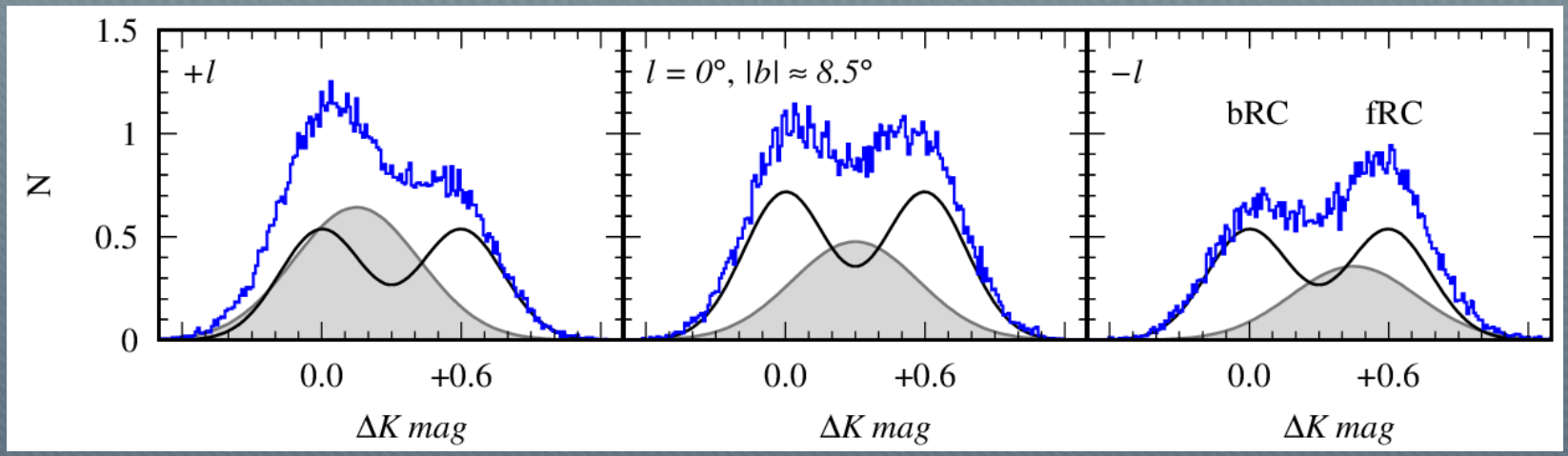
New Insight on the Origin of Double Red Clump in the Milky Way Bulge

- The observed dRC feature can be reproduced by our models in relatively large parameter space: Fine-tuning (for age, [Fe/H]) is not required, if ΔY (bRC − fRC) > ~0.1
- Our models can also reproduce the Longitude dependence of the RC luminosity function at b ≈ − 8.5° by a combination of the classical bulge and bar populations
  - geometric & projection effects



