Stellar Content of the GSH 224-01+24 /Seagull Nebula Region

Nadia Kaltcheva, ***Department of Physics and Astronomy, University of Wisconsin Oshkosh, USA, kaltchev@uwosh.edu***

Background and Stellar Sample

The Canis Major star-forming field is dominated by the extended Seagull Nebula (IC 2177) and contains a number of HI shells, associated with both the Local or Perseus arms. The positional coincidence of the bright O and B stars in this direction and GSH 224-01+24, as identified by Ehlerova and Palous (2005), may be indicative of an interaction with the shell's material.

The field in study is located between 220◦ to 230◦ galactic longitude and -8◦ to +5◦ galactic latitude. A sample of 260 O-B9 type field stars with uvbyβ photometry is available within this coordinate range. The sample completeness is 85-90% up to 11.5 -12 magnitudes. Figure 1, left panel, presents the sample and the known HI shells in this direction. The photometry was collected from the catalog of Hauck & Mermilliod (1998) and Paunzen (2015). A significant amount of these data were obtained by Kaltcheva, Olsen and Clausen (1999) and Kaltcheva and Olsen (1999) that specifically targeted O and B stars in star-forming fields. Comparisons between different sources do not indicate systematic offsets of the photometry.

This photometry is known to provide reliable color excesses and absolute magnitudes (Strömgren 1966). The uvbyβ photometric distances and color excesses were calculated using the intrinsic color calibrations of Crawford (1978) and Kilkenny & Whittet (1985), the luminosity calibration of Balona & Shobbrook (1984), and a total-to-selective extinction ratio of 3.1. The uvbyβ-based extinction estimates were compared to estimates from several dust models (obtained via the GALExtin VO-service; Amôres et al. 2021) and also to the *Gaia* DR2 *AG* estimates. The best agreement is with Green et al. (2019) model and the comparison is shown in Fig. 2 (upper panel). The lower panel is a comparison of the uvbyβ-based distances obtained here to the Gaia EDR3 distances (Bailer-Jones et al. 2021). The agreement in both extinction and distance is very good, without any systematic offset present between the data sets. The scatter for stars more distant than 1 kpc could be due to various reasons, including their peculiar nature affecting the photometry. We note, however, that for stars more distant than 2 kpc in this field, the photometric distances agree better with *the Gaia* EDR3 distances if a β index calculated from the uvby quantities is used instead of the observed β.

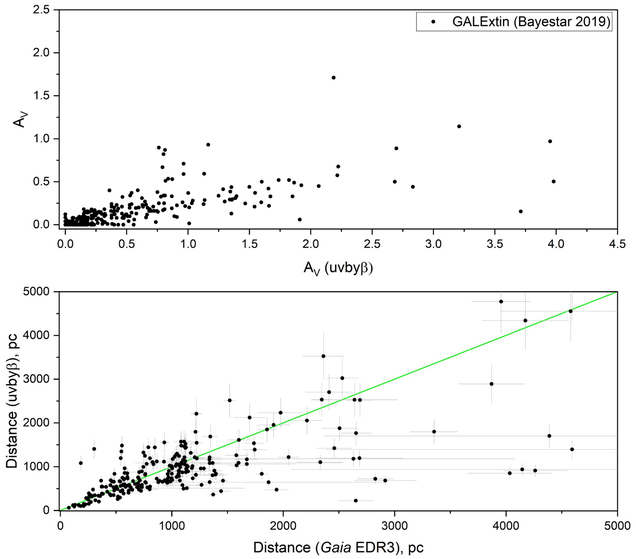

Fig. 2 *Top* –Comparison between uvbyβ extinction estimates and extinction estimates based on Green et al. (2019). *Bottom* – Comparison of the uvbyβ-based distances obtained here to the *Gaia* EDR3 distances (Bailer-Jones et al. 2021).

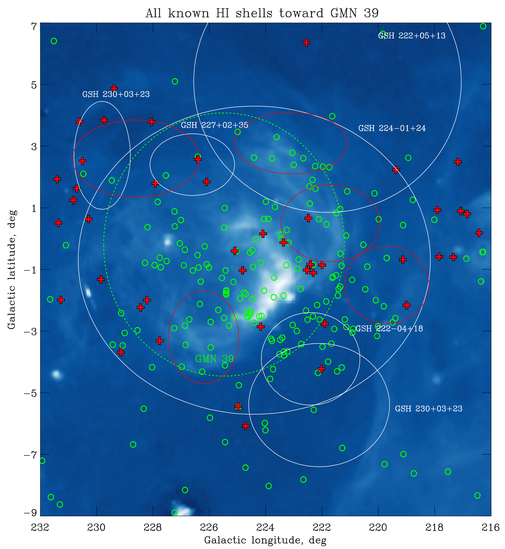

Fig. 1 The stars with available *uvby*β photometry superimposed on the distribution of Hα emission. Open symbols are used for stars closer than 1.5 kpc. The known HI shells located in the Local arm (white) and in the Perseus arm (red) are shown.

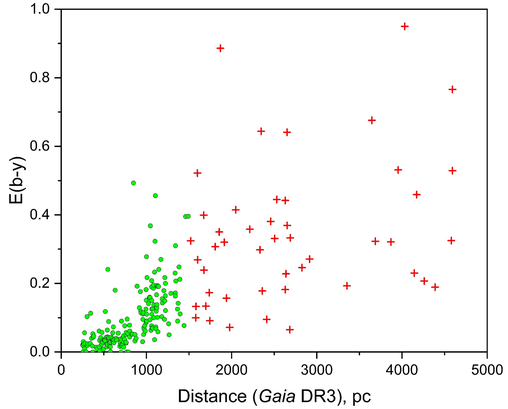

Fig. 3 Color excess based on uvbyβ photometry vs. *Gaia* EDR3 distance.

