A model for the Milky Way boxy bulge. Explaining the metallicity gradients through bar instability.

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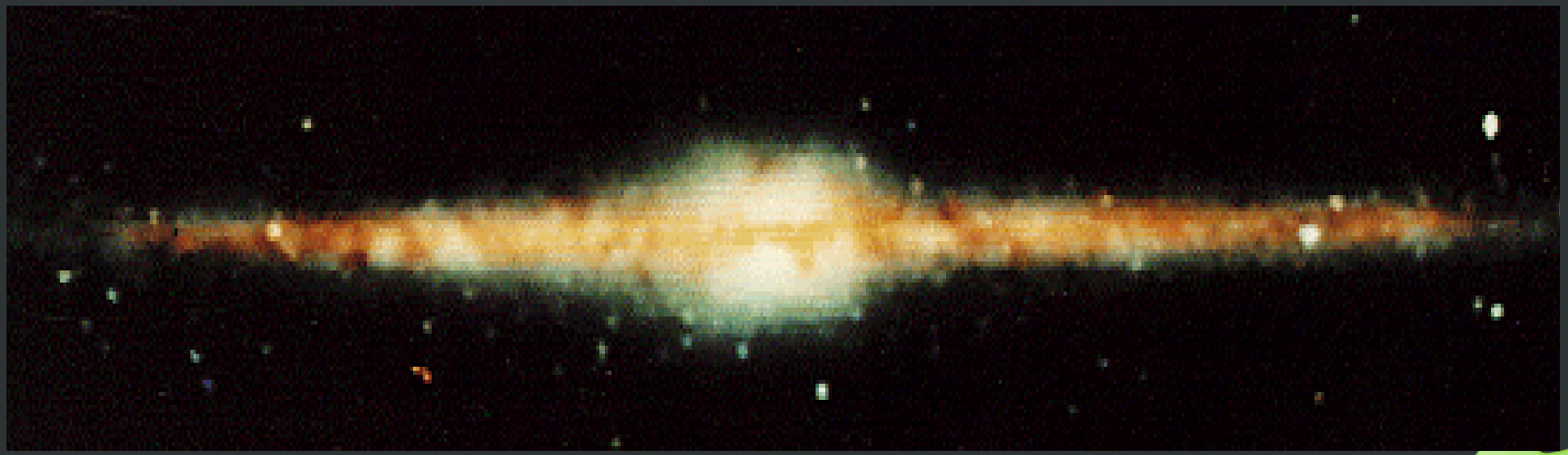
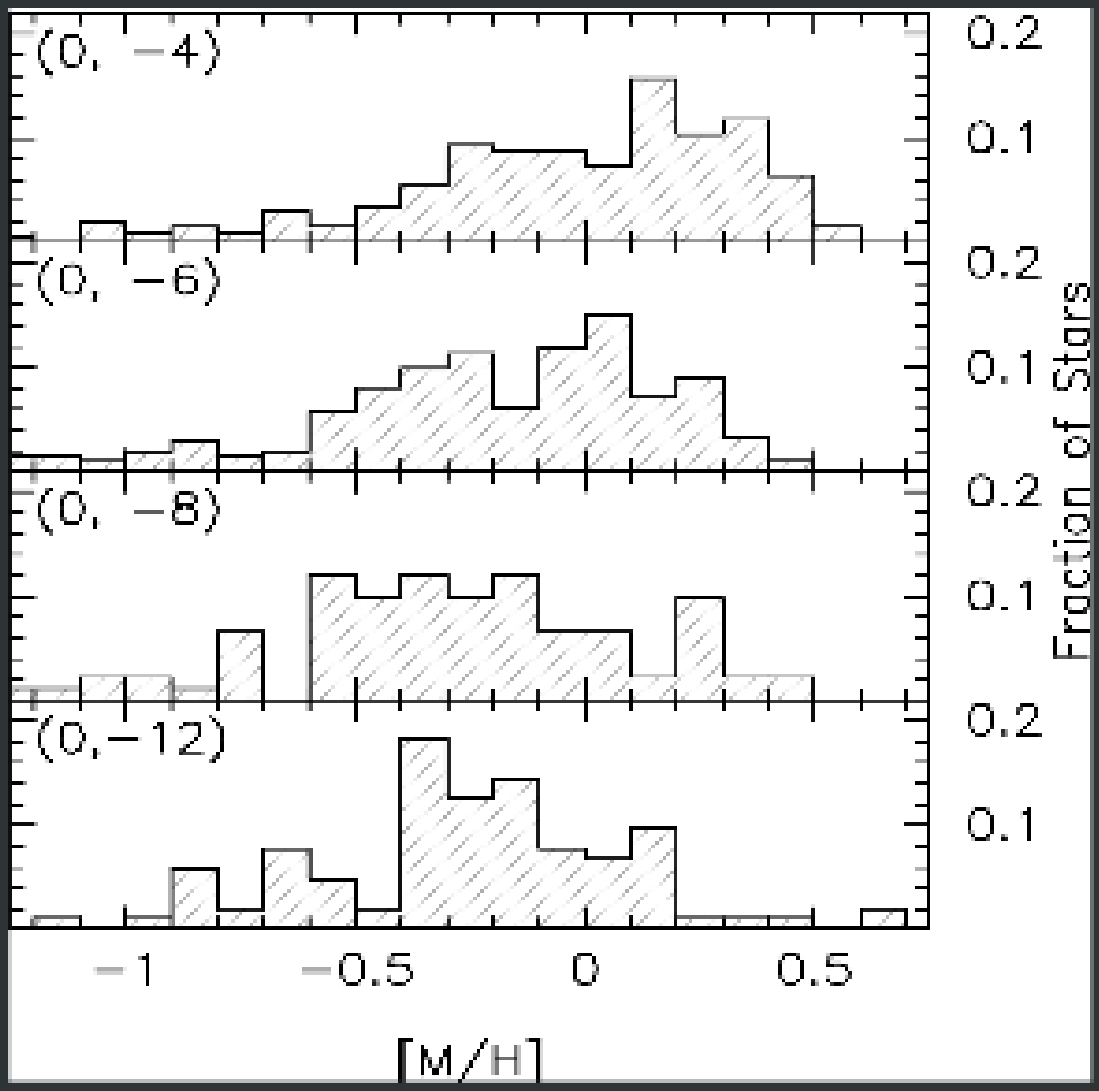


