Stellar associations: a variable stars nursery

The study of stellar associations and star formation regions is an important activity in the research of stars evolution and their systems. Stellar associations are concentrated along the spiral arms of our galaxy and come in several types. As a place where stars are born, these regions contain different kinds of objects, including variable stars, at the early stages of their life.

The term "stellar associations" was suggested as one of the basic concepts in the galactic astronomy by the outstanding astrophysicist of the Academy of Science of the USSR - V.A. Ambartsumian, in 1948. Stellar associations are sparse groups of loosely bound young stars, which have similar physical properties. The age of such associations does not exceed several tens of millions of years. About 90 percent of all stars originate as members of associations.

What makes associations different from regular young star clusters is their larger size and low stellar density. By size, an association can reach 50-100 pc, but the number of members can be just tens to hundreds of stars overall. Stellar associations are complex molecular clouds.

The weak gravity in associations determines their relatively short (in astronomical terms) lifetime - only 10-20 million years old. Groups' borders are continuously expanding, making it eventually impossible to distinguish an association from the background stars of “old” associations.

Viktor Amazaspovich Ambartsumian *(1908 - 1996), Byurakan Observatory, Armenia. Soviet astronomer and astrophysicist, best known for his theories concerning the origin and evolution of stars and stellar systems.*

Stellar associations are divided into three basic types:

- *OB associations*, containing mainly massive hot blue-giant stars;
- *T associations*, containing mainly low-mass T Tauri variable stars;
- *R associations* (R stands for "reflection"), containing stars of spectral classes O to A2, surrounded by reflection nebulae, gas and dust.

OB associations consist largely of very young, massive stars (about 10 to 50 solar masses) of spectral types O to B2. These stars do not live long, so OB associations are all young. The size of OB associations ranges from 40 to 200 parsecs, and the number of members (spectral type O-B2 stars) is limited to several dozen. T associations are made up of numerous cooler lower-mass dwarf T Tauri stars, which exhibit irregular variations of brightness. R associations are characterized by medium-mass stars. A well-defined lane of R associations extends from Cygnus to Monoceros along the inner edge of the Orion arm. All three types may be found together. The internationally approved designation for associations is the name of the constellation followed by an Arabic numeral (e.g. Perseus OB2).

Left: VISTA infrared image of the star-forming region Monoceros R2 within the constellation of Monoceros (the Unicorn).

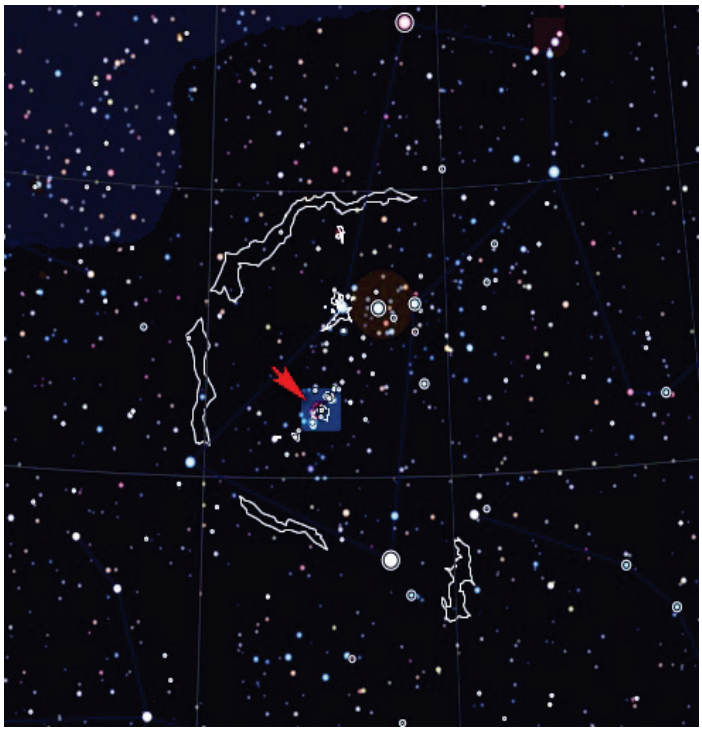
Image credit: ESO / J. Emerson / VISTA.

Nevertheless, the fact that stellar associations exist within our galaxy, along with other types of star clusters, is an irrefutable proof that the stars are not born alone, but in groups. One of the clearest examples of stellar associations, which can be seen currently in the constellation of Orion, is the "trapezium". This is a group of young blue stars. The Scorpius -Centaurus Association is the nearest OB association to the Sun. It is composed of three subgroups of stars, whose mean distances range from 380 to 470 light years.

The most interesting association type for variable stars researchers are T associations. These are home to relatively cool dwarfs with hydrogen emission lines in their spectra. Nearly 40 of such associations are currently known. These regions are formed by groups of young T Tauri variable stars associated with the clouds of interstellar matter (nebulae) in which they occur. This fact was noted by Ambartsumian and played a significant role in the future development of theoretical ideas about how stars are formed. T Tauri variables are newly formed stars of low mass (three or less solar masses) that are still in the process of contraction. Since T Tauri stars are dwarfs, T associations cannot be observed at great distances. They occur only in or near regions of galactic nebulosity, either bright or dark, and only in obscured regions showing the presence of dust.

T Tauri variable stars are in the stage of evolution before entering the main sequence, with masses less than two solar. They have spectral types of F to M; their rotation periods are on the order of 1 to 12 days. Compared to the main sequence stars, their luminosity is typically greater because of the larger size. There is evidence that their surfaces are covered with spots. Another source of T Tauri brightness variability is a protoplanetary disk surrounding the star.

The constellation of Cygnus has five T associations, and Orion and Taurus have four of them each. The richest is Ori T2, with more than 400 members; it has a diameter of 50 by 90 light-years and lies at a distance of 1,300 light-years around the variable star T Ori. This is, perhaps, the best known example of a stellar nursery, where new stars are being born, the Orion Nebula (M42) area. Observations of the nebula have revealed approximately 700 stars in various stages of formation within the nebula. Also, T associations were discovered in Monoceros, Perseus, etc.



The area containing the Orion T2 association and the M42 nebula (The Orion Nebula)

Besides T Tauri variables, another type of variable stars is found in stellar associations - UV Ceti. The most important common feature for those two classes of variable stars is a continuous emission. For UV Ceti stars the emission is observed during outbursts, while for T Tauri stars it appears at various stages of their variability cycle.

The study of variable stars in stellar associations is very important for understanding the fundamental concepts of star formation. Stars at the earliest stages of their evolution are an extremely valuable source of knowledge about the nature of their origin.

Valery Tsehmeystrenko

The list of 10 most recognizable T associations.

Association	Constellation	Nearby Object	Members Count	Angular Diameter	Approx. Distance, pc
Tau T1	Taurus	RY Tau	15	3	200
Tau T2	Taurus	T Tau	12	5	170
Aur T1	Auriga	RW Aur	15	7	170
Ori T1	Orion	CO Ori	49	4	400
Ori T2	Orion	T Ori, M42	450	4	400
Mon T1	Monoceros	S Mon, NGC2264	198	3	800
Ori T3	Orion	Σ, ζ Ori, I434	103	4	400
Sco T1	Scorpius	α Sco, ρ Oph	33	9	210
Del T1	Delphinus	V536 Aql, WW Vul	25	15	200
Per T2	Perseus	I348, ζ Per	16	0.4	380