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Supervisor's report on Ph.D. thesis submitted by Mgr. František Dinnbier

Thesis title:
Propagating star formation

Mgr. František Dinnbier completed his thesis as a part of his doctoral studies of the programme F1: Theoretical Physics, Astronomy and Astrophysics, which is a joint programme of the Charles University (faculty of Mathematics and Physics) and of the Astronomical Institute of the Czech Academy of Sciences. F. Dinnbier started his doctoral studies in October 2012, the thesis was submitted in January 2017.

In this thesis, F. Dinnbier studies the hypothesis that star formation can propagate due to the feedback from massive stars that compresses the ambient interstellar gas into a dense shell in which new stars form. This hypothesis is explored by both analytical and numerical models, and basic properties of fragments into which the shell decomposes are predicted. The results show that the fragment masses are typically too low to form massive stars needed for self-propagating star formation.

The main body of thesis consists of 6 chapters. Chapters 1 and 2 review literature and describe key observational (chapter 1) and theoretical (chapter 2) results related to the problem of propagating star formation. They show that F. Dinnbier has an excellent knowledge of the astrophysical background of the given field of research. Chapter 3 briefly describes hydrodynamic code Flash – a numerical framework used to obtain the majority of results, while chapter 4 concentrates on the modified Ewald method – a procedure to calculate the gravitational acceleration with mixed, periodic and isolated boundary conditions, developed and implemented by F. Dinnbier. This module became part of the official releases of two publicly available hydrodynamic codes, which proves that F. Dinnbier has mastered these complex numerical tools well enough to be able to extend them with new high quality code. Results of numerical simulations, including the discovery of a new layer fragmentation scenario, are described in chapter 5. Their astrophysical implications are discussed in chapter 6, where also predictions related to self-propagation of star formation are formulated. The results are original and astrophysically interesting and part of them has already been published. The thesis is written in a good English; all information adopted from literature is properly cited.

The thesis includes original scientific results. In particular, it includes the discovery of a qualitatively new mechanism of the fragmentation of self-gravitating gaseous layers, called the *coalescence driven collapse*. It is astrophysically interesting, because taking it leads to different estimates of masses of fragments formed in interstellar shells than previously published theories. Another interesting result is a non-detection of regular patterns that were suggested to form in fragmenting layers. It shows that the non-linear interaction of second order terms in the equations describing the layer evolution is less important than was originally believed. Additionally, F. Dinnbier has developed a new numerical method to calculate the gravitational acceleration of an arbitrary distribution of matter, which can have boundary conditions periodic in some directions and isolated in others (as is the case of the idealised infinite layer). This method has already been implemented into the grid-based hydrodynamic code Flash and the smoothed particle hydrodynamic code Gandalf, and it became a part of official releases of both codes.

The main results of this work have been published in Dinnbier et al. (2017, MNRAS, 466, 4423). Additional publications are in preparation. The results have also been presented at two international conferences ("Olympian symposium on star formation", Greece, 2014 and "6th Zermatt ISM symposium", Switzerland, 2015) and at a number of smaller workshops (at European universities and research institutions). Presentations of F. Dinnbier were always very well received and the results were considered to be interesting and important. F. Dinnbier was also PI of three applications for the super-computer time at the national supercomputing centre IT4I at Technical University Ostrava, and he received for the project in total 850 000 core hours.

In my opinion, the thesis of F. Dinnbier is excellent, the obtained results are original and scientifically interesting. Part of them has already been published in an international impacted journal. F. Dinnbier has proved that he is able to work independently and carry out high-quality research in astronomy. Therefore, I recommend the thesis to be admitted for the defense and advise that F. Dinnbier be awarded the Ph.D. degree.

Richard Wünsch