Radial Stellar Population Gradients in the Galactic Globular Cluster 47 Tucanae

Richard de Grijs,[1] Chengyuan Li[1,2] & Licai Deng[2]

1, Kavli Institute for Astronomy and Astrophysics, Peking University, Beijing, China
2, Key Laboratory for Optical Astronomy, National Astronomical Observatories, Chinese Academy of Sciences, Beijing, China

We present a deep near-infrared colour–magnitude diagram of the Galactic globular cluster 47 Tucanae (47 Tuc), obtained with the Visible and Infrared Survey Telescope for Astronomy (*VISTA*) as part of the *VISTA* near-infrared *Y, J,* K_s survey of the Magellanic System (VMC). The cluster stars comprising both the subgiant and red-giant branches exhibit apparent, continuous variations in colour–magnitude space as a function of radius. Subgiant-branch stars at larger radii are systematically brighter than their counterparts closer to the cluster core; similarly, red-giant-branch stars in the cluster's periphery are bluer than their more centrally located cousins. The observations can very well be described by adopting an age spread of ~0.5 Gyr as well as radial gradients in both the cluster's helium abundance (Y) and metallicity (*Z*), which change gradually from Y = 0.28, *Z* = 0.005 in the cluster core to Y = 0.25, *Z* = 0.003 in its periphery. We conclude that the cluster's inner regions host a significant fraction of second-generation stars, which decreases with increasing radius; the stellar population in the 47 Tuc periphery is well approximated by a simple stellar population.

