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DISTRIBUTION OF NH_3 IN THE STAR FORMING REGION

A multi-wavelength analysis of the large Galactic infrared bubble N 24 is has been presented in this paper in order to investigate the molecular and star formation environment around expanding H_{II} regions. Using archival data from Herschel and ATLASGAL, the distribution and physical properties of the dust over the entire bubble are studied. To analyse the molecular environment in N 24, observations of NH_3 (1,1) and (2,2) were carried out using the Nanshan 26-m radio telescope. The mass-size distributions of the clumps and the presence of massive young protostars indicate that the shell of N 24 is a region of ongoing massive star formation. We have presented a multi-wavelength investigation towards the large Galactic IR bubble N 24 to analyse the physical properties of the dust and gas therein. The infrared structure and the distribution of the molecular emissions show that the two main regions of G 19.07-0.28 and G 18.88-0.49 in the N 24 shell are consistent with star formation triggered by the expanding bubble. As a result of the feedback from massive stars, some new bubbles have already formed in these two regions, which further affect the environs therein. The data obtained was processed using the Gildas software package. We found that ammonia NH_3 (1,1) and NH_3 (2,2) are present in the N24 bubble region in the early stages of star formation.

Key words: star formation, H_{II} regions, N 24 bubble, molecular clouds, high-mass stars.

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Жұлдыз қалыптасу аумағындағы NH_3-тің үлестірілуі

Берілген мақалада Үлкен Галактикалық инфрақызыл N24 көпіршігін зерттей келе, кеңейіп жатқан H_{II} аумағындағы молекулалық және жұлдыз түзуші орталарды анықтаудың көп толқындық анализі келтірілген. Herschel мен ATLASGAL-дың тарихи деректерін қолдана отырып, тозаңның көпіршікте таралуы және физикалық қасиеттері зерттеледі. Біз Қытай Халық Республикасындағы Үрімші қаласындағы 26-метрлік Наньшянь радиотелескобымен алынған мәліметтер арқылы N24 көпіршігіне талдау жасадық. Түйіндер массалық өлшем түрінде үлестірілуі N24 көпіршік қабыршағы жоғары массалы жұлдыз қалыптасу аумағы болып табылатындығының дәлелі екендігін көрсетеді. Біз мульти толқын ұзындықты зерттеуді үлкен инфрақызыл Галактикалық N24 көпіршіктегі шаң мен газ түйіршіктерінің физикалық қасиеттерін зерттеу үшін ұсындық. Инфрақызыл құрылым және молекулалық сәулеленудің үлестірілуі кеңейіп жатқан көпіршік N24 қабыршағындағы екі маңызды аймақта G 19.07-0.28 бен G 18.88-0.49 жұлдыз қалыптасуы орындалады. Алып жұлдыздардан кері байланыс нәтижесінде осы екі аумақта жаңа көпіршіктер пайда болып, олар одан да үлкен әсерін тигізуде. Алынған мәліметтерді Gildas бағдарламасы арқылы өңдей отырып, жылдамдық, координатаны, жолақ ендігін анықтай алдық. NH_3(1,1) мен NH_3(2,2) аммиактың жұлдыздың қалыптасуының алғашқы кезеңдерінде N24 көпіршік аймағында болатындығын анықтадық. Алынған мәліметтерді Gildas бағдарламасы арқылы өңдей отырып, жылдамдық, координатаны, жолақ ендігін анықтай алдық. Түйіндер массалық өлшем түрінде үлестірілуі N24 көпіршік қабыршағы жоғары массалы жұлдыз қалыптасу аумағы болып табылатындығының дәлелі екендігін анықтадық.

Түйін сөздер: жұлдыздардың қалыптасуы, H_{II} аймағы, N24 көпіршік, молекулалық бұлттар, жоғары массалы жұлдыздар.

