Deep Intermediate-Band CCD Photometry of Globular Cluster M13 and Its Stellar Population

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Abstract

We present CCD photometry, in 13 intermediate bands covering from 450-1000 nm, on the galactic globular cluster M13 (NGC 6205). The data — effectively low-resolution spectroscopy — were taken by the 60/90 cm Schmidt telescope, with a 1-degree field, as part of the Beijing-Arizona-Taipei-Connecticut (BATC) color survey. The spectral energy distribution of individual stars in the outer region of the cluster provides information of their membership and of the evolutionary status of the cluster. We will also derive surface color gradient of the unresolved core, from which stellar population and the dynamical status of the cluster are inferred.

The Galactic Globular Cluster M13

- **M13 (NGC6205,** $\alpha = 16^{\rm h}39^{\rm m}54^{\rm s}$; $\delta = 36°33'.2$**), one of the biggest and prominent galactic globular clusters in the northern hemisphere, discovered by Edmond Halley in 1714.**
- **Distance to the sun:** $7.9\ kpc$
- **Metallicity** $[Fe/H] = -1.54$**, a low metallicity GC**
- **Core radius:** $0.78'$
- **Tidal radius:** $25.18' \sim\ 1\ pc$ **(Harris, 1996)**
- **The surface brightness profile is well fitted by King model.**

BATC Color Survey

The Beijing-Arizona-Taipei-Connecticut (BATC) Color Survey of the Sky (`http://vega.bac.pku.edu.cn/batc/title/index.htm`) **(Fan et al., 1996) is a large field and multi-color photometry project. The main goal of BATC is to obtain the SED of every celestial object in the program fields and to classify special objects such as QSOs and active galaxies based on SEDs with efficiency.**
The BATC filter system including 15 intermediate band filters is designed to avoid the contaminations of sky background emissions. The transmission curve of each filter is shown in Fig.1.

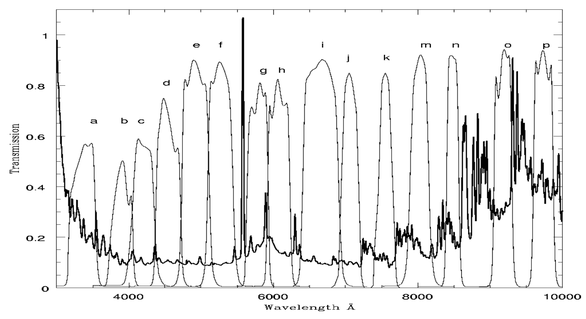


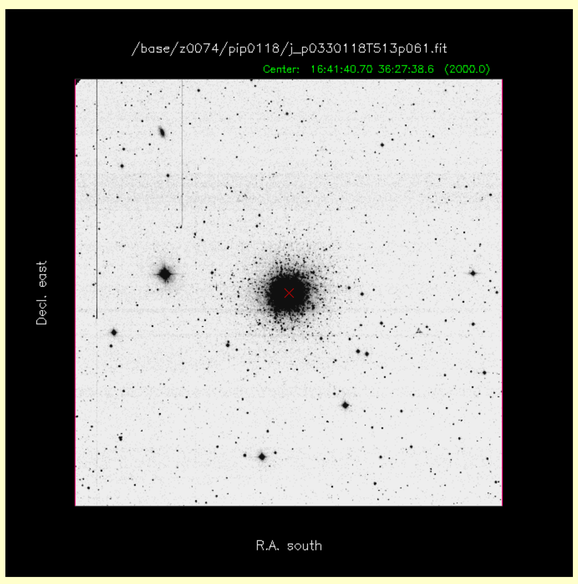
Fig.1 BATC filter system.

The BATC observations on M13 (see Table 1 for details) are performed with the 60/90 cm f/3 Schmidt telescope during 1995 to 2002. The telescope is equipped with a Ford 2048×2048 **CCD which gives a** $58' \times 58'$ **field of view (plate scale=**$1.67''$**/pixel).**

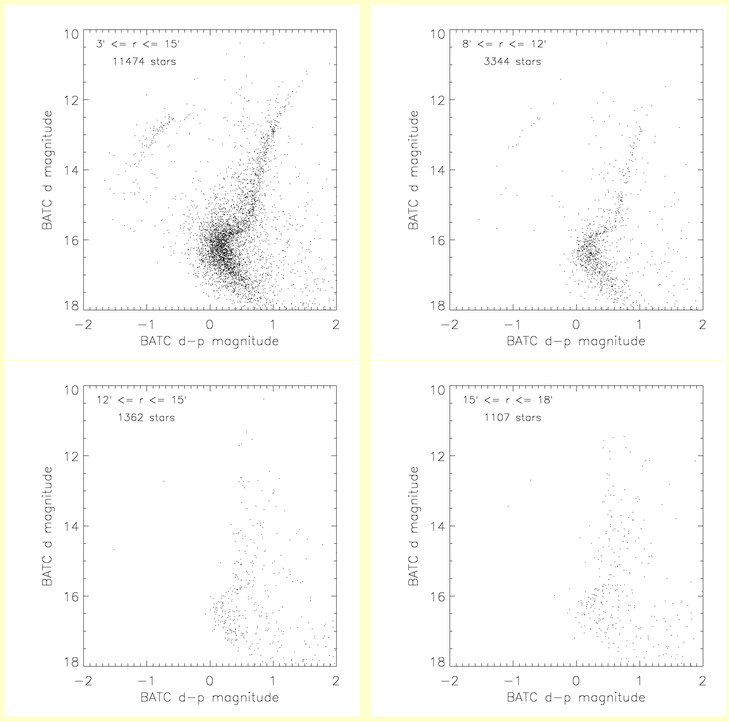
Table 1: Observational log of M13

No.	Filter	Wavel.(Å)	Exp.(s)	# stars
3	c	4193.5	300	1701
4	d	4540.0	15601	13174
5	e	4925.0	13511	11176
6	f	5266.8	7800	12450
7	g	5789.9	1800	11545
8	h	6073.9	10241	15197
9	i	6655.9	3000	18860
10	j	7057.4	4202	11895
11	k	7546.3	8400	13985
12	m	8023.2	10800	15684
13	n	8484.3	11400	14846
14	o	9182.2	15600	13029
15	p	9738.5	16800	10782

