneasy. Some of the abbreviations can also be confusing, e.g. CH for a cold head of a cryogenic cooler. Decimal separators are used without consistency, albeit comma is strictly used in Czech.

The thesis is accompanied by seven papers published in well-established and impacted

journals: 2 × Astronomy & Astrophysics; 3 × The Astrophysical Journal; The Journal of Chemical Physics; Physical Review A. Serhiy Rednyk is the main author of “Reaction of NH^+ , NH_2^+ , and NH_3^+ ions with H_2 at low temperatures, Astronomy and Astrophysics, 625:A74, 2019”. This paper already has six citations according to Web of Science (5 without a self-citation) which proves the high level of the publication. Scientific quality of the papers has been verified in a peer review process, so I do not add any comments on them. Three more papers are in the preparation at the moment. According to Web of Science, S. Rednyk is an author of 11 papers in impacted journals and 3 papers in conference proceedings. His h -index is currently 4.

Major comments and/or questions:

1. More comprehensive description of the author’s contribution to the studies is missing. What is the author’s contribution to the studies beside running and maintaining the experimental apparatus, as mentioned in the summary section?
2. For description of masses of ions both mass to charge ratio m/z and relative mass m_r in Da are used. Such dual use is sometimes confusing. Is there any risk when using m_r that multiple charged ions will be accounted for in the data analysis?
3. Varying sensitivity of MCP to different masses of ions is mentioned on several places in the work. No reference is given to the section 4.3, where the mass discrimination is studied. Again, it makes navigation in the work difficult. Some of the experimental data shown in the work are not corrected for the mass discrimination. Is this always taken into account in the data analysis?
4. Two works by D. Mulin are referenced to as Mulin, 2015. Which one is meant on pages 46, 62, and 67?

In summary the thesis demonstrates the author’s ability to perform independent and creative scientific work. Despite the abovementioned shortcomings, I fully recommend the presented thesis for the defence, and the author to be awarded the Ph.D. title after a successful defence.

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