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Распределение NH_3 в области звездообразования

В этой статье представлен многоволновой анализ большого галактического инфракрасного пузыря N 24 с целью исследования молекулярной среды и среды звездообразования вокруг расширяющихся областей H_{II}. Используя архивные данные Herschel и ATLASGAL, изучаются распределение и физические свойства пыли по всему пузырю. Для анализа молекулярного окружения в N 24 наблюдения NH_3 (1,1) и (2,2) проводились с помощью 26-метрового радиотелескопа Наньшань в городе Урумчи, Китай. Распределение масс-размеров сгустков и наличие массивных молодых протозвезд указывают на то, что оболочка N 24 является областью продолжающегося массивного звездообразования. Мы представили многоволновое исследование в направлении большого галактического ИК-пузыря N 24 для анализа физических свойств пыли и газа в нем. Инфракрасная структура и распределение молекулярных выбросов показывают, что две основные области G 19.07-0.28 и G 18.88-0.49 в оболочке N 24 соответствуют звездообразованию, запускаемому расширяющимся пузырем. В результате обратной связи от массивных звезд в этих двух областях уже образовались новые пузыри, которые еще больше влияют на их окрестности. Полученные данные обработали, используя программный пакет Gildas. Мы обнаружили, что аммиак NH_3 (1,1) и NH_3 (2,2) присутствует в области пузырьков N 24 на ранних стадиях звездообразования.

Ключевые слова: формирование звезд, области H_{II}, N 24 пузырь, молекулярные облака, массивные звезды.

Introduction

High-mass stars play an important role in the development of galaxies because they energize the interstellar medium and carry heavy elements, which in turn determine the cooling mechanism of the galaxy. However, the concept of the formation of high-mass stars is very important. Most people do not know that about the fact that the evolution of isolated small-mass stars is more contradictory than in the early stages of the formation of massive stars [1]. This happens when the study of the condition is poor, except in isolated cases. High-mass stars are formed in clusters [2], respectively, they are located at greater distance than molecular clouds, which form low-mass stars. At the same time, high-mass stars evolve gradually over a short period of time, in a dynamically complex environment, and in the first deep phases.

It is well known that high-mass stars are formed in giant molecular clouds [3]. Cold and high-mass clusters $\geq 500\ M_{\odot}$ are similar to the formation of low-mass stars in that they consist of massive stars or the molecular gas required for the initial states of cluster formation [4]. The development of young massive (protostar) stars in the core density in the beam of ultraviolet radiation is the basis for the formation of the ultra-compact H_{II} region ($UCH_{II}Rs$). Most of them are VLA-registered in the territory of the radio continuum [5], which describes its distribution and number. These areas have helped to determine the trajectories of the many stages of star formation in the galaxy. Often $UCH_{II}Rs$) are likened to hot molecular nuclei [6], which was the origin of $UCH_{II}Rs$). However, high-mass protostars have been called HMPOs or massive young stellar objects (MYSO). They are recently discovered [7]. Under certain conditions, these clouds, which are infrared dark clouds (IRDC), are reflected back into the light background, which provides radiation from polycyclic aromatic hydrocarbon molecules [8]. Simon and Peretto and Fuller presented a large catalog of IRDC. Previous studies have shown that IRDC is cold (< 25 K), dense (> 10^{15} cm^{-3}) and has a high column density [9] (~ 10^{23}-10^{25} cm^{-3}) [10]. Their size (~ 2 pc) and mass (~ 10^2-10^4 $M_{\odot}$) are similar to molecular clouds formed by classes. Here, cold temperatures and fragmented substructures suggest that they are protoclusters [11]. The kinetic distance is determined using ^{13}CO (1-0) and CS (2-1) radiation in the first and fourth galactic quadrants for IRDC models [12]. However, the research is aimed at studying the early stages of the formation of massive mass stars [7], usually one of these stages for HMPOs, MYSO, IRDC are tracers. To date, several hundred massive protons or young interstellar objects have been studied. However, objects in the early stages of the formation of these and high-mass stars require detailed study.