M13 in BATC p ($9738\mathring{A}$**) band.**

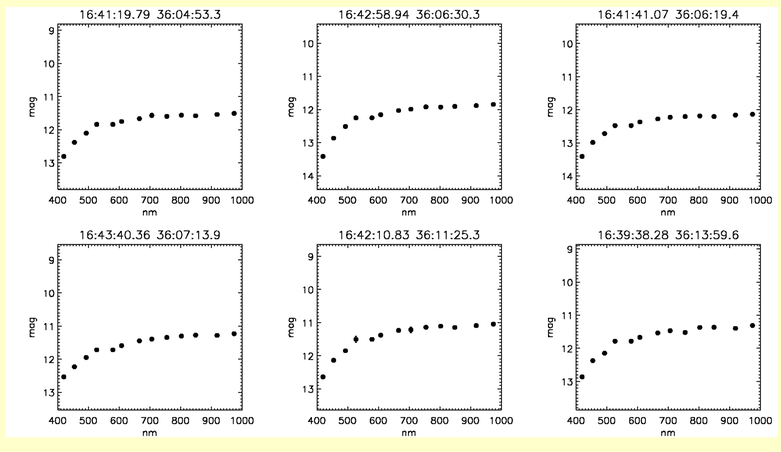


Color-Magnitude Diagram (CMD) & Stellar SEDs

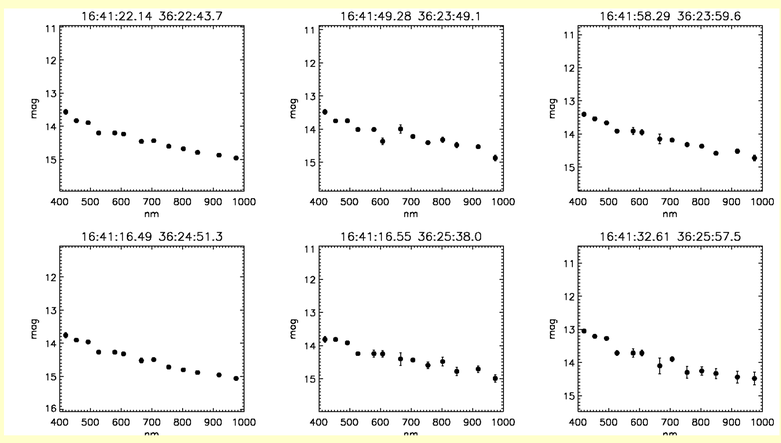


The BATC CMD is deep enough to allow for stellar population analysis of post-main sequence and some main sequence stars.

- **Red Giant Branch Stars (RGBs)**



- **Blue Horizontal Branch Stars (BHBs)**



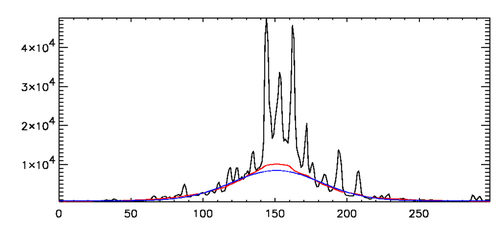
The BATC photometry provides unique information of the spectral type and existence of peculiar spectral lines of each object in the field, more so than a CMD.

Data Reduction and Calibration

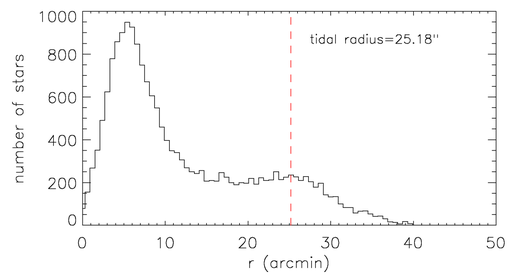
- **The coordinates and instrumental magnitudes of stars are resolved with BATC Pipeline II (a customized DAOPHOT package).**
- **BATC magnitudes (Zhou et al., 2002) are defined on the Oke-Gunn (1983) system as** AB_ν **magnitudes. The AB magnitude relates to physical energy flux directly.**
- **After photometric calibration, we obtained the SED of resolved objects.**

Stellar Population and Color Gradient

Color gradient has been seen almost exclusively in post-core-collapse clusters (in M30, M15 and 47 Tuc, Piotto et al. (1988), Burgarella et al. (1996), Guhathakurta et al. (1998)) which show a power law cusp in the core of their surface brightness profiles. So far there has been only one prominent case of color gradient detected in a King-type globular cluster, NGC 7089 (Sohn et al., 1996). The analysis of individual stellar SEDs in the outer region provide us the information of stellar population so does the color gradient, and after smoothing the extended core of M13 with a proper running-box median filter in order to mask the giant stars, we would exploit if such color gradient (hence stellar population or chemical abundance distribution) exists in M13.



A Halo in M13???



In the histogram of angular distance from an object detected in i band to the center of M13, we can depict an enhancement in star numbers around the tidal radius. The genuineness of the peak or its possible causes still need further examinations and explanations.

References

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