Brief information about the project

Name of the project	AP14972694 «The influence of the interstellar medium and circumstellar shells on the evolution of stars»
Relevance	Her project is supposed to investigate the effect of the accretion of interstellar gas, mainly hydrogen and helium, as well as gas and dust in the circumstellar shells, on the evolution of stars. In most modern models of stellar evolution, a star is studied as a separate complex, unrelated to the external environment. The exception is the models of the evolution of binary stars and stars located in large gas-dust complexes. Models of the interaction of single stars with the interstellar medium have been studied to a lesser extent. To date, the dependence of the relative content of chemical elements in the atmospheres of stars on the potential of the second ionization of the corresponding elements, discovered back in 1949, has not been explained. In the early 1970s, as a result of the first attempts to explain this observed effect, the deceleration of the rotation of magnetic pecular stars of the main sequence to almost zero values and the origin of galactic cosmic rays with relatively low energies (up to 20 Mev per particle) were explained. The theory was based on the effect of the accretion of interstellar gas, at that time only hydrogen, on the atmosphere of a normal star with a strong magnetic field. 30 years later, it was shown that the effect exists not only in stars with strong magnetic fields, but also in normal main sequence stars. Studies of the last decade have made it possible to detect the studied effect in the stars of the red giant branch and binary star systems of the Galaxy, in several stars of the Magellanic Clouds and in the dwarf galaxy Fornax. Previous studies have revealed noticeable traces of this effect in many stars with radiative energy transfer in the atmosphere. Within the framework of this project, it is proposed to review the observed dependences of the relative contents of chemical elements in stellar atmospheres on the second ionization potential of these elements based on published observations of supergiants of the Galaxy and a Local group of galaxies, to perform an additional analysis of the chemical composition of several stars and to begin constructing a more detailed model of the observed effect, in which an attempt will be made to explain the existence of this phenomenon for stars with small magnetic fields.
Purpose	Basing on observational data for many stars in the Galaxy and in the LocalGroup, we are going to investigate the dependencies of relative abundance of chemical elements in stellar atmospheres on the secondionization potential of these elements and to construct a preliminary theoreticalmodel to explain this observedphenomenon.
Objectives	1. The analysis of observational data (published by other authors) on the chemical composition of stars in the Galaxy and the Local Group of galaxies,

	including the abundance surveys for several million stars in the Galaxy, primarily the GALAH and APOGEE surveys. The fulfillment of this task makes it possible to learn the dependence of the abundance of chemical elements on the second ionization potential of these elements in stars of different types. 2. Determination of the chemical composition of several supergiants of our Galaxy (Betelgeuse, α Perseus) and the Local Group of galaxies. To implement this task, we will use already observed spectra obtained with obtaining spectral resolution on the best world telescopes. The list of these telescopes can be found here before. These observations were obtained the project consultant, they are currently being pre-processed and the first results are published. This task allows one to obtain high precision observed dependences, which will be used to analyze a large number of fainter stars in the Galaxy and the Local Group of galaxies. 3. Development of a preliminary theoretical model that allows considering the influence of the interstellar medium and circumstellar shells on the evolution of stars. When implementing this task, special attention will be paid to the interaction of interstellar gas flows with the hydrogen ionization zones - Strömgren spheres. At the same time, the spacecraft's data for solar system are needed, especially the results ofPioneer-10, Pioneer-11, Voyager-1, Voyager-2 and New Horizons. These probes now are far beyond the orbit of Pluto. It should be noted that some of the probe measurements occurring before and after the passage of the heliopause were unpredicted and possibly can help to build a theory of effect investigated in the current project. Upon completion of the project task, program codes for data processing, an analysis methodology and a preliminary theoretical model for discussed effects will be developed.
Expected and achieved results	• The parameters of the alpha Perseus atmosphere and the content of light elements will be determined by the synthetic spectrum method. • Software will be created to process reviews of GALAH, APOGEE, GAIA, and others. • The content of the maximum possible number of chemical elements in the atmosphere of α Perseus will be determined. • The dependences of the relative contents of chemical elements on the potential of the second ionization of these elements for stars of different temperatures and luminosities will be analyzed. • A theory will be developed to explain the dependence of the relative contents of chemical elements

	in stellar atmospheres on the potential of the second ionization of these elements. The developed theory will be applied to stars of various types located in different regions of the Galaxy; • The analysis of possible changes in spectral lines in the Beltheuse spectrum will be carried out based on observational data including more than a hundred spectra obtained with the highest spectral resolution. The chemical composition of the atmospheres of stars will be analyzed using the Beltheise spectra. • The analysis of observational data for stars located in regions of the Galaxy with high and low values of interstellar medium density will be carried out. • The content of chemical elements in the atmospheres of 30 cepheids of the Large and Small Magellanic Clouds will be analyzed. • The content of chemical elements in the atmospheres of 80 supergiants of the dwarf spheroidal galaxy Fornax will be determined. The results obtained within the framework of the project will be published in at least 2 (two) articles in journals from the first three quartiles by impact factor in the Web of Science database or having a CiteScore percentile in the Scopus database of at least 50.
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List of publications with links to them	-
Patents	-