Porto, November 2014

Metallicity Gradients Through Bar Instabilities

- Vertical metallicity gradient in the Milky Way Bulge.
- Main reason to support a classical bulge in the Milky Way.
- The Milky Way has a clear boxy bulge+other arguments it is a barred galaxy.
- Previous works (for different reasons) always assuming that bars erase pre-exinting metallicity gradients.

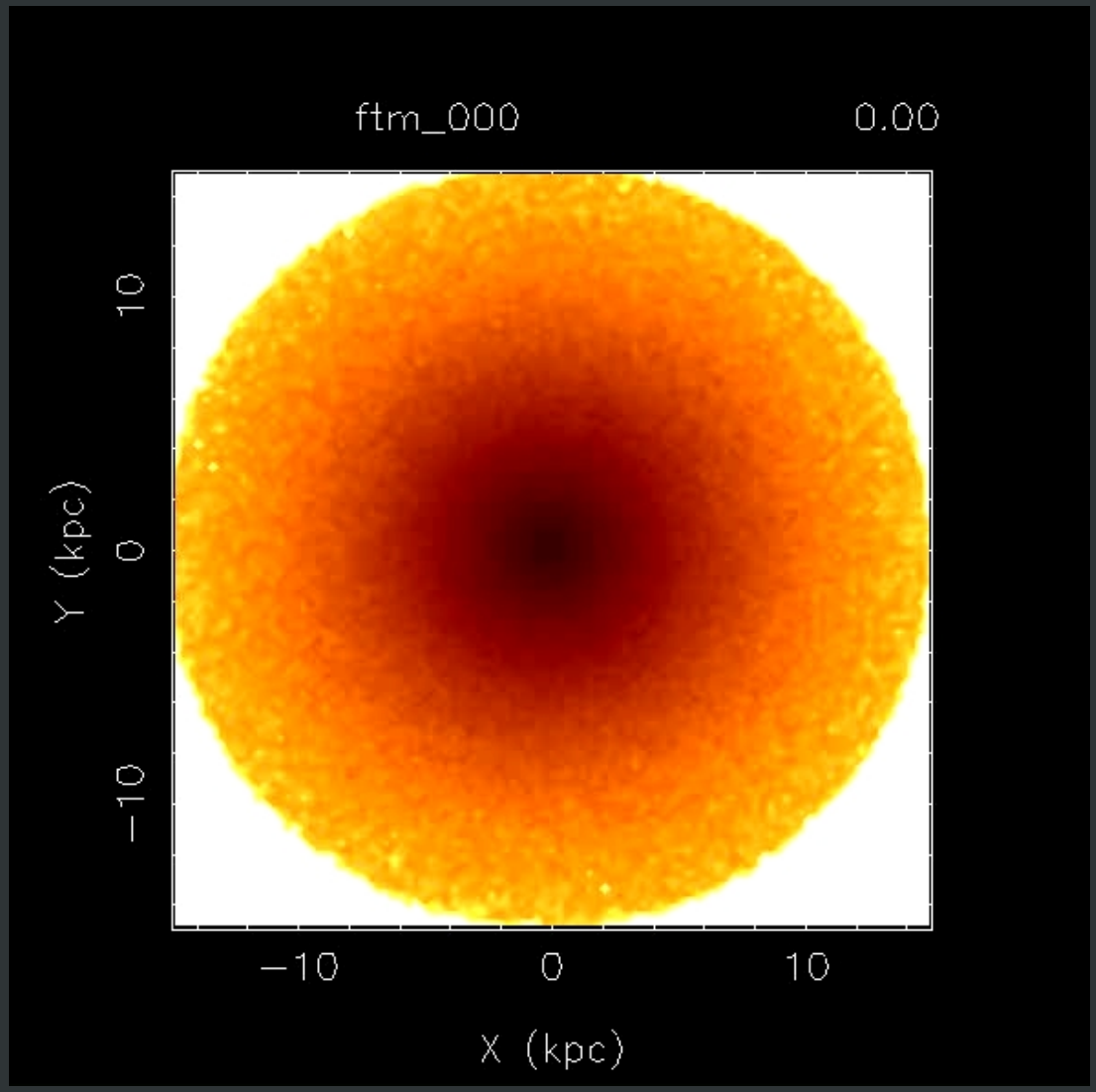
Milky Way Data



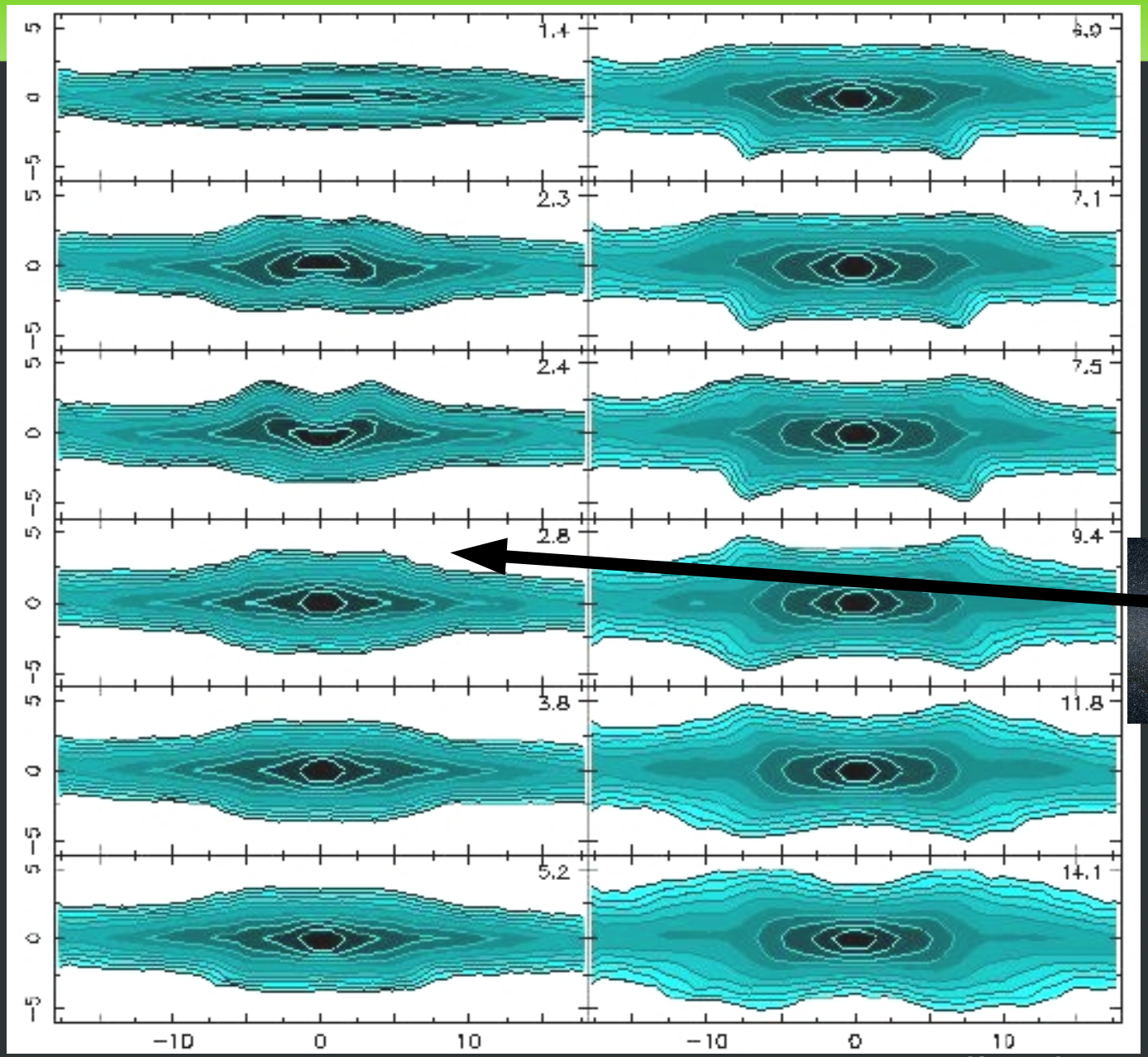
The histograms are based on data from Zoccali+08 for b=-4deg, -6deg, -12deg, and from Johnson+11 for b=-8\deg.

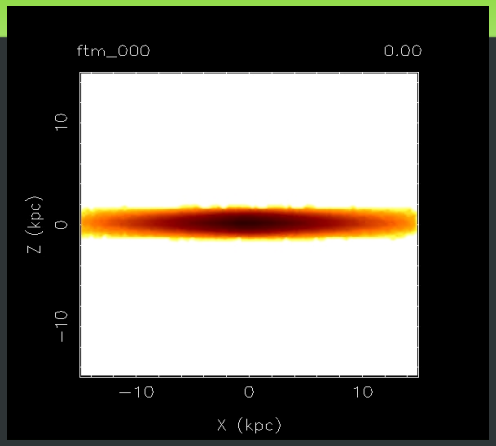
Also present in
Ness+2013 (ARGOS)
Gonzalez+2013 (VVV)
Rojas-Arriagada+2014 (GES)
+++++

