

## WASHINGTON CCD PHOTOMETRY OF THE BULGE GLOBULAR CLUSTER NGC 6624

SUNG-CHUL YANG,<sup>1</sup> MYOUNG GYOON LEE<sup>1</sup>, AND DOUG GEISLER<sup>2</sup>  
<sup>1</sup>Department of astronomy, Seoul National University, Seoul, 151-742, Korea  
<sup>2</sup>NOAO/KPNO, U.S.A.

### I. INTRODUCTION

About 150 globular clusters are known in the Galaxy. The metal rich population ( $[\text{Fe}/\text{H}]_{\text{c}} \sim -0.8$  dex) is concentrically distributed at the Galactic plane and the Galactic bulge. The metal poor population ( $[\text{Fe}/\text{H}]_{\text{c}} > -0.8$  dex) is spherically distributed at the Galactic halo. Among the globular cluster populations, the metal rich globular clusters are important for understanding their relationship to other disk and bulge populations. However, it is difficult to study the metal rich clusters, because most metal rich clusters suffer from large interstellar reddening and field star contaminations are serious. At the moment metallicities are poorly known for many of the metal rich clusters, although accurate estimate of metallicity is necessary for the age determination using main-sequence isochrone fitting. We have performed Washington CCD Photometry of NGC 6624, one of the bulge globular clusters, in order to obtain more accurate metallicity of the cluster. Washington system is a broad band photometric system developed to obtain accurate metallicities for G, K giants (Canterna 1976). The integrated type of NGC 6624 is G5 indicating high metallicity. Also, NGC 6624 is well known for the strong X-ray source and two millisecond pulsars in its central region.

### II. RESULTS

#### (a) The Color-Magnitude Diagram

The Color-Magnitude Diagram for this cluster reaches down to almost main-sequence turnoff and shows clump, red horizontal branch and well defined branch which has a gentle slope. The color-magnitude diagram of nearby comparison field shows the bulge population and the distinctively bluer field population which is superimposed on the red horizontal branch of the cluster (Fig 1). Previous estimates of the interstellar reddening for NGC 6624 are in the range  $0.25 \leq E(B-V) \leq 0.28$ . We adopt  $E(B-V) = 0.26 \pm 0.01$ , the mean value of the previous results.

#### (b) Metallicity

We have estimated the metallicities of the cluster giants using the calibration described in Geisler (1991). From the two-color diagrams, the resultant mean metallicity is  $[\text{Fe}/\text{H}] = -0.56 \pm 0.14$  dex for NGC 6624 (Fig 2).

#### (c) Distance

We have determined the distance of NGC 6624 using the HB brightness of NGC 6624. The observed mean

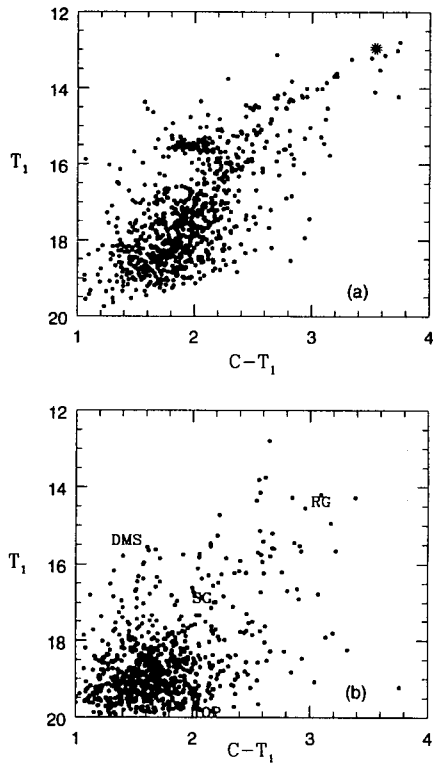
HB magnitude  $T_1(\text{HB}) = 15.51 \pm 0.10$  ( $V(\text{HB}) = 16.09 \pm 0.10$ ) is in good agreement with the result of Sarajedini & Norris (1994),  $V(\text{HB}) = 16.11$  and Liller & Carney (1978),  $V(\text{HB}) = 16.06$ . We adopt the mean value of above three studies as the mean HB magnitude of NGC 6624,  $\langle V(\text{HB}) \rangle = 16.09 \pm 0.03$ . The absolute HB magnitude is determined from the calibration  $M_V(\text{RR}) = 0.82 + 0.17[\text{Fe}/\text{H}]$  (Y.W. Lee et al 1990),  $M_V(\text{RR}) = 0.72$ . Assuming  $A_V = 3.2 E(B-V)$ , the distance modulus of NGC 6624 is  $(m - M)_0 = 14.51 \pm 0.12$  ( $d = 8.09 \pm 0.37$  kpc) and the galactocentric distance  $R_{GC} = 1.27$  kpc. The magnitude of NGC 6624 are consistent with the characteristics of the  $[\text{Fe}/\text{H}] - R_{GC}$  relations of the globular clusters in our Galaxy.