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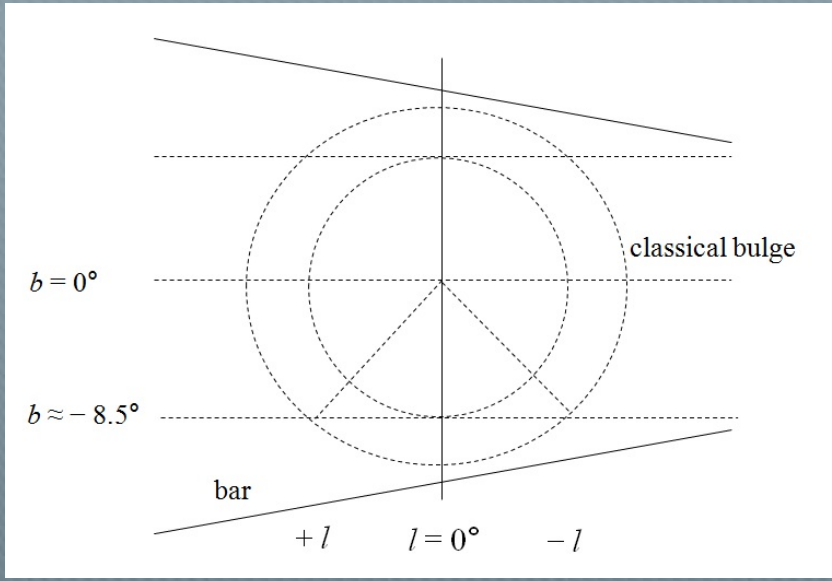
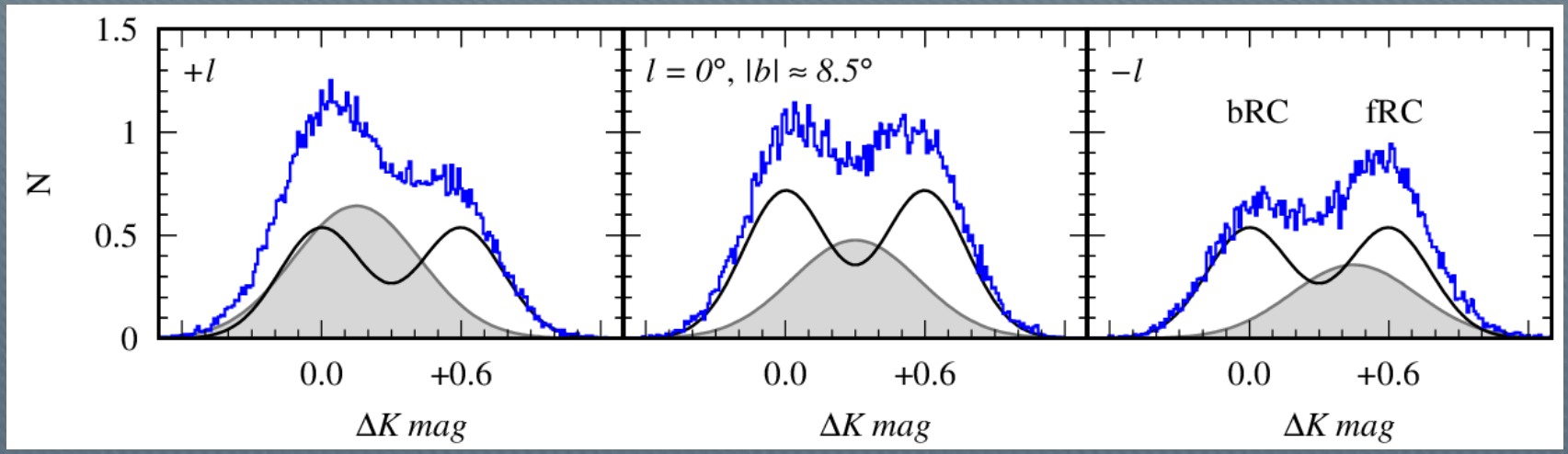
Abstract

- The double red clump (RC) observed in the Galactic bulge is regarded as evidence for an X-shaped structure (ex., McWilliam & Zoccalli 2010). In our recent study, however, we have suggested an alternative interpretation that the double RC is originated from multiple stellar populations (Lee, Joo, & Chung 2015). While a more recent study has shown the presence of the faint X-shaped structure in the Milky Way bulge (Ness & Lang 2015), it is still not clear whether the double RC is mostly due to the X-shaped structure or the multiple populations. Here we construct the population models in a large parameter space to investigate the effects of metallicity, age, and helium abundance on the double RC feature. Our models show that the magnitude difference between the two RCs is mostly affected by the difference in helium abundance between the second- (G2) and the first-generation (G1) stars, while the color of RC stars is mainly affected by metallicity. It also indicated that the double RC feature is relatively little affected by the variation in age. We show that our models can also reproduce the longitude dependence of the RC luminosity function, at $b \approx -8.5°$ (see Gonzalez et al. 2015).