The formation and evolution of a bar in a nutshell

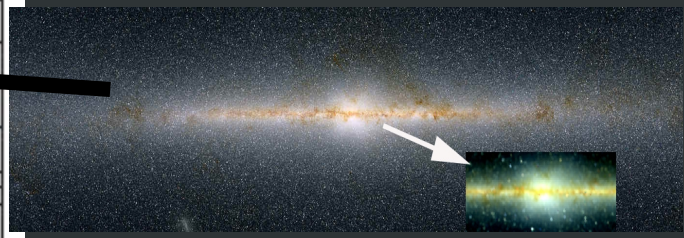


The vertical evolution of a bar



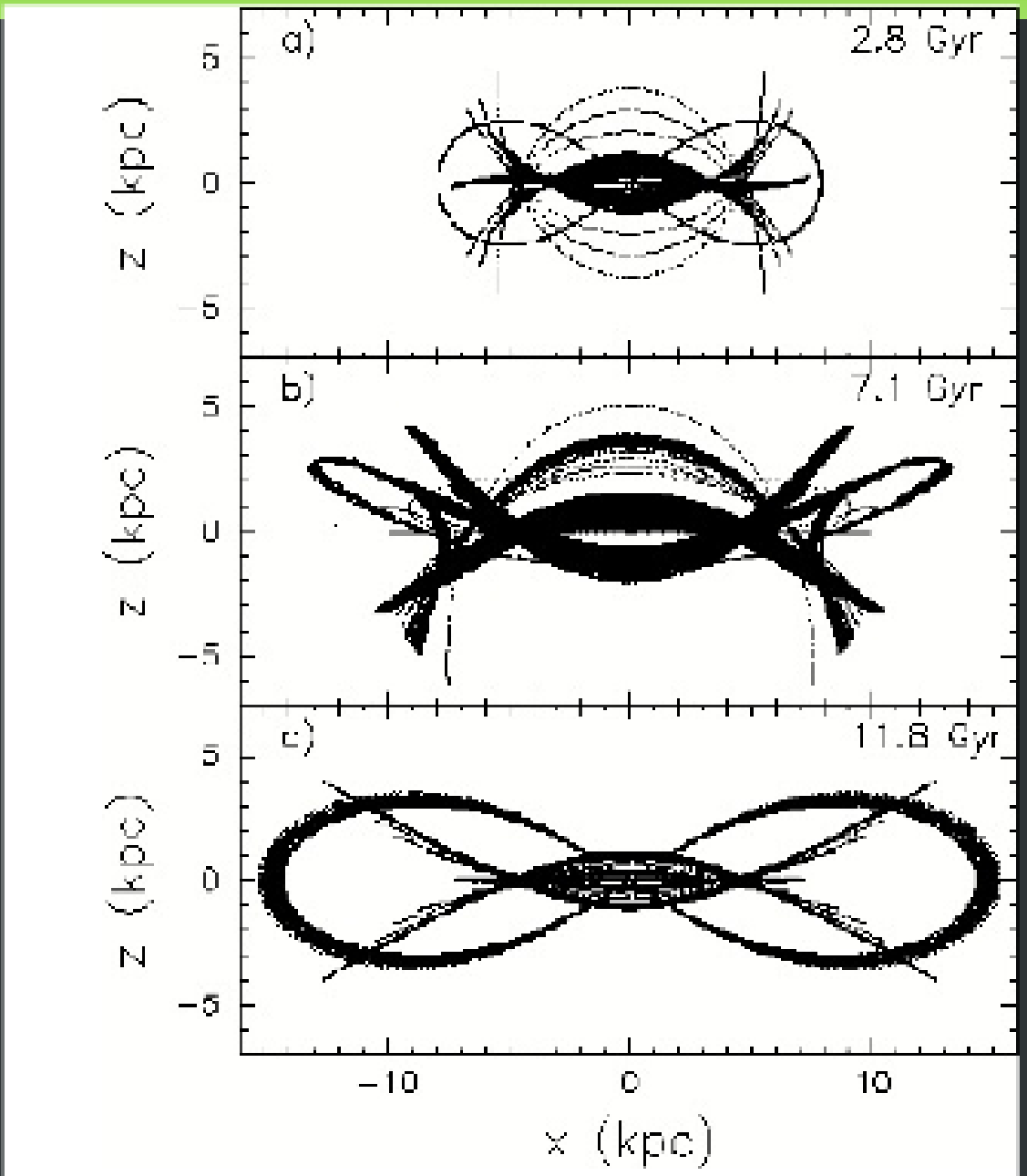


Milky Way (2MASS)



Martinez-Valpuesta, Shlosman & Heller (2006)

Typical orbit of a bulge of type Boxy/Peanut:



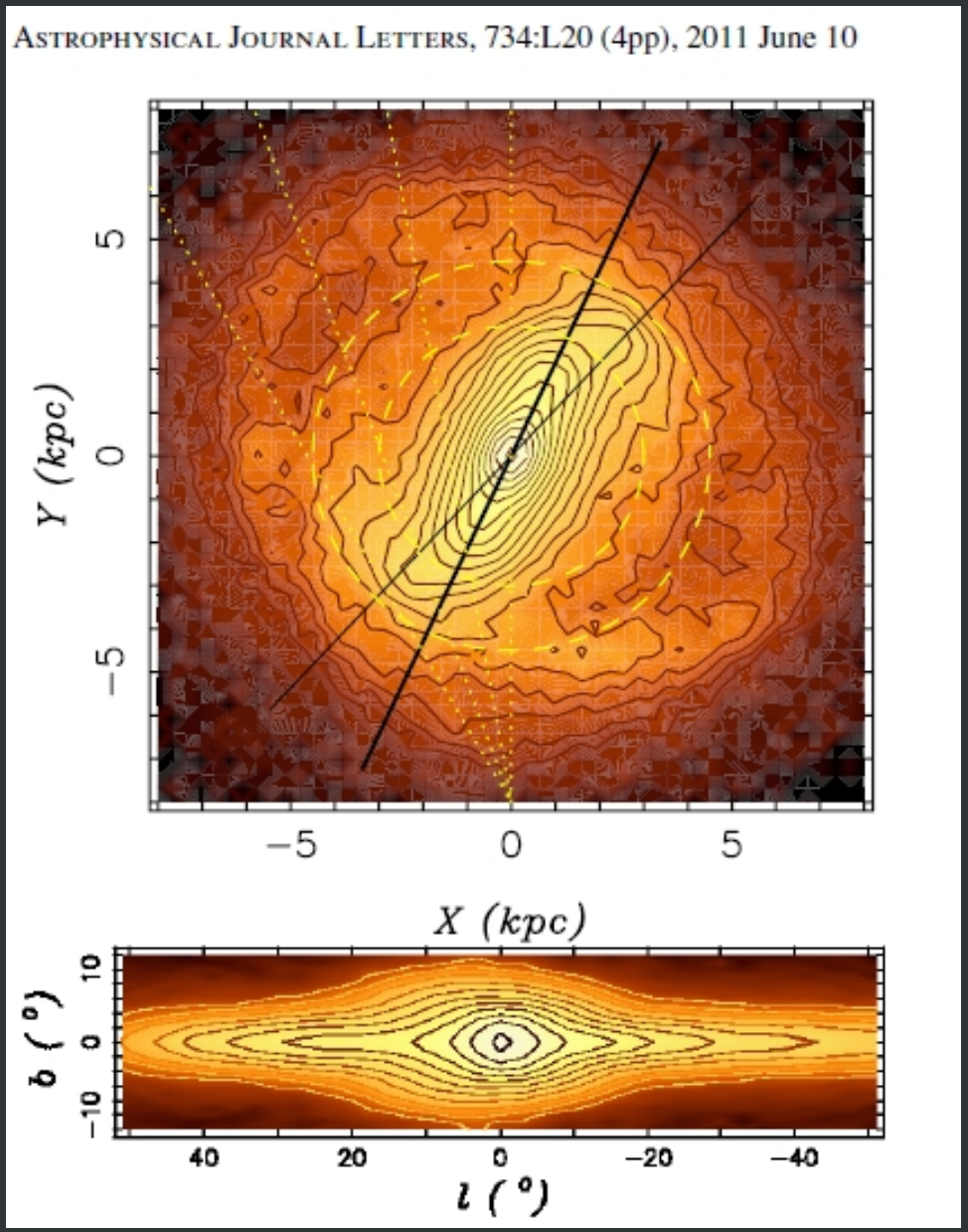
Projection of three-dimensional orbits onto the xz-plane in three different snapshots: after the first buckling, during the second buckling, and after the second buckling. Only stable orbits of the main families are plotted. The horizontal extension of the orbits increases with time. The general shape evolves from a peanut/boxy shape to a vertically asymmetric shape and then to a peanut/X-shape.

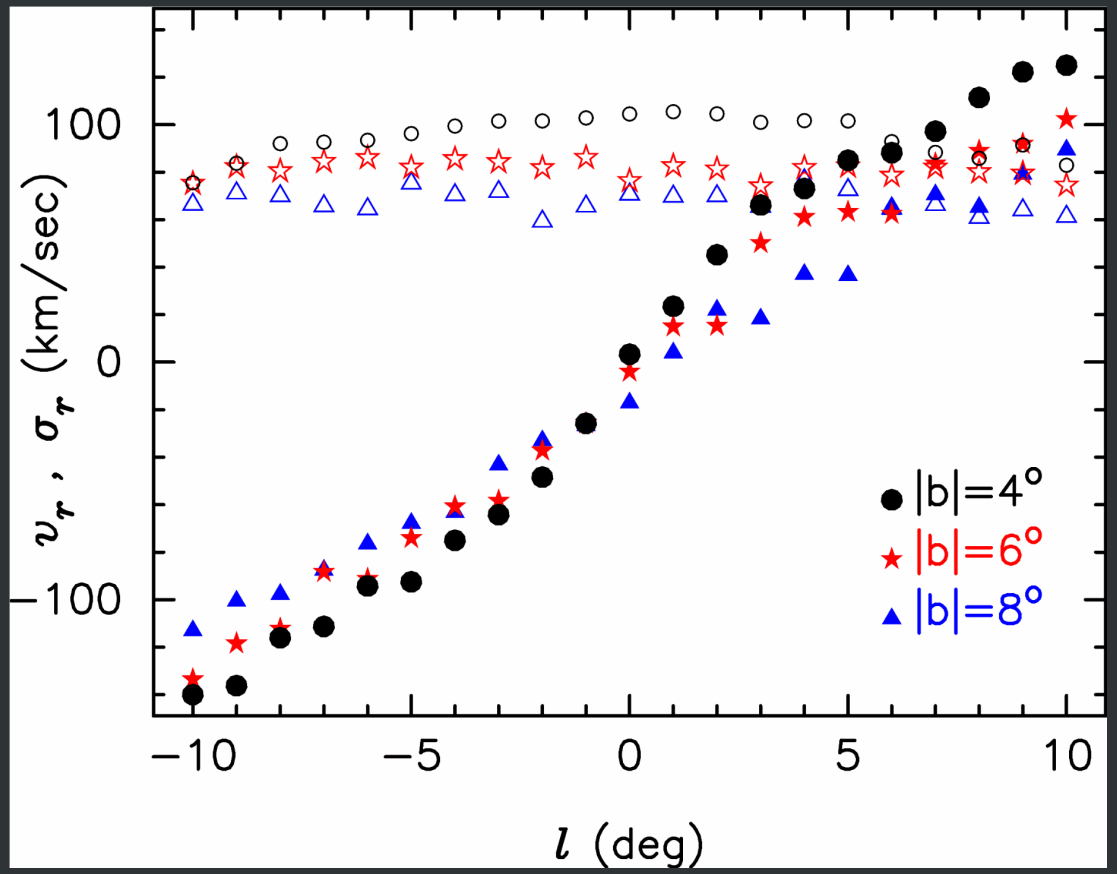
For more information about orbits in bars see Patsis + 02 series

