

# The double red clump of the Milky Way bulge has nothing to do with an X-shaped structure!

Young-Wook Lee<sup>1</sup>, Sohee Jang<sup>1</sup>, Jaeyeon Kim<sup>1</sup>,  
Daniel Han<sup>1</sup>, Chul Chung<sup>1</sup> and Seok-Joo Joo<sup>2</sup>

<sup>1</sup>Center for Galaxy Evolution Research & Department of Astronomy,  
Yonsei University, Seoul, Korea

<sup>2</sup>Korea Astronomy and Space Science Institute, Daejeon, Korea  
email: ywlee2@yonsei.ac.kr

Because ...

1. The double red clump (RC) observed in high latitude field of the Milky Way bulge (McWilliam & Zoccali 2010; Nataf *et al.* 2010) is another manifestation of helium-enhanced multiple stellar population phenomenon (Lee *et al.* 2015; Joo *et al.* 2017).

2. In the metal-poor regime of the bulge, the same phenomenon is observed as two sequences of RR Lyrae stars (Pietrukowicz *et al.* 2015) on the period-amplitude diagram (Lee & Jang 2016; Jang & Lee 2015).

3. The required helium enhancement ( $\Delta Y/\Delta Z = 6$ ) for the second generation stars is naturally predicted by chemical evolution models (see Kim & Lee, this volume).

4. The observed spread in [Na/Fe] among bulge RGB stars is 2-3 times larger than that of the disk (bar) population, and is consistent with our chemical evolution models (see Kim & Lee, this volume).

5. The claimed X-shaped structure from WISE residual map (Ness & Lang 2016) is most likely an artifact or exaggeration. Even if it is real, the stellar density in the faint X-shaped structure is way too low to be observed as the double RC (see Han & Lee, this volume).

6. The observed difference in I magnitude between the RR Lyrae stars and the RC ( $\sim 0.55$  mag) is consistent with our multiple population models.

7. There is also no evidence for the X-shaped structure from RR Lyrae stars, main sequence stars & Mira variables (Pietrukowicz *et al.* 2015; López-Corredoira 2016, 2017).

## References

- Jang, S. & Lee, Y.-W. 2015, *ApJS*, 218, 31  
Joo, S.-J., Lee, Y.-W., & Chung, C. 2017, *ApJ*, 840, 98  
Lee, Y. W., Joo, S. J., & Chung, C. 2015, *MNRAS*, 453, 3906  
Lee, Y.-W. & Jang, S. 2016, *ApJ*, 833, 236  
López-Corredoira, M. 2016, *A&A*, 593, A66  
López-Corredoira, M. 2017, *ApJ*, 836, 218  
McWilliam, A. & Zoccali, M. 2010, *ApJ*, 724, 1491  
Nataf, D. M., Udalski, A., Gould, A., Fouqué, P., & Stanek, K. Z. 2010, *ApJ*, 721, L28  
Ness, M. & Lang, D. 2016, *AJ*, 152, 14  
Pietrukowicz, P., Kozłowski, S., Skowron, J., *et al.* 2015, *ApJ*, 811, 113