Longitude dependence of the RC LF at b ~ − 8.5°

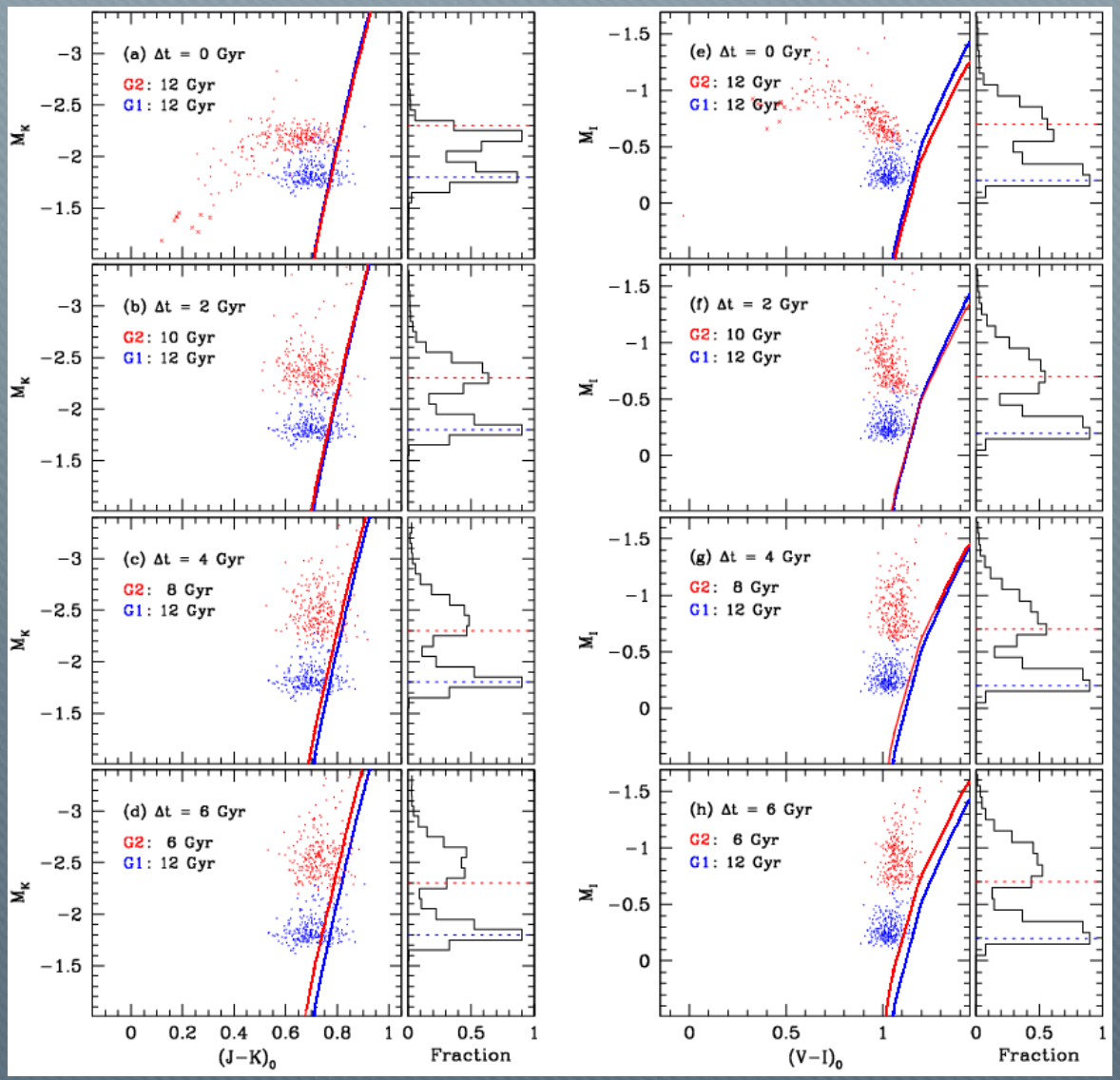


- Schematic illustration for the geometric & projection effects in the bulge field (see Wegg+15; Gonzalez+13)
- Schematic diagrams for the longitude dependence of the double RC feature (blue histograms) at |b| ≈ 8.5° by a combination of the CB (bimodal distribution) and bar (unimodal grey distribution) components (See Lee, Joo, & Chung 2015; Gonzalez+2015)