Model for the MW. I

- We already have a good model which represents fairly the star counts in the MW for the outer bar (Martinez-Valpuesta & Gerhard 2011)
- The same model reproduces the inner region and has been also tested with different observations (Gerhard & Martinez-Valpuesta 2012, Gonzalez+12, Nataf+12, Nidever+MV+12)
- The model shows cylindrical rotation and the kinematics are in good agreement with BRAVA data and ARGOS data (Martinez-Valpuesta 12).

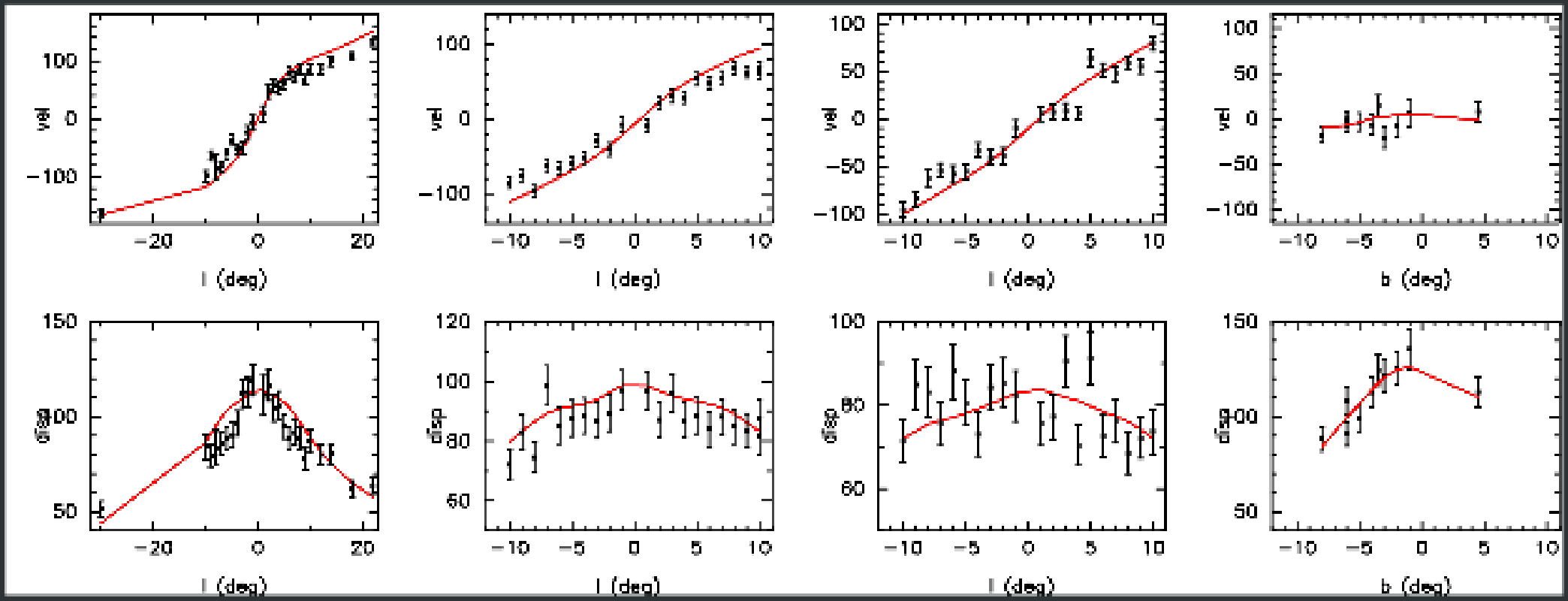
Model for the MW. II





Model for the MW. III

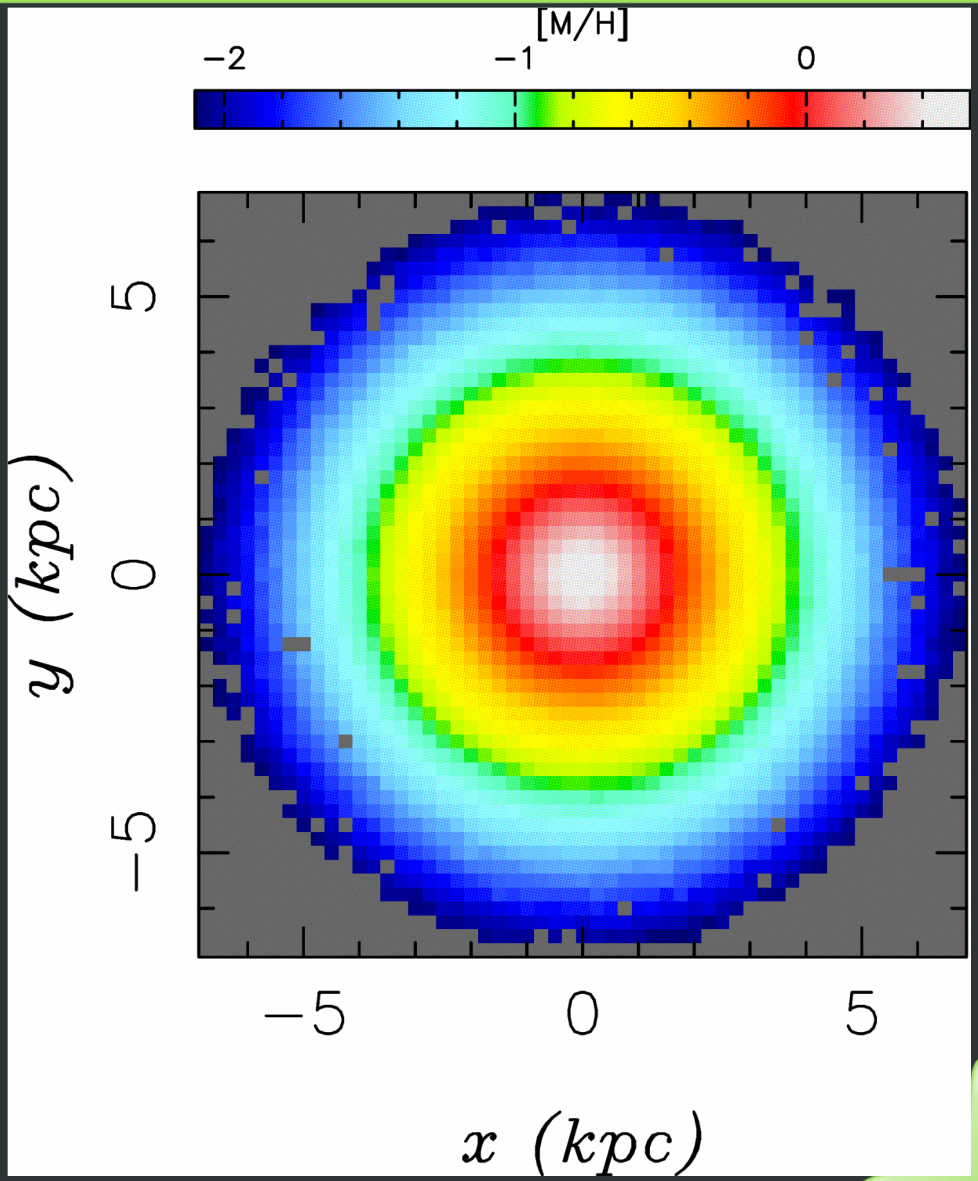
b=-4 b=-6 b=-8 Minor Axis



Black dots correspond to BRAVA data

