A SEARCH FOR POST-COLLAPSE CORES

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ABSTRACT. We report the preliminary results of a surface photometry survey of globular cluster cores. Two new cores with post-collapse morphology have been found, and two possible candidates. The estimated fraction of clusters with this core morphology in the Galaxy is only a few percent. Most clusters do not show a morphology similar to the predictions of the central black hole models.

1. THE SURVEY

The problem of globular cluster core collapse is currently receiving much attention. Recent theoretical developments are described in the reviews by Heggie, Spitzer and Cohn elsewhere in this volume, whereas a review of relevant observations to date is given by King.

We have completed a CCD surface photometry survey of 36 compact globular clusters at Lick Observatory during 1982-1983. Some 190 CCD frames were obtained in a wide red bandpass. This is a very preliminary report; the data reductions are now almost complete, and the full details and further analysis will be presented in the upcoming paper.

The use of a red bandpass is not optimal: discreetness and the small number of red giants (which contribute most of the light) are the principal cause of observational difficulties and errors in this work. The error bars are determined by azimuthal variations of surface brightness in the concentric annular apertures used for photometry. Thus, if there is a positive "bump" in the profile, with large error bars associated with it, it is due to a statistical fluctuation in the spatial distribution of red giants. Some of our surface brightness profiles shown in Fig. 1.

2. THE PRELIMINARY RESULTS

The main scientific goal of this survey was to search for more globular clusters with a post-collapse morphology, following the survey by Djorgovski & King (1984). The characteristic signature of a post-core–

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-collapse (PCC) cluster is a power law surface brightness profile with a slope ~ -1 to -1.2, going all the way into the seeing disk. The King (1966) models are all steeper in the outer parts, and have flat cores. We have found two new PCC clusters, NGC 6642 and NGC 6342, and two possible ones, NGC 6235 and NGC 6717. Our sample also contains the two "classical" PCC clusters, NGC 7078 (M 15) and NGC 7099 (M 30). The statistics of the known PCC clusters so far is given in the Table 1 below.

TABLE 1

Cluster	Best fit pow. slope	Fit range (arcsec)	Bandpass	Reference
NGC 6342	-0.94	2 - 30	Red	This work.
NGC 6624	-1.09	3 - 20	UV	Djorgovski & King (1984)
NGC 6642	-1.11	2 - 30	Red	This work.
NGC 6681 (M 70)	-1.03	3 - 20	UV	Djorgovski & King (1984)
NGC 7078 (M 15)	-0.91	3 - 30	Red	This work. See also Newell & O'Neill (1978)
NGC 7099 (M 30)	-0.85 -1.13	3 - 30 3 - 20	Red UV	This work. Djorgovski & King (1984)

The estimated errors for the power law slopes are ~ 0.05 . Note that the distribution of slopes is in the range predicted by the PCC models (approaching the singular isothermal sphere, with the slope -1), and that the central black hole model prediction (slope -0.75) seems to be ruled out.

There are also four more possible PCC clusters, viz. NGC 6235 and NGC 6717 (this work), NGC 1851 (Bahcall, Lasker & Wamsteker 1977) and NGC 6397 (Auriere 1982). It should be noted that the surveys so far have been biased in the favor of finding possible PCC clusters, and we estimate that the fraction of clusters with PCC morphology in the Galaxy is only several percent. This may be in conflict with the timing estimates of what now emerges as a "standard model" - viz., many more should be found. One possibility is that the effects of the core collapse may be hidden in the distribution of dark stellar remnants (Goodman 1984). If this is true, then more complete statistics of PCC clusters can teach us something about the IMF variations among the globulars. Note in this respect the models of Larson (1984). However, this apparent discrepancy may also be an indication of a defficiency in our understanding of the PCC phenomenon. Another interesting fact is that several of the "established" and possible PCC clusters are very sparse, e.g., NGC 6642, NGC 6235 or NGC 6717. This may be additional evidence

