DYNAMICAL STUDY OF THE LMC GLOBULAR CLUSTER NGC 1978 FROM CORE VELOCITY DISPERSION

G. MEYLAN
Space Telescope Science Institute
3700 San Martin Drive
Baltimore MD 21218
USA

P. DUBATH, M. MAYOR
Observatoire de Genève
CH-1290 Sauverny
Switzerland

ABSTRACT. The projected velocity dispersion in the core of the Large Magellanic Cloud (LMC) intermediate-age globular cluster NGC 1978 is deduced from integrated light spectra. A numerical cross-correlation technique gives a projected velocity dispersion σ_p(core) = 5.8±1.2 km s^{-1}. Multimass anisotropic King-Michie dynamical models are applied to the observational constraints given by the surface brightness profile and the above central projected velocity dispersion. Depending on the model, the values obtained for the total mass of the cluster range from 0.36 to 1.44 10^6 $M_\odot$, corresponding to mass-to-light ratios M/L_v ranging from 1.2 to 4.2 $(M/L_v)_\odot$, values typical of galactic globular clusters.

1. Integrated light spectra

Integrated light spectra were obtained at the European Southern Observatory at La Silla, Chile, with CASPEC, the Cassegrain Echelle Spectrograph, mounted on the ESO 3.6-m telescope. During the exposure of the globular cluster, scanning of the nucleus was done with the entrance slit, in order to cover a zone of 6 x 6 arcsec^2, avoiding any problem of sampling which could occur when integrating only over a few bright stars.

2. Numerical cross-correlation

The new software developed for numerical cross-correlation technique (Dubath *et al.* 1990) mimics the photoelectric spectrometer CORAVEL (Baranne *et al.* 1979): it reproduces numerically with registered spectra what is achieved optically online at the telescope with CORAVEL. To take advantage of our experience with CORAVEL, only the spectral domain common to the CORAVEL mask (3600-5200Å) and to the present CASPEC spectra (4400-5200Å) has been used, viz., the interval from 4400 to 5200Å. After normalization of the cross-correlation function of the cluster, in order to have the same depth as the cross-correlation function of the two comparison stars, the projected velocity dispersion in the core of NGC 1978 is derived: σ_p(core)=5.8±1.2 km s^{-1}. A

discussion of the uncertainties in this projected velocity dispersion measurement is given in Dubath *et al.* (1990).

3. The model

King-Michie dynamical models are constructed in an approach identical to that of Gunn and Griffin (1979). To mimic a real cluster, heavy remnants (such as neutron stars), white dwarfs and main sequence stars are distributed into ten different subpopulations, each having the energy-angular momentum (E, J) distribution function $f_i(E, J) \alpha$ [exp($-A_i E$)-1]exp($-\beta J^2$). In the cluster centre, thermal equilibrium is assumed to force A_i to be proportional to the mean mass of the stars in the subpopulation considered. A model is specified by a mass function exponent x, and by four parameters: the scale radius r_c, the scale velocity v_s, the central value of the gravitational potential W_o, and the anisotropy radius r_a.
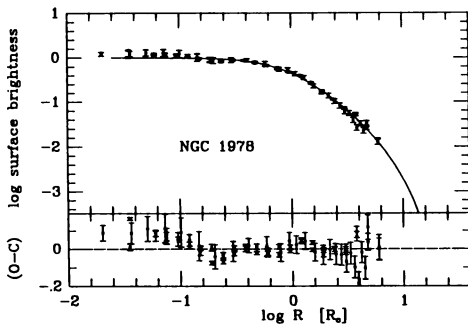
Figure 1. Observed and computed surface brightness profile for an isotropic model with x=1.25 and W_o=8.0. The observed profile is a merger of Mateo (1987) and Meylan and Djorgovski (in prep.) profiles.

4. Results

A grid of models has been calculated for a wide range of values of each parameter. The surface brightness profile lacking star counts in its outer parts and the velocity dispersion profile reduced to its core value do not fully constrain the King-Michie model. Nevertheless, areas in the parameter space are delineated. The mean value of the exponent x of the mass function is $\simeq$ 1.00-1.50, a value close to Salpeter's value of 1.35. Depending on the model, the values obtained for the total mass of the cluster range from 0.36 to 1.44x$10^6 M_\odot$, corresponding to mass-to-light ratios M/L_v ranging from 1.2 to 4.2 (M/L_v)$_\odot$, values typical of galactic globular clusters. These results are consistent with Illingworth's (1973) method which gives M_{tot}=0.51x$10^6 M_\odot$ with M/L_v=2.1.

References

Baranne, A., Mayor, M., Poncet, J.L. (1979), *Vistas in Astronomy* **23**, 279.
Dubath, P., Meylan, G., Mayor, M. (1990), *Astron. Astrophys.* in press.
Gunn, J.E., Griffin, R.F. (1979), *Astron.J.* **84**, 752.
Illingworth, G.D. (1973), PhD Thesis, Australian National University, Australia.
Mateo, M. (1987), PhD Thesis, University of Washington, USA.