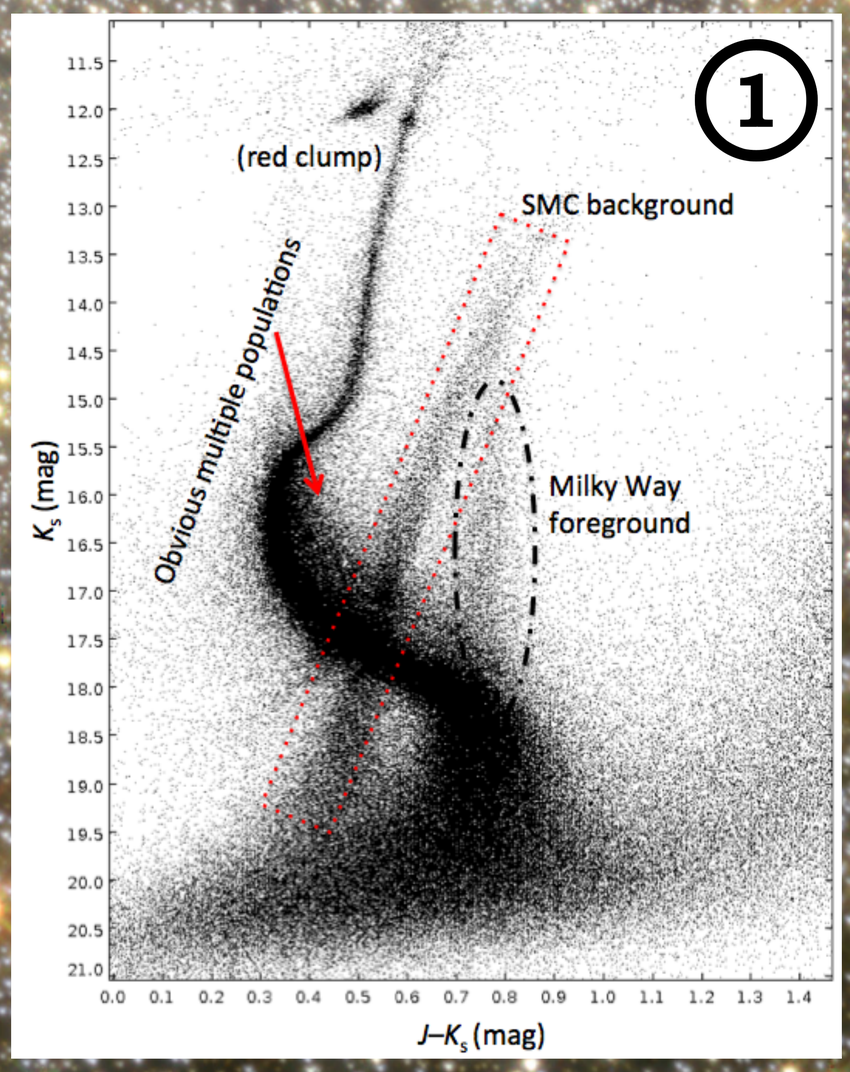


Fig. 1: Extremely rich stellar population data *(left: "raw" data)*

