Stars and their variability observed from space
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POSSIBLE CONNECTION BETWEEN P CYGNI AND NEIGHBORING OPEN CLUSTERS

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Abstract. According to earlier investigations by Turner and co-authors, P Cygni could be a member of a hypothetical, sparsely-populated open cluster. The star lies near the east boundary of this hypothetical cluster. There is another, but known open cluster IC 4996 on the vicinity of P Cygni. The same authors believe that the above mentioned two clusters are connected to each other and they could represent a double cluster. As P Cygni is a hypergiant and consequently has very a strong and variable stellar wind, so a cluster membership can enable us to determine the age, distance, and reddening of the star relatively precisely. We used new data of different catalogues, for example, PPMXL and GAIA and tried to resolve the problem.

Keywords: Open clusters, LBV, P Cygni

1 Introduction

Early-B (B1Ia) spectral type hypergiant star P Cygni, a Luminous Blue Variable (LBV) (Conti 1984) has been well-known since its 1600 eruption, when it suddenly brightened like a Nova. During decades many authors made photometric and spectral observations of P Cyg to explain its real nature. But still its evolutionary status is not certain. The characteristic prototype "P Cygni" profiles of its spectral lines indicate an outflow of material from the star and is characteristic for Novae, Wolf-Rayet stars and LBVs. P Cyg has three different types of variation: 1. Short, 17-day variation; 2. 100-day variation, which is also observed in other Luminous Blue Variables; 3. Long-period variation of several years duration. P Cygni is the nearest LBV, at a distance of about 1.7 kpc (1.3 kpc according Gaia DR2). It has the following properties: T_{eff}=18200 K; L=5.6·$10^5 L_\odot$; R=75 $R_\odot$; M=30 $M_\odot$ (Najarro et al. 1997). A. Kashi (Kashi 2010) suggested that P Cyg′s 17-th century eruption can be explained by mass transfer to a B-type binary companion. He found that the mass of the companion is approximately 3-6 $M_\odot$ and the orbital period is about 7 years. Using photometric observations taken from AAVSO and photometric data from Abastumani Astrophysical Observatory (obtained during 1951-1983 by Magalashvili and Kharadze; Kochiashvili et al. (Kochiashvili et al. 2018); Michaelis, Amir; Kashi, Amit and Kochiashvili, Nino (Michaelis et al. 2018) found that the orbital period of P Cyg′s companion is about 4.7 years.

2 "P Cygni cluster"

P Cygni - 34 Cyg ($20^h\ 17^m\ 47^s.2$ $+38°\ 01'\ 58''.5$) is a member of the Cyg OB1 association. This region is abundant with deep-sky objects, has active star formation, contains Wolf-Rayet stars and other early-type massive stars and also young open clusters. Open clusters are very important objects for studying stellar evolution. Because all the stars in an open cluster have the same age and chemical composition, all the properties of their stars are much easier to study than when they are isolated stars. There are many open clusters around P Cyg: NGC 6910, M 29, NGC 6883, IC 4996 and so on.
Several authors believe that P Cyg and stars around it belong to an anonymous open cluster "P Cygni Cluster" (Turner (1985); Turner et al. (2001)). We attempt here to check this hypothesis. For this we used the Clusterix program. "Clusterix is a web-based, interactive application that allows the computation of membership probabilities from proper motions through a fully non-parametric method and also allows the possibility of gathering physical parameters (parallaxes, radial velocities)" (Balaguer-Núnez et al. 2017). We use the GAIA/DR2 catalogue and choose a 5-arcmin radius around P Cyg with magnitude limits from 4 to 16 and found 211 stars.
After that we tried to find stars with similar proper motions to that of P Cyg (-3.18; -6.45). From these selected 211 objects we find 172 possible cluster-member stars (Fig. 1). If they really are members of the cluster, than P Cygni probably is located near the center of it.

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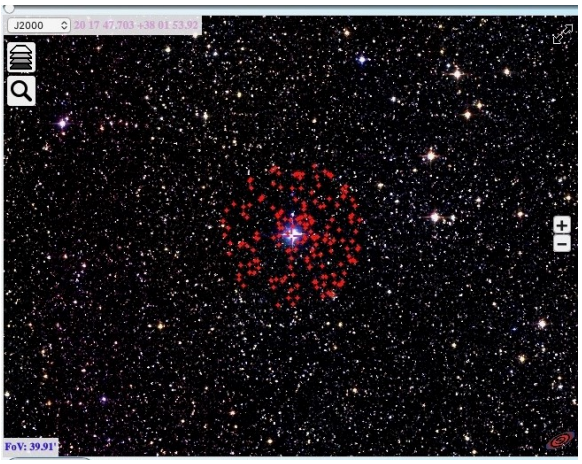

Fig. 1. 172 stars which have similar proper motions to that of P Cyg from the GAIA/DR2 catalogue

Turner and co-authors obtained a similar result according to the photometric study of stars in the vicinity of P Cyg (Turner et al. 2001).
IC 4996 is the nearest open cluster to P Cygni. It is predicted that it forms a double cluster with "P Cygni cluster" ((Turner et al. 2001). According to the proper motion data from GAIA/DR2 catalogue it seems that this hypothesis could be true. The distance of IC 4996 from various sources covers the range from 1.67 kpc to 2.40 kpc, and the ages of the cluster are given from 6 Myr to 9 Myr (Straižys et al. 2019).

3 In Future

We are going to analyze data on all these 211 stars around P Cyg. We will check if the "P Cygni cluster" really does exist and if there is any connection with the young open cluster IC 4996. Then we will construct an HR-diagram, which will give us the possibility to determine precisely the parameters of P Cyg, like - mass, distance, age and luminosity.

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