

«Утверждаю»



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A handwritten signature in black ink, appearing to read "M.E. Sachkov".

1 11 2022 г.

Review

of the leading organization on the thesis of Naira M. Azatyan "Search and study of young infrared stellar clusters", submitted for a degree of candidate in physical and mathematical sciences, specialty 01.03.02 "Astrophysics and Radioastronomy".

The process of star formation from the interstellar medium is the most extensive process in galaxies. This process and its history determine the galaxy's structure and luminosity, colour and spectral characteristics, as well as the chemical composition of its stars and gas. A sign of active star formation in a galaxy is the presence of massive stars that live for short periods, as well as associated objects: H II regions, young star clusters and associations, and supernovae. An observational manifestation of star formation is usually an increased luminosity in the infrared range, in which heated dust shines.

N. Azatyan's thesis is devoted to the study of star formation regions based on the analysis of a large number of modern infrared data and actively uses both modern (along with already classical) data and modern efficient methods of data processing.

The thesis is based on seven refereed papers (published in highly ranked international and national journals), with the majority of the papers being the first or only author, which is more than a solid basis for a PhD thesis.

The thesis consists of an **Introduction**, a **Conclusion** and three more chapters. The Introduction (first chapter) discusses the relevance of the work, formulates the goals and objectives, discusses the scientific novelty and practical significance, and formulates the statements made by the author for the defense.

Chapter 2 introduces the methods based on which the author searched for star-forming regions and investigated them. The used observational data, covering a wide infrared range, are also described here. The Chapter also contains a discussion on the selection effects and description of the procedure for determination of young stellar objects parameters.

In **Chapter 3**, the results of the search of compact stellar clusters in the sample of 20 star-forming regions, as well as the determination of their sizes and the special distribution of the stellar content in them are presented. In order to detect clusters in these star forming regions the author constructed surface stellar density distribution maps around every IRAS source using NIR and FIR observational data. Radial density distribution of stars with respect to the geometric center of the group was also constructed, to confirm the previous results. The Chapter also

contains description of all considered star forming regions and parameters of their central young stellar objects.

Chapter 4 contains a detailed study of three star-forming regions which include the behavior of interstellar medium in them and the identification of the young stellar population with their properties. These star forming regions are of particular interest because they are located at large distances, and it allows the author to test the capabilities of the data sets used in the present study. Three sub-sections, devoted to IRAS 05137+3919, IRAS 05168-3634, and IRAS 19110+1045 / IRAS 19111+1048 regions, respectively, contain study of stellar population, analysis of color-magnitude diagrams, construction and analysis of luminosity functions and initial mass functions, describe structure of molecular clouds and clusters, discuss distance to the regions, their content and origin.

The **Conclusion** section formulates the main results and conclusions of this thesis work.

The **References** section contains references to 205 sources cited in the thesis.

The significance of this work lies in the fact that it addresses a very large scientific problem and answers a number of important questions. The quality and relevance of the findings leave no doubt. All the main results of the thesis are scientifically valid and reliable, as they are based on modern methods of observation and data analysis. Almost all results were obtained for the first time. The validity of the results is confirmed by comparison with the data of other authors, whose publications are cited intensively and appropriately. The thesis is well illustrated.

I have a few remarks on the text.

The text labels in Figures 1, 10, 16, 18, 19, 23 are too small and difficult to read

Table 1: IRAS mission produced several catalogues. Which one is mentioned in Table 1?

Page 49, Section 4.1.5: here it would be useful to recall that the acronym IMF means Initial Mass Function.

Page 106, line 3 in the text

"... their mass functions (MF's) ..."

better to say

"... their present day mass functions ..."

The same paragraph: mentioning Salpeter-type IMF it is necessary to cite (Salpeter 1955).

However, the mentioned drawbacks do not impair the overall impression. The publications of the author are strongly related and relevant for the research topic, and the dissertation builds on the original results that have been published in top-ranked international journals.

The results of the thesis can be used in astronomical research carried out in the Republic of Armenia, Russian Federation (MAO (Pulkovo) RAS, INASAN, SAI MSU, SAO RAS), as well as in organizations and observatories in other countries conducting similar research.

The thesis presented by N. Azatyan is a qualified scientific work, which presents the results carried out by the author or (much more rarely) with the author's participation. The thesis fully complies with the requirements for a thesis for the degree of candidate in physical and

mathematical sciences, and its author N. Azatyan undoubtedly deserves to be awarded the degree of candidate of physical and mathematical sciences

Nov 01, 2022



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Официальный отзыв по кандидатской диссертации Н.Азатян подготовлен 1 ноября 2022.

Подпись зав. отд. ИНАСАН д.ф.-м.н. Малкова О.Ю. заверяю.

Ученый секретарь ИНАСАН, к.ф.-м.н.

А.М.Фатеева