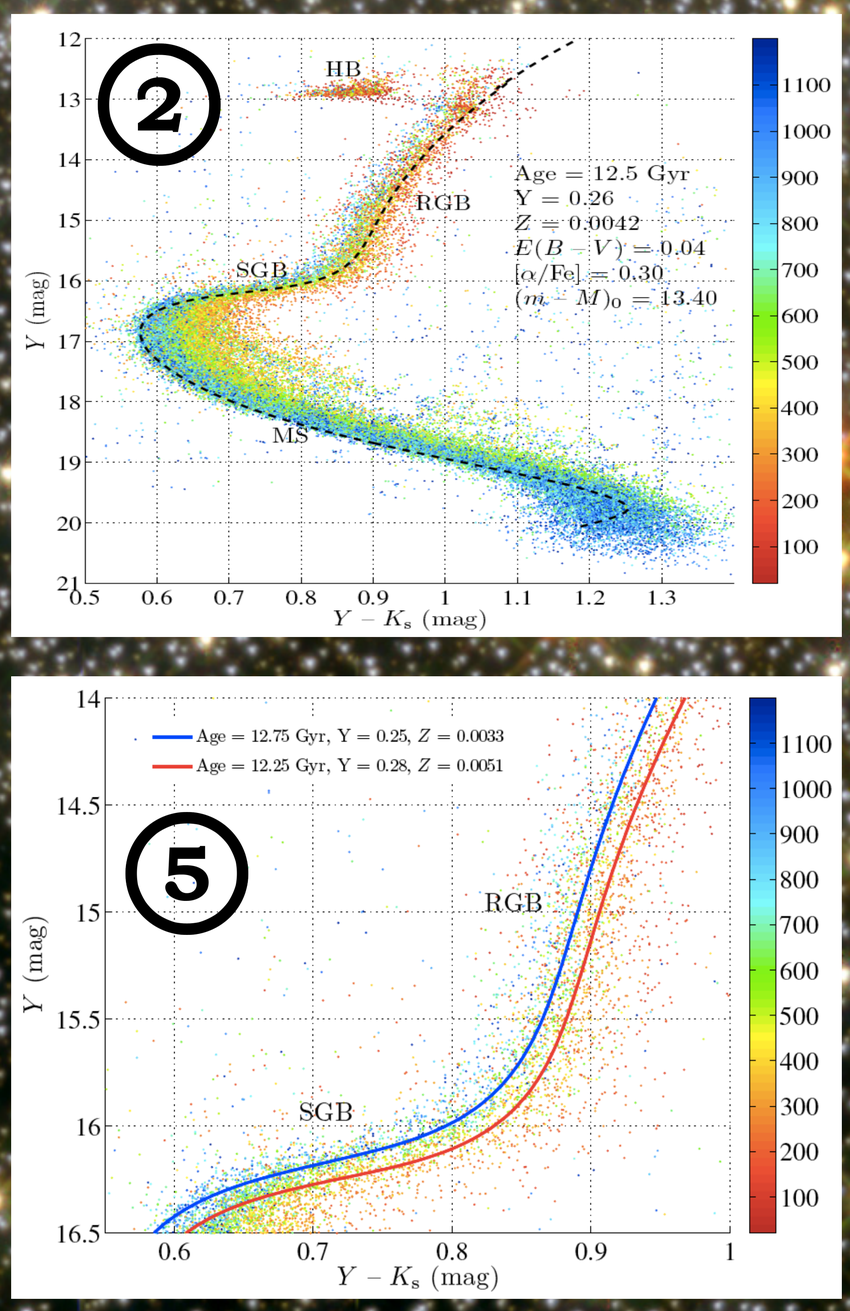
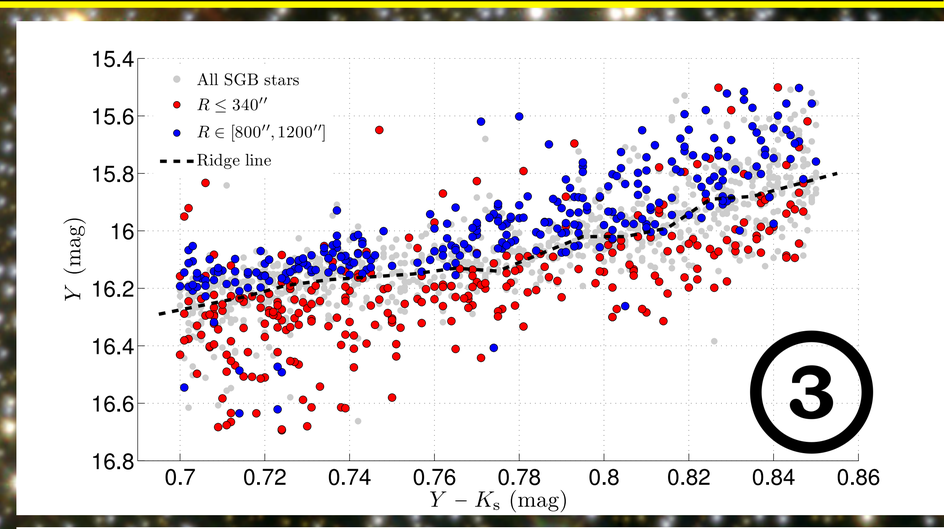