Joo, Lee, & Chung, to be submitted soon

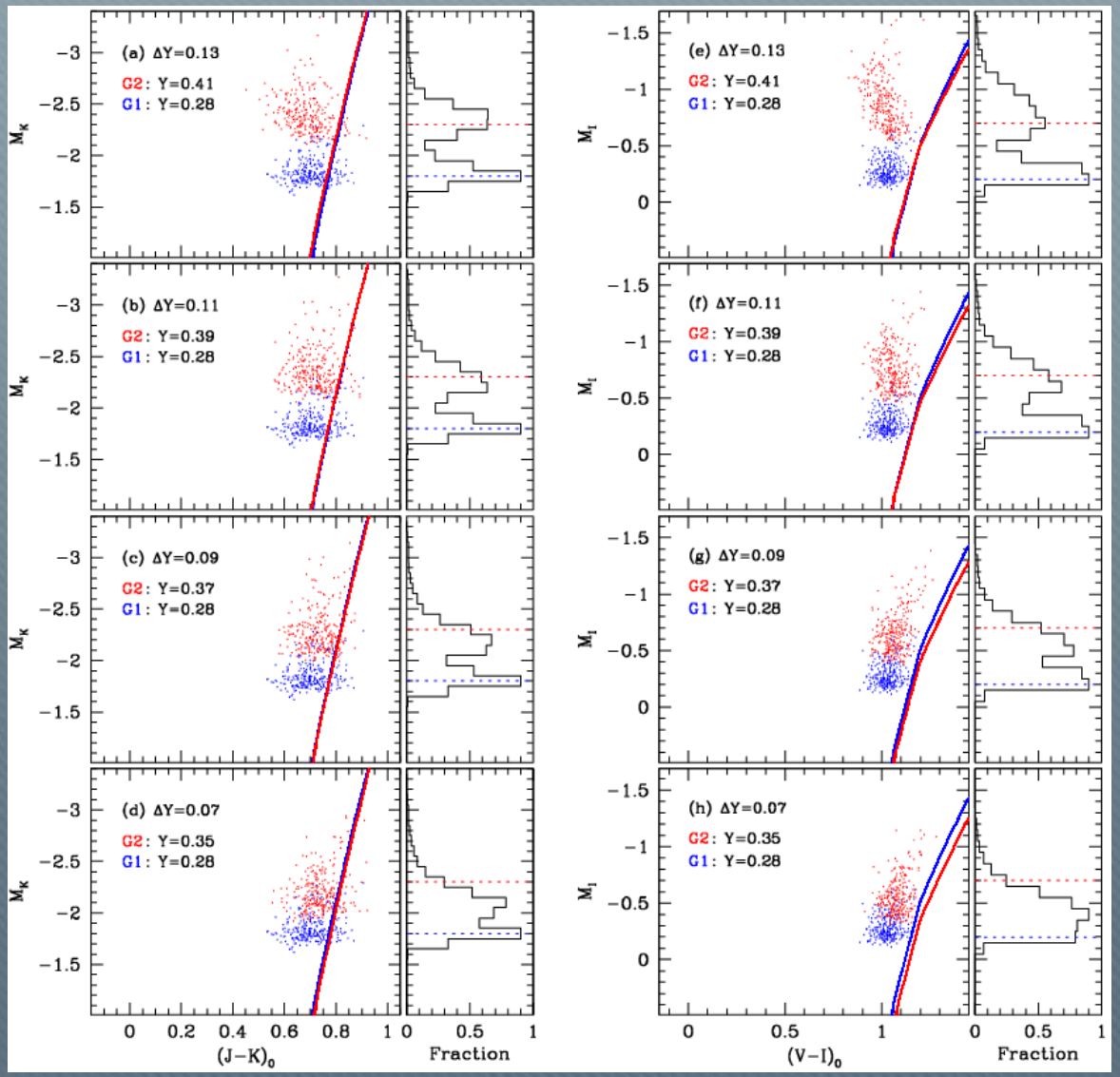
Effect of age variation on G2 (bRC)



- (J-K,K) & (V-I,I) CMDs and luminosity functions from our models
- Age of G2 (bright RC) changes from t =12 to 6 Gyr
- Metallicity & helium abundance of G2 are fixed as [Fe/H] = +0.1 & Y=0.406
- G1 (faint RC) is fixed to be t = 12 Gyr, [Fe/H] = −0.1, & $\Delta Y/\Delta Z = 2.0$

