On the claimed X-shaped structure in the Milky Way bulge

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Abstract. A number of recent studies have claimed that the double red clump observed in the Milky Way bulge is a consequence of an X-shaped structure. In particular, Ness & Lang (2016) report a direct detection of a faint X-shaped structure in the bulge from the residual map of the Wide-Field Infrared Survey Explorer (WISE) image. Here we show, however, that their result is seriously affected by a bulge model subtracted from the original image. When a boxy bulge model is subtracted, instead of a simple exponential bulge model as has been done by Ness & Lang, we find that most of the X-shaped structure in the residuals disappears. Furthermore, even if real, the stellar density in the claimed X-shaped structure is way too low to be observed as a strong double red clump (dRC) at $l = 0°$.

Keywords. Galaxy: bulge - Galaxy: structure

Recently, Ness & Lang (2016) report that a faint X-shaped structure appears in the WISE image of the Milky Way bulge. They claim that the structure is revealed more clearly in the residual map which is a simple exponential model subtracted from the original image. However, as illustrated in Fig. 1, an artificial X-shaped structure remains in the residual map when an ellipsoidal bulge model is subtracted from a boxy bulge model. It is well-known that the Milky Way has a boxy bulge (c.f., Dwek *et al.* 1995; López-Corredoira *et al.* 2005). This has motivated us to investigate in more detail whether the X-shape in their results is affected by a model subtracted from the original image (see Fig. 2).
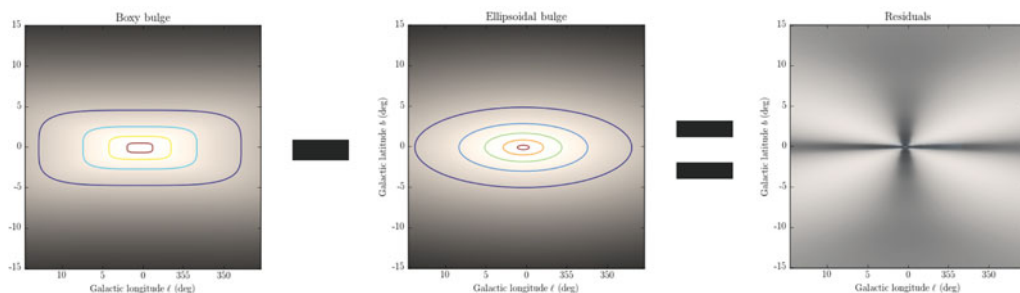

Figure 1. Formation of an artificial X-shaped structure. When an ellipsoidal bulge model (middle) is subtracted from a boxy bulge model (left), an artificial X-shaped structure remains in residuals (right).

Moreover, even if a faint X-shaped structure is real, it appears to have little to do with the double red clump phenomenon. Our synthetic population models at $b = -8°$ using the metallicity distribution function and density map from Zoccali *et al.* (2017) show that the stellar density in the X-shaped structure is way too low to be observed as strong dRC. For our models, we assume that the metal-rich/poor subpopulations can be
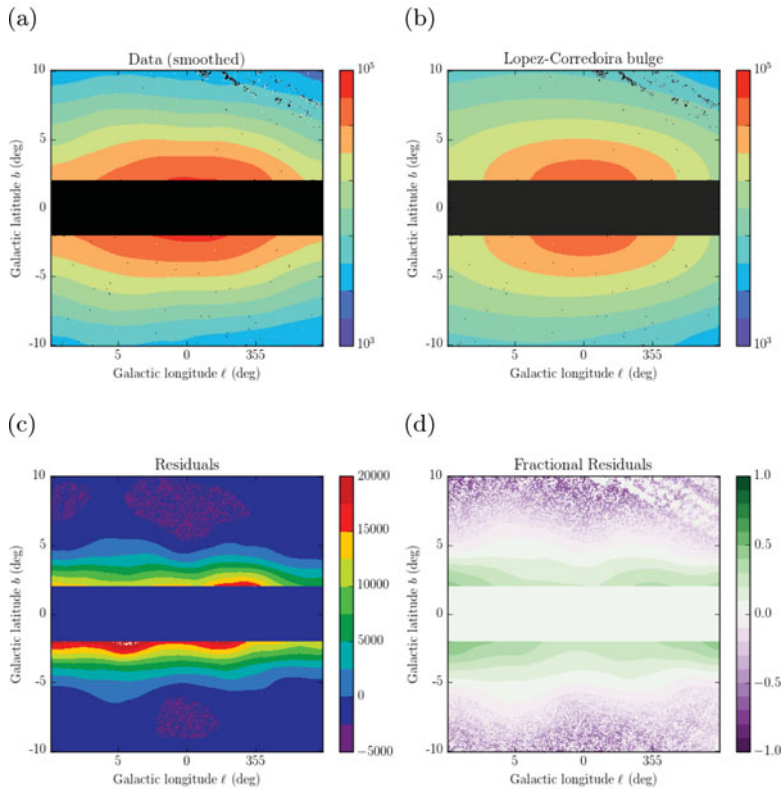
Figure 2. When a boxy bulge model (b), instead of the ellipsoidal model, is subtracted from the WISE W1 data (a), the residual map (c) shows no X-shape, but just a peanut shape as has already been shown in the COBE image (Dwek *et al.* 1995). For a boxy bulge model, we adopt the model of López-Corredoira *et al.* (2005) which is based on star counts in the 2MASS survey. The structure of fractional residuals (d) defined by $(N_{obs} - N_{mod})/N_{obs}$ also shows no X-shape at high latitudes. For the WISE W1 data (a), we adopt $E(B-V)$ values for the dust extinction correction from Schlegel *et al.* (1998) and the extinction coefficients for the WISE bands from Yuan *et al.* (2013).

attributed to the X-shaped and spheroidal bulge, respectively. On the contrary, the dRC is reproduced by the helium-enhanced multiple popluation phenomenon (see Lee *et al.* 2015; Joo *et al.* 2017)

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