Supplementary Material

1 APPENDIX

1.1 Cluster Membership

Accurately identifying probable cluster members is crucial for reliably deriving cluster parameters from techniques like isochrone fitting of CMD and TCD. The presence of field star contamination introduces errors in cluster parameters. Using proper motions, kinematic studies of star clusters allow the identification of probable cluster members based on their distinct proper motion distribution relative to field stars in the vector point diagram (VPD; see Figure A1). The Gaia DR3 data release provides precise parallax measurements for faint stars with limiting G $<$ 21 mag. Therefore, we have used PM data analog with G bands magnitude from Gaia DR3 to calculate the membership probability of stars located within $\sim 20'$ $\times$ $20'$ FoV around Be 65. We have plotted the PMs of stars within the cluster region on a VPD (panel 1 in Figure A1). From VPD, it is clear that a prominent clump of stars with similar PMs is likely cluster members. The remaining scattered stars are likely field stars. Panel 2 in Figure A1 shows the CMD (G vs (G_{BP} - G_{RP})) for all stars in FoV, members, and for field stars in sub-panels 2(a), 2(b) and 2(c), respectively. As member stars show a well-defined MS, it confirms their higher probability of membership. Assuming the distance of 2.27 kpc (from WEBDA) for Be 65 and the radial velocity dispersion of 1 (km/sec) for the open cluster (Girard et al., 1989), we have calculated the expected PM dispersion (σ_c) for cluster members. Considering stars within a circle centered at $\mu_{RA} = -0.70(mas/year)$, $\mu_{Dec} = -0.43(mas/year)$ and radius of 0.3 (mas/year) on VPD, as probable members, we have derived frequency distribution σ_c^{ν} and σ_f^{ν} for member and field stars, respectively then we have calculated membership probability for stars in the field. The detailed procedure is described in Sharma et al. (2020). The membership probability, associated errors in proper motion, and parallax values are plotted as a function of G magnitude in Figure A1 (panel 3). It is clear that the stars with a high membership probability ($P_{\mu} > 80\%$) exist down to faint magnitudes of G $\sim$20, and there is a clear separation between member and field stars at brighter magnitudes. The bottom sub-panel of panel 3 in Figure A1 shows the parallax of the stars as a function of G magnitude. With a few outliers, most stars with a high membership probability ($P_{\mu} > 80\%$) follow a tight distribution. The membership probability was estimated for 3517 stars in the cluster region, of which 540 stars were found to be cluster members ($P_{\mu} > 80\%$).

REFERENCES

Girard, T. M., Grundy, W. M., Lopez, C. E., and van Altena, W. F. (1989). Relative Proper Motions and the Stellar Velocity Dispersion of the Open Cluster M67. *AJ* 98, 227. doi:10.1086/115139

Sharma, S., Ghosh, A., Ojha, D. K., Pandey, R., Sinha, T., Pandey, A. K., et al. (2020). The disintegrating old open cluster Czernik 3. *MNRAS* 498, 2309–2322. doi:10.1093/mnras/staa2412

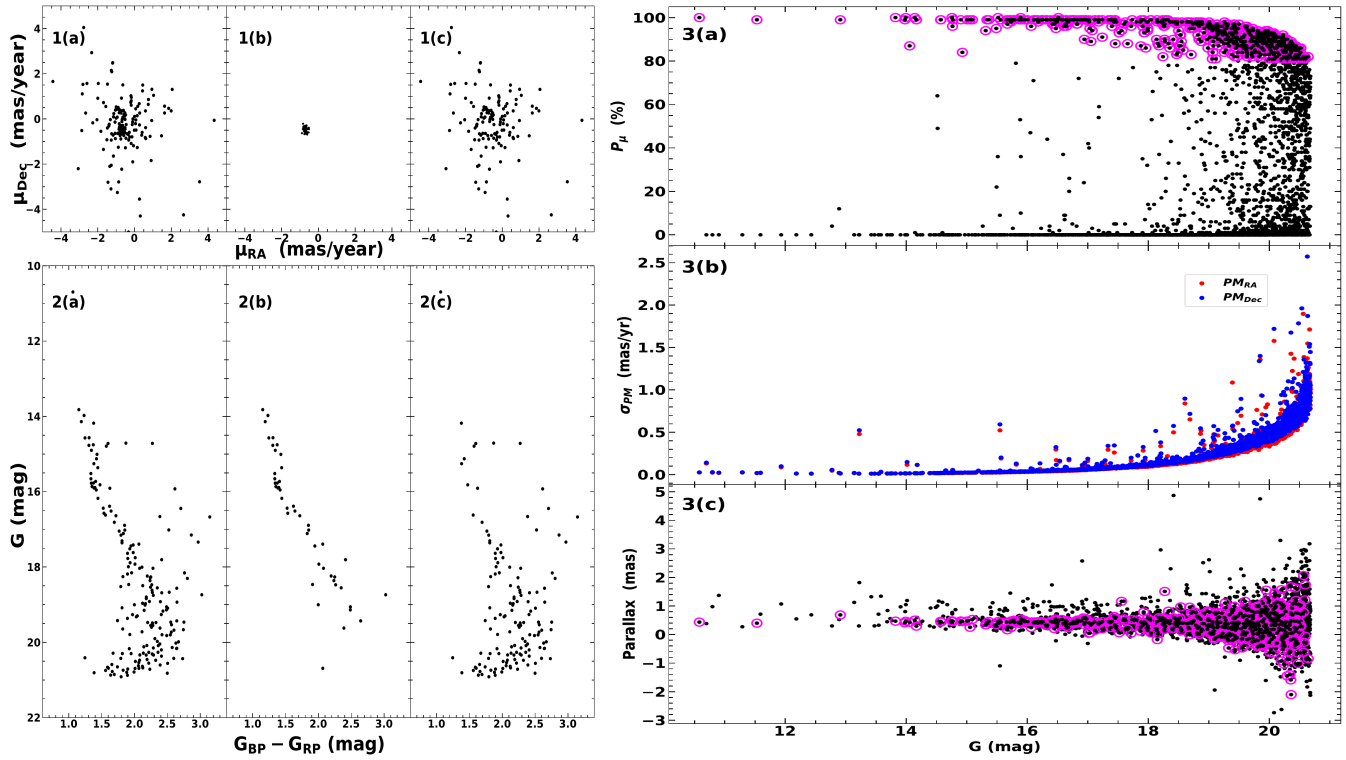

Figure A1. Left panels (**1** and **2**): PM VPD (panel **1**) and Gaia DR3 G vs (G_{BP} - G_{RP}) CMDs (panel **2**) for stars located in the Be 65 cluster region. The left sub-panels (**1(a)** and **2(a)**) show all stars in the cluster, while the middle (**1(b)** and **2(b)**) and the right sub-panels (**1(c)** and **2(c)**) show the probable cluster members and field stars, respectively. Right panels **(3)**: Membership probability Pμ **(3(a))**, PM errors (σ_{PM}) **(3(b))**, and parallax **(3(c))** of stars as a function of G magnitude for stars in the Be 65 cluster region. 540 stars with $P_\mu > 80\%$ are considered members of the Be 65 cluster and are shown by circles with magenta rings.