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Detailed Studies of Trapezium-type Multiple Stellar Systems

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Abstract. A brief review of observational studies of Trapezia-type stellar systems is presented. The important role of such systems in investigating problems of star formation is discussed.

1. Introduction

Trapezium-type multiple star systems are amongst the most interesting and significant objects. A number of important conclusions for present-day understanding of the origin and evolution of stars are based on their study. In Abastumani investigations of Trapezium-type multiple systems have been carried out for several decades.

2. Catalogue of Trapezium-type Multiple Systems

The first list of Trapezia like stars was compiled by Ambartsumyan (1954) on the basis of Aitken's Double star Catalogue (ADS,1932). This list is incomplete and contains a high percentage of pseudo-trapezia. In the early 1970's, the Abastumani Trapezium-type multiple system catalogue was compiled by Salukvadze (1978). The Abastumani catalogue contains 412 systems.

Among the multiple systems with primary components of O-B spectral type, the percentage of real Trapezia is important. The existence of Trapezia with primary components of A,F,G and K spectral types is not excluded. In addition, the Abustamani cataogue of Trapezia stars is likely to be incomplete. The compilation of a complete catalogue of Trapezia stars would give us the possibilty of refining statistical and other characteristics.

We have decided to search for multiple systems with spectral types from O to B2, since real Trapezia occur in multiple systems of these types. The Russian Center of Astronomical Data has selected stars of spectral types O–B2 from the SAO catalogues. The number of such stars was found to be 2601. Almost half of them are northern stars ($\delta > -10°$). Photographic observations of these stars with the 125 cm telescope have been started in Abastumani. About 1000 plates and films have so far been obtained. The search of southern stars is to be carried out using the ESO southern sky atlases.

We decided to search for Trapezium type multiple stars in T-associations from Kholopov's (1970) list for distances up to 500 pc. The search has been done in 12 T-associations using the 70 cm Meniscus telescope plates of the Abastu-

mani Observatory and on the Palomar charts. After the optical pairs had been excluded, the multiple systems and double stars were listed. To ascertain the percentage of Trapezium type multiple systems included in the total number of multiple systems investigated, we made some calculations on the basis of the above lists. We found that T-association Ori T1 Trapezium type multiple stars are 75% of the total number of multiple stars; in Ori T2 - 90%; in Ori T3 - 94%, in Ori T4 - 93%, in Tau T1, T2, T3, T4 – 100%. The total number of the Trapezium systems is 120, of which no more than 20 systems can be optical.

3. Kinematics

The problem of the expansion of Trapezium systems is still of great interest. We have tried to examine the problem by studying the kinematics of Trapezium-type multiple systems with O–B2 spectral type primary components. The results are discussed by Salukvadze (1987). Fifteen Trapezia were found to have adequate observational data: ADS 719, 2843, 3709, 4241, 4728, 5322, 5977, 13374, 13626, 14526, 14831, 15184, 16095, 16381. In most cases the observational data embrace time intervals longer than 100 years. The most important point is the accuracy of the earliest and latest measurements. The earliest ones are mainly those of V. Struve, and most of the latest ones are the results of photographic observations carried at the Naval and Abastumani Observatories and of micrometric observations by Ch. Worley.

After consideration of the observational data, it was found that 14 Trapezia out of the 15 indicated expansion. The fact that in an overwhelming majority of cases, divergence of the pairs under consideration was noted, makes us infer that divergence occurs not as a result of the orbital motion along confined orbits, but due to the positive sign of the total system energies.

We searched for wide Trapezium-type multiple systems in which all the components are of O–B2 spectral-type since a large percent of Trapezium-type real systems are encountered among this spectral-type. Around each of 2601 O–B2 stars selected from the SAO catalogues all O–B2 stars were picked out in a square of side 15 arcmin. The lists of stars were carefully examined and all the sample groups were extracted. Finally 60 groupings were revealed. It was found that many groups did not satisfy the definition of Trapezium-type multiple systems. These are called ϵ Lyrae systems. Other groups consisting of several components involve groups of young O–B2 stars. Finally, only data for 15 Trapezia were left in the list. The distance moduli to the stars forming the Trapezia systems were determined and it was shown that they are almost at the same distance. The fact that wide systems exist favours the suggestion of a positive total energy in Trapezium-type multiple systems. It is clear that, with a negative total energy, the configuration of multiple stars conforming to the Trapezium definition would not be satisfied.

4. Radial Velocities of the Components

With the fine device for the measurement of radial velocities designed and constructed by Tokovinin (1987) it became possible to determine the radial velocities of the Trapezium-type multiple system components. The observations were

taken in November 1988 and in October 1990 with the 125 cm Abastumani Observatory reflector. The folowing systems were observed from the Abastumani Catalogue: 3, 9, 12, 14, 16, 26, 27, 28, 33, 38, 39, 46, 47, 50, 52, 56, 64, 84, 96, 99, 212, 236, 244, 254, 255, 264, 271, 283, 293, 302, 309, 310, 322, 328, 341, 342, 353, 360, 362, 372, 374, 381, 394, 397, 401, 402, 403, 411. In all, 48 systems have been observed with 82 components. In most cases, the main components of the selected Trapezia were observed, in 19 cases two components were observed, and in 7 cases, three components. The mean error of the radial velocities is 0.5 kms^{-1}. The results will be published soon.

5. Electrophotometry of the Components

Electrophotometry has been done using the $ubvy\beta$ system. Colour indices $(b-y)$, m_1, c_1 and β of components have been determined with the aim of establishing photometric spectral classes, calculating absolute stellar magnitudes, effective temperatures and surface gravities of stars.

The Trapezium-type multiple systems have been selected from the Abastumani Catalogue of Trapezia. 41 stars were observed, constituting the following ABAO systems: 2, 34, 48, 51, 313, 316, 348, 356, 359, 363, 387, 396. The observations were taken with the 125 cm telescope, automatically controlled from the computer, with the use of a single-channel photometer counting photons. The reduction of the data and calculation of the above mentioned parameters of the Trapezia components were described by Salukvadze & Javakhishvili (1989).

6. Future Work

- Determination of relative proper motions for Trapezia stars in the Abastumani Catalogue. Observations for obtaining the second epochs will be taken using the 70 cm Meniscus telescope of the Abastumani Observatory. The "Carte du Ciel" catalogue will be used as the first epoch.

- A search of the Trapezium-type multiple systems among O–B2 stars in the Smithsonian Observatory catalogues. A search of "northern" stars is now being carried out photographically with the Abastumani Observatory 125 cm (f = 16 m) telescope. Searches for southern stars will use the ESO atlasses.

- Determination of the radial velocities of the components of Trapezium-type multiple systems. The observations will be carried out using the 125 cm Abastumani Observatory reflector.

- Determination of physical characteristics of the Trapezia stars according to electro-photometric observations in the six-colour $uvby\beta$ photometric system. The observations have been conducted and will be continued with the Abastumani 125 cm telescope using a two-channel electrophotometer.

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