Joo, Lee, & Chung, to be submitted soon

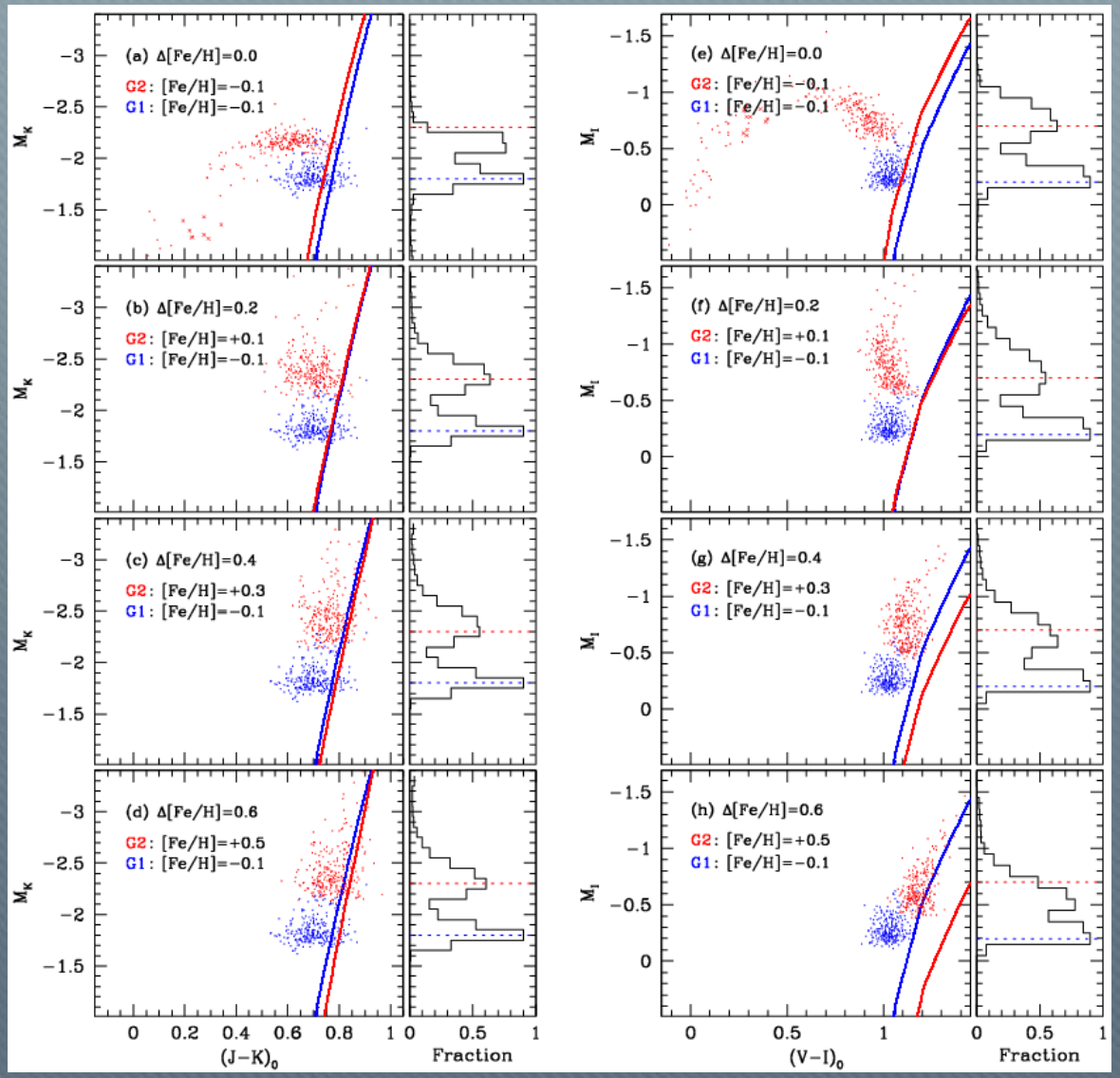
Effect of helium abundance variation on G2 (bRC)



- Helium abundance of G2 changes from Y = 0.41 to 0.35
- Age & metallicity of G2 are fixed as t=10 Gyr & [Fe/H]=+0.1
- G1 (faint RC) is fixed to be t = 12 Gyr, [Fe/H] = −0.1, & $\Delta Y/\Delta Z = 2.0$

Joo, Lee, & Chung, to be submitted soon

Effect of metallicity variation on G2 (bRC)



- Metallicity of G2 changes from [Fe/H] = −0.1 to +0.5 dex
- Age & helium abundance of G2 are fixed as t=10 Gyr & Y= 0.406
- G1 (faint RC) is fixed to be t = 12 Gyr, [Fe/H] = −0.1, & $\Delta Y/\Delta Z = 2.0$

Joo, Lee, & Chung, to be submitted soon