THE DYNAMICS OF NGC 1866

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ABSTRACT. High-precision radial velocity measurements have been obtained for 62 stars in the young LMC cluster NGC 1866 using the Las Campanas 2.5m with échelle spectrograph. The mass-weighted mean-square velocity dispersion is $\sigma^2 = 6.5 \pm 1.3$ km^2 s^{-2}. The mass of the cluster M(r < 20) = 8.1 ± 1.6 x 10^4 $M_\odot$, implying a M/L of 0.20 ± 0.04 in solar units.

1. Observations

Wew have obtained radial velocities ($\sigma \sim$ 1-2 km s^{-1}) for 62 supergiants in the young (~ 10^8 yrs) LMC cluster NGC 1866. All but three are within 20 pc of the cluster centre. V-band surface photometry was also obtained using the Las Campanas 1.0m with CCD.

2. Photometry

The surface photometry revealed that the cluster is not yet tidally limited by the gravitational field of the LMC. The observed surface brightness profile leads to a spatial density given by

$$\rho(r) = 610(1 + (\frac{r}{4.52pc})^2)^{-3.96/2} \mathrm{L}_\odot \mathrm{pc}^{-3}.$$

The integrated V luminosity of the cluster is L(r < 20) = 4.1 x 10^5 $L_\odot$.

3. Velocity dispersion and mass.

For models with no rotation the mass-weighted mean-square projected velocity dispersion is σ (R < 20) = 6.5 ± 1.3 km^2 s^{-2}. Assuming isotropy, the virial mass is M(r < 20) = 8.1 ± 1.6 x 10^4 $M_\odot$ (M(r < 20)/L(r < 20) = 0.20 ± 0.04). No account has been made for projection effects or velocity errors.

4. Rotation

The velocity data appear to have a sinusoidal trend with position angle of amplitude 1.3 km s^{-1}. The significance of this was tested with Monte Carlo simulations (see Section 6.).

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5. Monte Carlo simulations

A total of 2000 Monte Carlo simulations of the globular cluster stellar velocities have been carried out. Half were executed assuming purely radial orbits, and the other half with purely circular orbits. The models have the same projected positions as the NGC 1866 data and line-of-sight positions are chosen randomly for the stars based on the spatial density function. Neither of the two orbital models seems to provide a superior match to the observations. (See Fig. 1 for a plot of the average model values superimposed on the observed dispersion function. The solid line is for radial orbits, the dashed line for circular orbits.) It is seen, however, that only ~3% of the models exhibit rotation with an amplitude equal to, or greater than, that observed in NGC 1866.

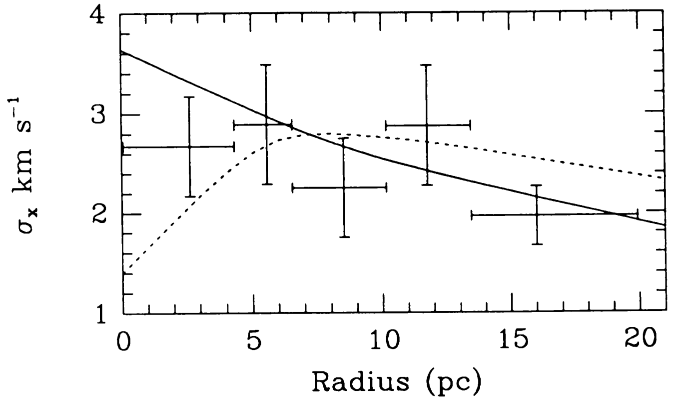

Figure 1. The dispersion function.

6. Conclusions and future work

1. NGC 1866 is found to have a mass of $M(r < 20\text{ pc}) = 8.1 \pm 1.6 \times 10^4\ M_{\odot}$, although further simulations of model clusters may alter this conclusion slightly.
2. $M/L = 0.20 \pm 0.04$ in solar units.
3. There is no preference between purely circular v. purely radial orbits. More sophisticated models incorporating isotropic orbits are currently being attempted.
4. There is a high probability that NGC 1866 is rotating. Further simulations are currently being attempted to quantify this rotational effect and its implication on the mass estimates.

Radial velocity data for more MC clusters will be obtained in the near future to achieve the goal of deriving a homogeneous set of mass determinations.

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