In a study conducted by ATLASGAL, objects corresponding to the formation of giant stars in different position in a galactic length of ±60° and a width of ±1.5° were recorded and compared [13]. Studies with other galactic flying instruments, such as GLIMPSE 3 to 8 μm and HiGAL 70 to 500 μm, have been performed in this area [14]. Studies of the submillimetric glory continuum play an important role in the identification of giant mass nodes, which require information on important parameters. Distance is especially important when identifying new sources. This requires determining other properties, such as mass and brightness. But in the field of giant mass formation, all this comes down to the study of molecular bands. This is because their dencity is approximately the critical density of NH_3. This molecule can accurately determine the properties of nodules in the structure of large-scale clouds without contamination. Therefore, the molecular gas in the core is dense (~10^5 cm^{-3}) and cold [7], so many molecules, such as CS and CO, are partially frozen in the dust particles. In contrast, the stability of ammonia residues in the early nuclei of the star is characterized by an abundance of decomposed gas [15].

NH_3 is known as a reliable test for temperature in interstellar clouds [16]. The energy levels of rotation are given by the total angular moment J and its projection on the molecular axis K. Radioactive displacements between K-levels are prohibited and low metastable energy levels of J=K are excited in the event of a collision. Their inversion displacement and intensity radio provides the gas circulation temperature [17], which is necessary to estimate the kinetic temperature of the rod. It is necessary to estimate the correct mass from the submillimeter data. In addition, inversion displacements are clearly broken down into very thin components and their ratio provides information on determining the size of the optical depth, column density and rotational temperature.

Observations

In accordance with the study of molecular emissions, the frequencies NH_3 (1,1) (23.694495 GHz) and NH_3 (2,2) (23.722633 GHz) proposed ere have been set to 23.708564 GHz. These observations were taken in March 2018 from a 26-meter radio telescope operated by the Xinjiang Astronomical Observatory of the Chinese Academy of Sciences. The beam width of this telescope (full width at half the maximum, FWHM) is about 2′ (0.22 parsecs at a distance of 383 parsecs) and has a resolution of 23 GHz at a speed of 0.098 km/h. It is obtained from a digital filter of 8192 channels in the bandwidth mode of 64 MHz. The spectral current was periodically calibrated and a signal was transmitted from the noise diode every 6 seconds. Adjustment and control of the telescope should be at least 18 seconds. Double polarized channel superheterodyne with a frequency of 22-24.2 GHz was used as a receiving device with a system temperature of about 50 K at 23 GHz. The maps were assembled and used in on-the-fly (OTF) mode in good weather and at a height of 20° above the horizon, with a grid size of ′6 by 6′ and a pitch of 30″.

Results

We processed the NH_3 (1,1) signal using CLASS and GREG software from the GILDAS package. The speed integration interval is 60-70 km/h to cover the entire width of the base NH3 (1,1). This study was performed at the N 24 bubble facility. The intensity of the strip under study can provide information about the column density of NH3 and the deviation from the kinetic temperature and thermal equilibrium in the cloud. By processing the received signal, we obtained the coordinate distribution of ammonia (Fig.1). WE also received information about the speed and wigth of the lane.

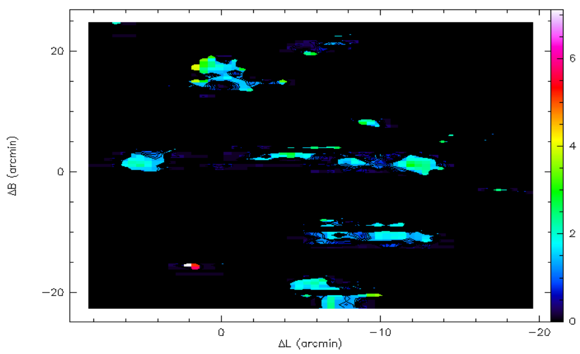

Figure 1 – Distribution of NH_3 ammonia by coordinates

Conclusion

We have been able to study the physical properties of dust and gas granules in a large infrared galactic N 24 bubble and explain the formation of stars using data from the Nanshan Radio Telescope. The research can be summarized as follows:

1) The mass distribution in dense nodes indicates that the giant stars are in the region of formation.

2) The formation of stars G 19.07-0.28 and G 18.88-0.49 is performed in two important regions of the bubble N 24, where the infrared structure and the distribution of molecular radiation are expanding.

3) We found that NH_3 (1,1) and NH_3 (2,2) ammonia are present in the N 24 bubble region in the early stages of star formation.

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