Fig. 2: (left) "Cleaned" colour–magnitude diagram. A clear trend in stellar population composition is seen as a function of radius *(Colour scale: distance from the cluster centre in arcsec; dashed line: best-fitting isochrone for parameters as indicated)*

Figs 3, 4: (right) Both the subgiant and red-giant branches (SGB, RGB) exhibit a radial dependence of their stellar content



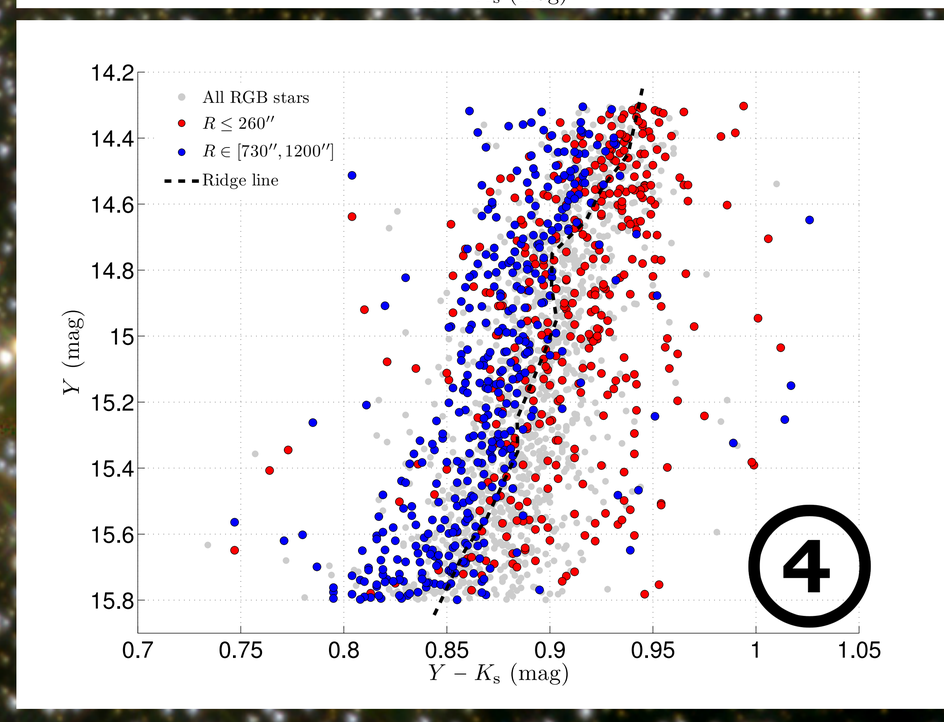
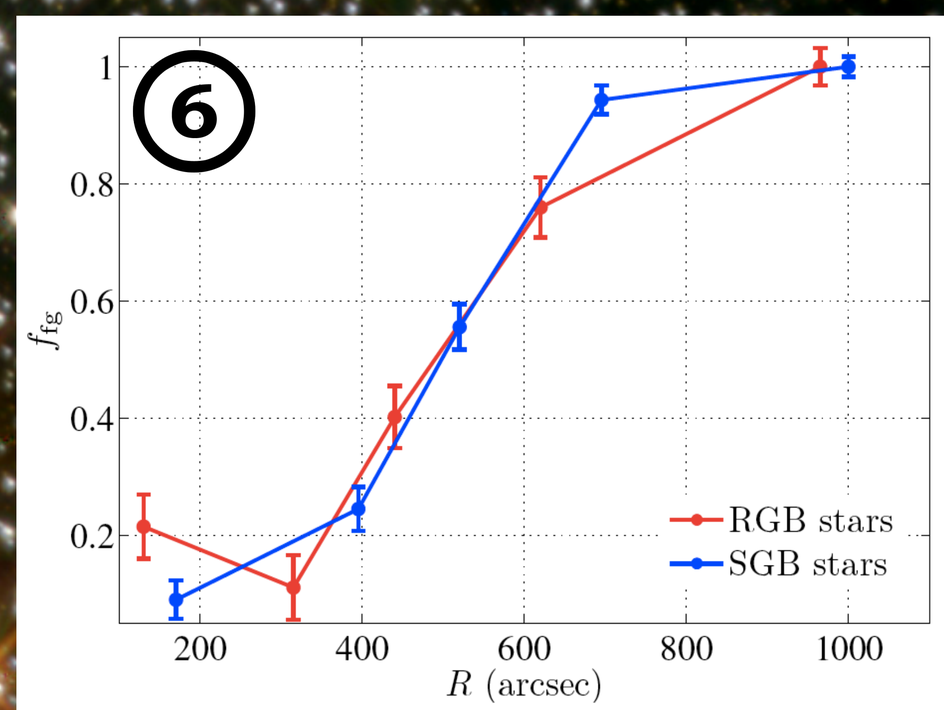


Fig. 5: (left) For simplicity, we can represent the 47 Tuc stellar population by two distinct populations *(see figure legend)*

Fig. 6: (right) The fraction of first-generation stars (blue isochrone in ***Fig. 5***) increases steeply from the cluster's core to its periphery



The VMC Survey

The near-infrared *YJK*$_s$ *VISTA* survey of the Magellanic Clouds system (VMC; ***Cioni et al. 2011, A&A, 527, A116***) is the most sensitive near-infrared survey of the Magellanic system ever performed. Its photometric depth allows the derivation of the star-formation history with unprecedented quality thanks to the uniform and high-quality photometry reaching stars at the main-sequence turnoff across the entire area and with a reduced sensitivity to differential extinction. We have collected about 60% of the observations; VMC data are processed and analysed regularly. The third pubilc data release, including five tiles of the Large Magellanic Cloud and two tiles of the Small Magellanic Cloud, is now available.

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***For more details, see*:**
Li, C., de Grijs, R., & Deng, L., et al. 2014, ApJ, 790, 35