References

Amôres et al., 2021, 2021arXiv210800561A; Balona & Shobbrook, 1984, MNRAS, 210, 375; Bailer-Jones al., 2021, AJ, 161, 147; Crawford, 1975, AJ, 80, 955; Dias et al, 2021, MNRAS, 504, 356; Ehlerova and Palous, 2005, A&A,437,101; Finkbeiner, 2003, ApJS, 146, 407; Green et al. 2019, APJ, 887, 93; Hauck & Mermilliod, 1998, A&AS, 129, 431; Kalberla et al., 2010, A&A, 521, A17; Kaltcheva, & Olsen, 1999, A&A, 352, 600; Kaltcheva et al., 1999, A&A, 352, 605; Kilkenny & Whittet, 1985, MNRAS, 216, 127; McClure-Griffiths et al., 2009, ApJS, 181, Paunzen, 2015, A&A, 580, A2; Santos-Silva et al., 2021, arXiv:2108.06234v1, Strömgren, 1966, ARA&A, 4, 433

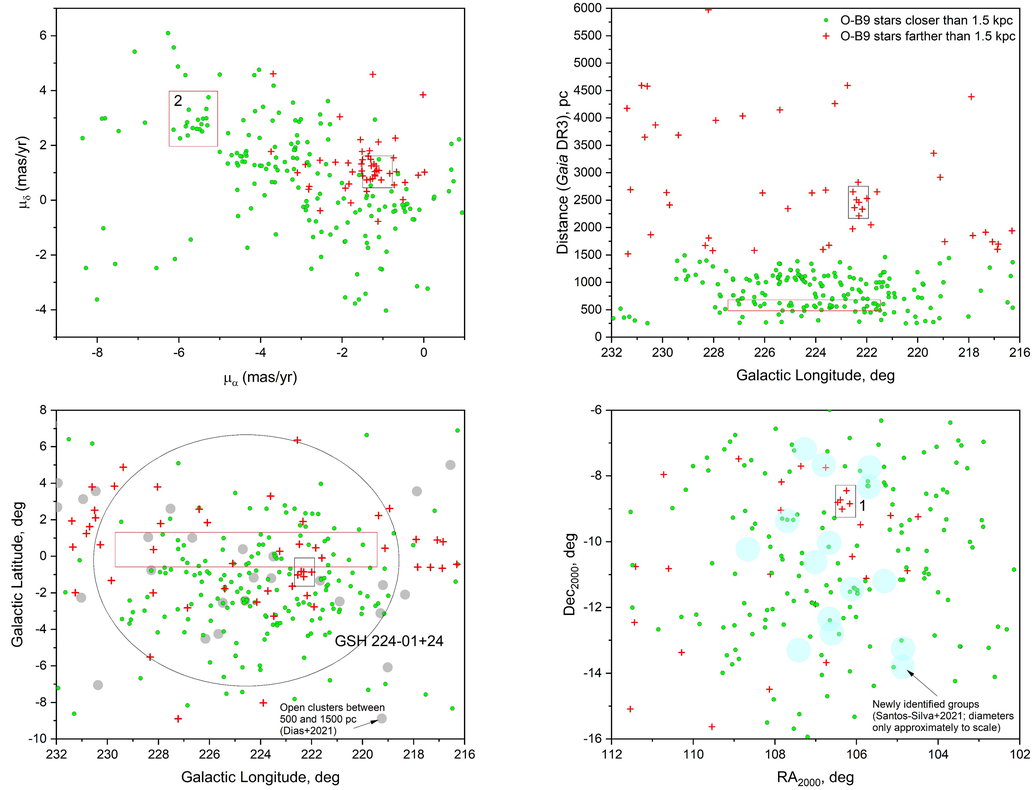

Fig. 4 *Top* – A proper motion diagram and distance vs. galactic longitude diagram for the sample stars. *Bottom left* – The sample stars plotted in galactic coordinates together with the open clusters from Dias et al. (2021). *Bottom right* – The sample stars plotted in equatorial coordinates together with the groups identified by Santos-Silva et al. (2021).

Preliminary Analysis

Toward GSH 224-01+24, the bright O-B9 stars with available uvbyβ photometry show clear separation of stars located in the Local arm and stars located in the Perseus arm. The former should be associated with GSH 224-01+24. They form two layers at 500 pc and 1200 pc that show a different pattern of color excesses, with a sharp increase observed at 1 kpc (Fig. 3). This could be associated with the distribution of the interstellar material within GSH224-01+24. In the Dias et al. (2021) catalog, 30 open clusters between 500 and 1500 pc are identified in this coordinate range, showing a similar distribution of extinction with distance.

Acknowledgements

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Next Steps

- Only a few stars can be placed in groups based on similar position, distance and proper motion (group 1, Fig. 4, is an example). Other stars (group 2 as an example), although with similar proper motion and distance, are spread over several degrees in galactic latitude across GSH 224-01-24. A study of the large-scale kinematics patterns would help to elucidate the connection of these stars to GSH 224-01+24.
- Examine this sample in the context of recent studies of the CMa OB1 stellar groups. Some of the stars match the groups determined by Santos-Silva et al. (2021) and yield similar parameters (the extinction can be obtained with less uncertainty involving the uvbyβ photometry) but others could not be associated with these groups.