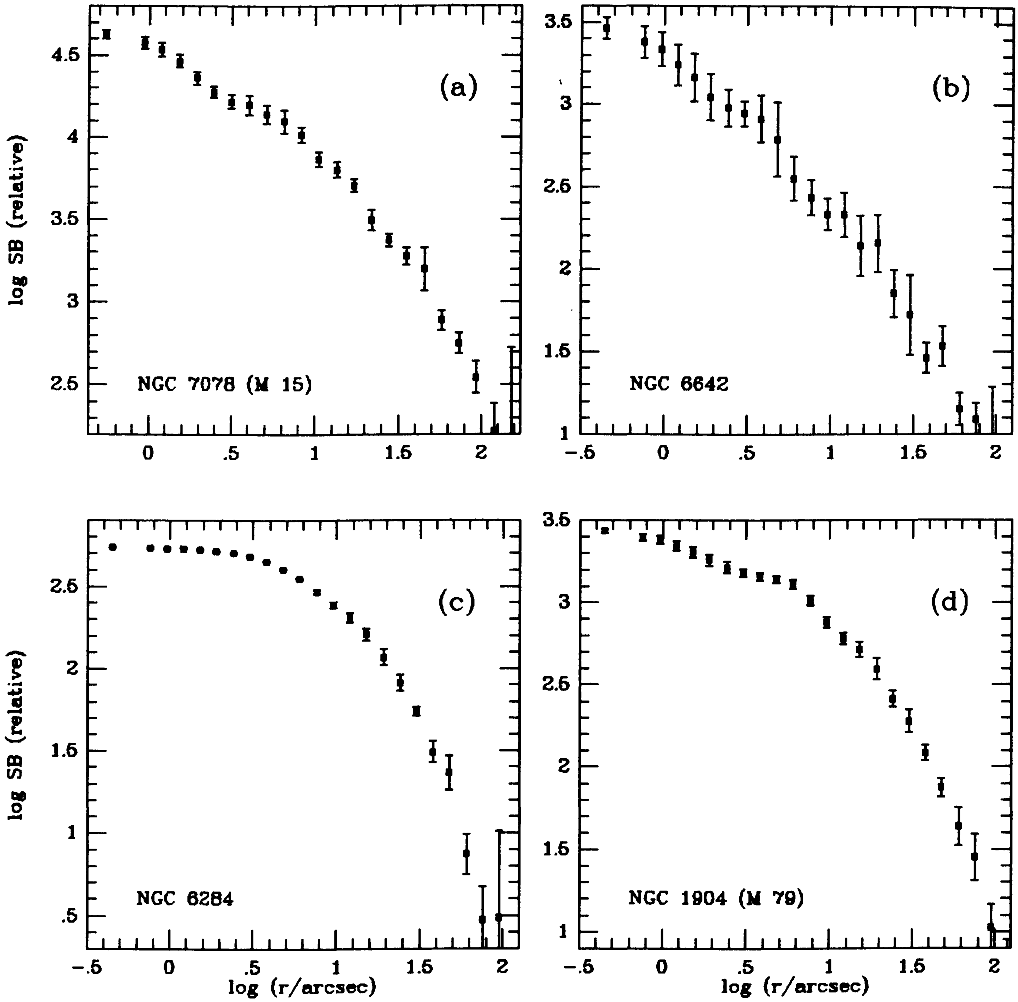

FIGURE 1. Selected surface brightness profiles from our CCD survey. (a) M 15 is the classical example of PCC morphology. (b) NGC 6642 is one of the newly found PCC clusters. (c) NGC 6284 is an example of a highly concentrated, but purely King model-like cluster. (d) M 79 is one of our "strange" clusters, which exhibit a shoulder in their light profiles, and cannot be fitted by either a King model or a simple power law.

for their advanced state of dynamical evolution. The central binary which stops the collapse and stabilizes the cluster also serves as a source of energy which accelerates the dissolution of the cluster.

Some clusters, of which NGC 1904 (M 79) may be the best example in our survey, exhibit a prominent shoulder in their suface brightness profiles, which appears to be statistically significant. They cannot be fitted either by King models, or seeing-convolved power laws. However, they may be fitted with a King model with a seeing-smeared shallow power law cone added in the center. The only model which predicted a profile similar to this is the central black hole model of Bahcall & Wolf (1976). The reality of such features should be confirmed with the data taken in the UV, and in better seeing.

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REFERENCES:

Auriere, M. 1982, Astron. Astrophys. 109, 301.

Bahcall, J. N. and Wolf, R. A. 1977, Astrophys. J. 216, 883.

Bahcall, N. A., Lasker, B. M. and Wamsteker, W. 1977, Astrophys. J. (Lett.) 213, L105.

Djorgovski, S. and King, I. R. 1984, Astrophys. J. (Lett.) 277, L49.

Goodman, J. 1984, Astrophys. J. 280, 298.

King, I. R. 1966, Astron. J. 71, 64.

Larson, R. 1984, M.N.R.A.S. (in press).

Newell, E. B. and O'Neill, E. J. 1978, Astrophys. J. Suppl. 37, 27.