Institut für Astrophysik
Türkenschanzstraße 17, **A- 1180 Wien**

phone: +43 - 699 – 1810 6244
Fax: +43 - 1 - 4277 9518
email: simone.recchi@univie.ac.at

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Report on the PhD Thesis „Shell-like structures in the ISM: Observation versus simulations" by V. Sidorin

To whom it may concern,

I have read with extreme interest the PhD thesis entitled „Shell-like structures in the ISM: Observations versus simulations" by V. Sidorin (Supervisor of the doctoral thesis: Prof. RNDr. Jan Palouš, DrSc.). The thesis is divided into three main parts. In the first part the candidate presents a literature review of interstellar medium (ISM), turbulence, and shell-like structures in the ISM. In the second part, he reprints a published article on the shell N107, adding some unpublished material. In the third part, he describes the clump finding code QUICKLUMP, developed by the candidate. In the following I will briefly describe and comment on these three parts, separately, and I will conclude with some general considerations about the presented work and about the candidate.

Chapter I

The first part of the thesis is relatively long, and reviews extensively the literature on three topics: ISM, turbulence (models and observations), shell-like structures in the ISM. This part is exceptionally well written. The review work has been very careful, the arguments and concepts are well exposed and the illustrations are clear. It is particularly noteworthy that the student always looked for the original sources, and did not just report what other papers write about the original sources. My problem with this part of the thesis is that it is perhaps too broad: one looses contact with the aims and scopes of the PhD work. Some concepts introduced in the first part on ISM (for instance magnetic fields and cosmic rays) do not appear

in the rest of the work. Even the whole subject of turbulence is relatively marginal for the work done (turbulence is only briefly mentioned in Sect. 2.2.5). The further problem with such a broad introduction is that some topics (like for instance element mixing due to turbulence) are treated quite superficially. Personally I would have preferred a more focused introduction, centered on the two main themes of the thesis: shell-like structures and clumps, including clump-finding algorithms. Let me add also some very minor remarks on specific points: 1. Some is said about compressible vs. incompressible turbulence, but not much. In particular, Sect. 1.2.9 concludes that the ISM turbulence is compressible, but very little (almost nothing) is said on the differences between compressible and incompressible turbulence. 2. On the relation between shells and turbulence: shells without massive stars can be due to SNeIa explosions (e.g. Recchi & Hensler 2006). This could be relevant also for the work on the N107 shell. 3. End of Sect. 1.3.4. Contrary to what stated, most of authors nowadays believe that high velocity clouds are not related to galactic fountains, because of their velocities and chemical compositions.

Chapter 2

The second part of the thesis is a reprint of the high-quality paper „Exploring GLIMPSE bubble N107. Multiwavelength observations and simulations", published in 2014 on A&A. This paper is very detailed and show a good mixing of analysis of observations and modelling of the N107 shell. The supplementary, unpublished material (Sect. 2.2) is also of very good quality, and a useful supplement to the results published on A&A. Also here I have some very minor remarks and comments: 1. In Sect. 2.1.2.3. one wonders whether it is possible to better constrain the distance of N107, for instance by means of background objects. However, if this has not been done so far, it is evidently a complicated undertaking. 2. In Sect. 2.1.2.4 (Eqs. 2.3 and 2.5) another source of uncertainty (not considered in the paper) is T_ex (fixed at 20 K, without much justification). 3. The sections on modelling and comparison with observations (2.1.4.2, 2.1.4.3) are very good and accurate, although it seems to me that many other parameters might change the appearance of the simulated bubble. It is clear however that the authors can not take all parameters into account; the number of simulations they run is already large (Table 2.3). I wonder whether a genetic algorithm might have helped searching the best solution through this parameter space.

Chapter 3

The third part on QUICKLUMP is very good. The description of the software is very accurate and the way it outperforms DENDROFIND is impressive. It is very laudable that the student has made the code publicly available for the community.

Summary and final considerations

In summary, this is a high-quality work, performed by a committed and evidently talented student. The scientific quality of the work and the scientific English are both excellent. The third part of the thesis (the QUICKLUMP software) is particularly noteworthy, as it provides the community with a fast and effective

algorithm to search for enhancements in a datacube. Although tailored for clump search in astronomical observations, it might be adapted to other scientific problems. If a weakness must be found in the presented work, this is in the structure of the thesis. The introduction is not fully linked to the main content of the thesis. My feeling is that a bit more effort could have been spent to give the thesis a more unified narrative and to tell a more coherent scientific story. But, as I already wrote, this does not diminish the overall quality of the work done during the PhD course.

The candidate is versatile, talented in programming, has clearly a good knowledge of the relevant astrophysical topics, and his English is very good. His career perspectives are certainly good shall he strive for an academic career. I must however mention that his publication list is not quite at the same level of his peers. I guess this is mostly due to the fact that the candidate concentrated on software development in the last three years, after the publication of the N107 paper on A&A. This is of course understandable; we all know how time-consuming software development can be. However, in case the candidate strives for an academic career, it would be important to keep on publishing. Some side-project on N107 or on some other shell would be important. At least, he should publish his code in repositories like the Astrophysics Source Code Library (ASCL, ascl.net), which is indexed by Web of Science and ADS, and is citable, with citations to its entries tracked by ADS.

Faithfully,

Simone Recchi