#### (d) Age

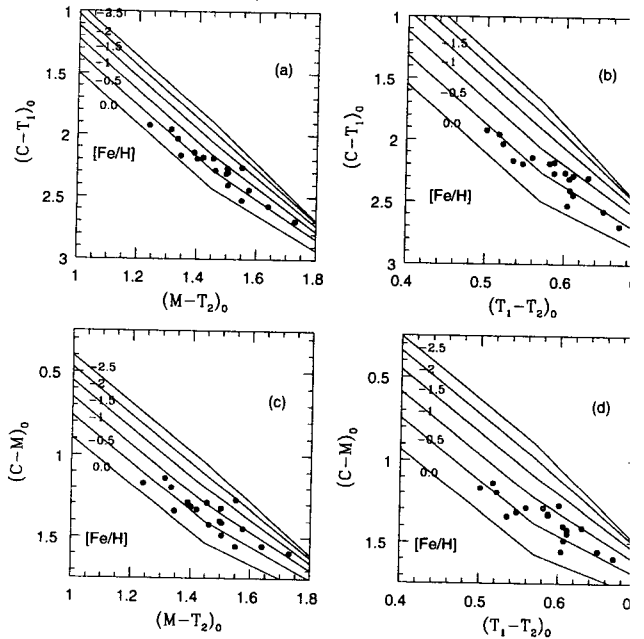
Fitting the isochrone for  $[\text{Fe}/\text{H}] = -0.56$  dex, which obtained as above, we estimate the age of NGC 6624 using the HSTBV photometry given by Sosin & King (1995), obtaining a value of  $t = 13 \pm 2$  Gyrs. This value is much smaller than the estimate by Richtler et al (1994), 18 Gyr. The difference between these two estimates appears to be primarily due to the different metallicity. The age of 13 Gyr we derived here, is similar to those of other bulge globular clusters (NGC 6553 Ortolani et al 1990; NGC 5927 Demarque & Lee 1992)

### REFERENCES

- Canterna, R. 1976, AJ, 81, 228  
Demarque, P. and Lee, Y. W. 1992, A&A, 265, 40  
Geisler, D. 1991, AJ, 102, 1836  
Lee, Y. W., Demarque, P. and Zinn, R. 1990, ApJ, 350, 155  
Liller, M. H., Carney, B. and Bica, E. 1990, A&A, 236, 362  
Ortolani, S., Barbuy, B. and Sica, E. 1990, A&A, 236, 362  
Richtler, T., Grebel, E. K. and Seggewiss, W. 1994, A&A, 290, 412  
Sarajedini, A. and Norris, J. E. 1994, ApJS, 93, 161  
Sosin, C. and King, I. R. 1995, AJ, 109, 639



**Fig. 1.**— (a) Color-Magnitude diagram of NGC 6624 showing alumpy, red horizontal branch indicative metal rich clusters. The asterisk represents a variable star candidate. (b) Color-Magnitude diagram for the nearby comparison field (SW17) showing the characteristics of the bulge populations, indicated as RG (red giants), SG (sub giants) and MSTOP (main sequence turn off point); location of disk stars is DMS (disk main sequence)



**Fig. 2.**— Two-color diagrams for selected giants in NGC 6624. Solid lines represent isoabundance relations for metallicities  $[Fe/H] = 0.0, -0.5, -1.0, -1.5, -2.0$  and  $-2.5$ .