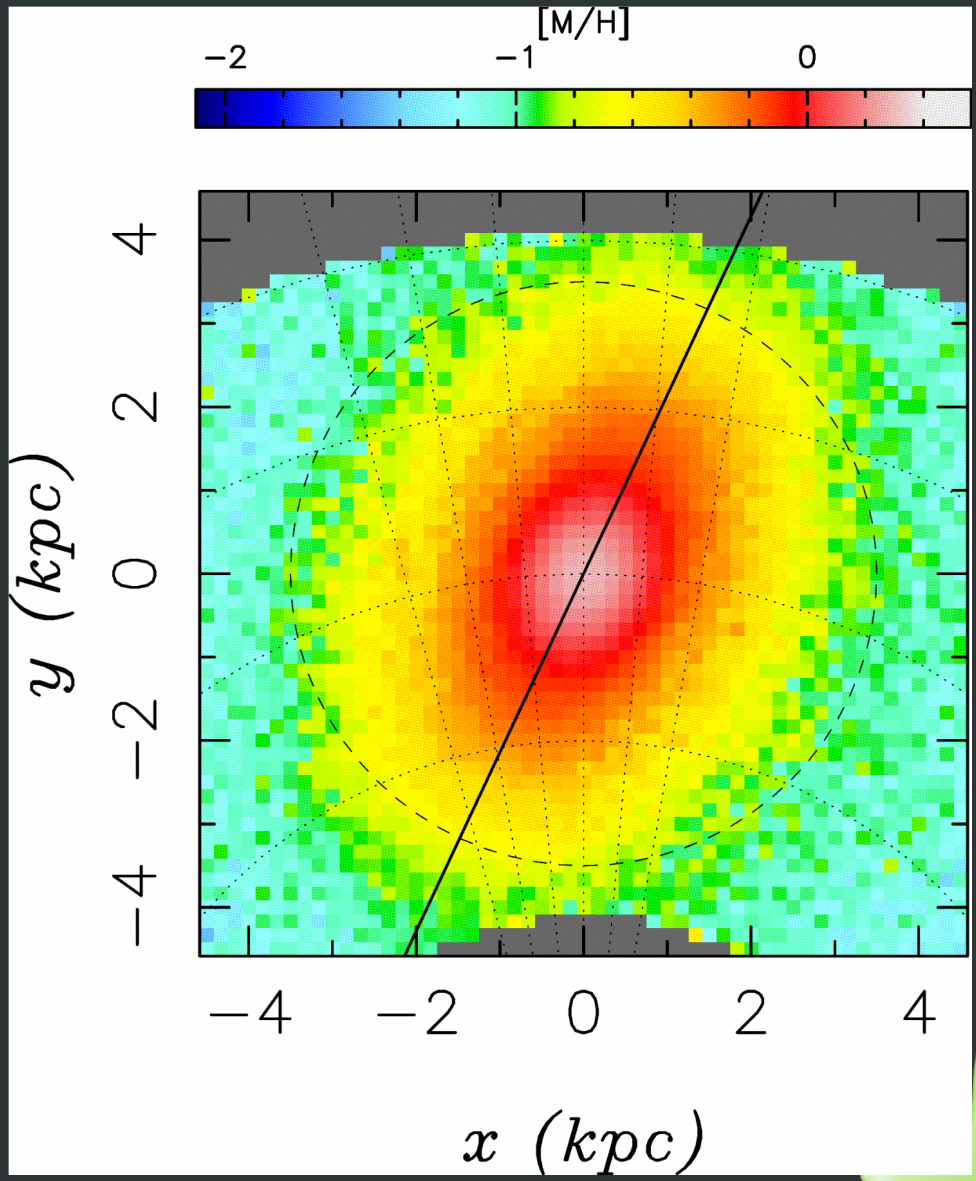
Asigned metallicity gradient

- -0.4 dex/kpc
- Bar length 4.5 kpc



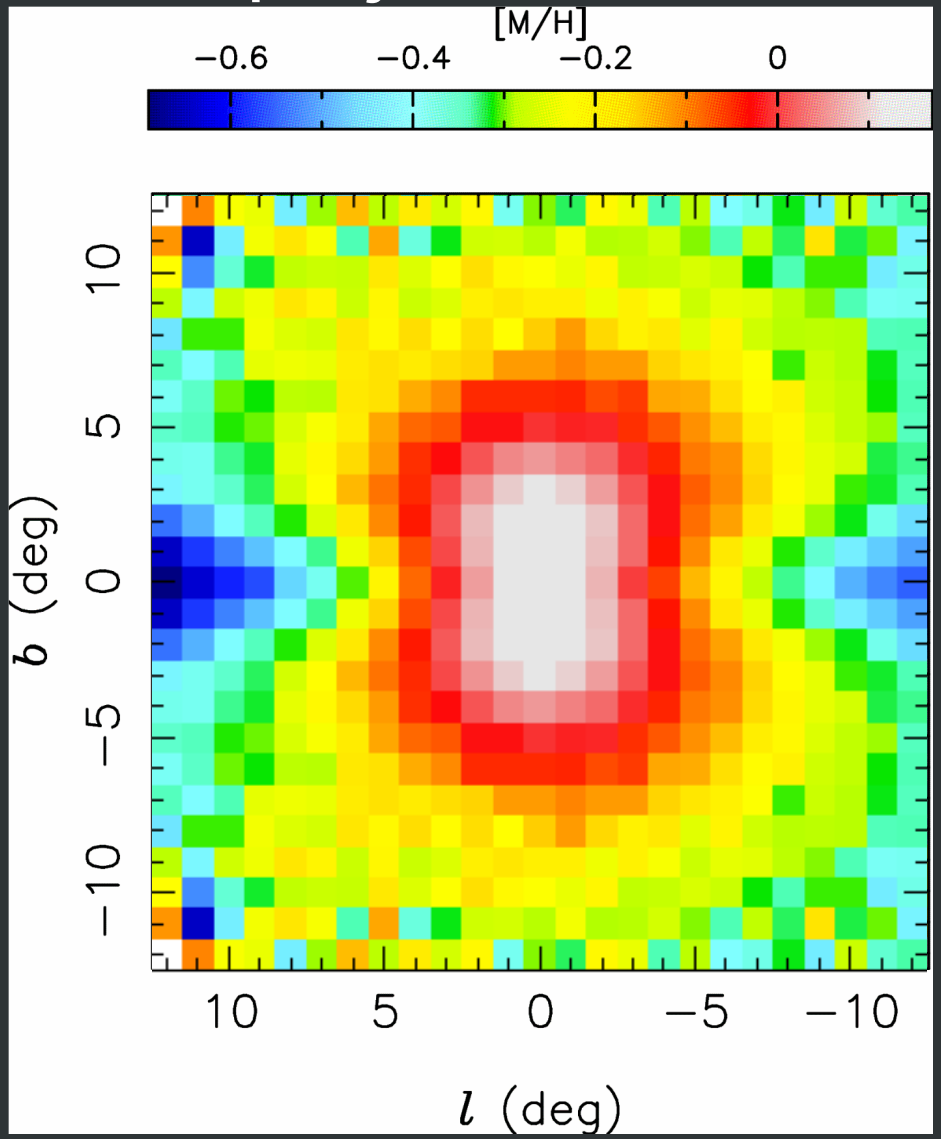
Final metallicity gradient I

- -0.4 dex/kpc Initial
- Bar length 4.5 kpc
- -0.26 dex/kpc Final



Final metallicity gradient II

MW projection MODEL



VVV Survey

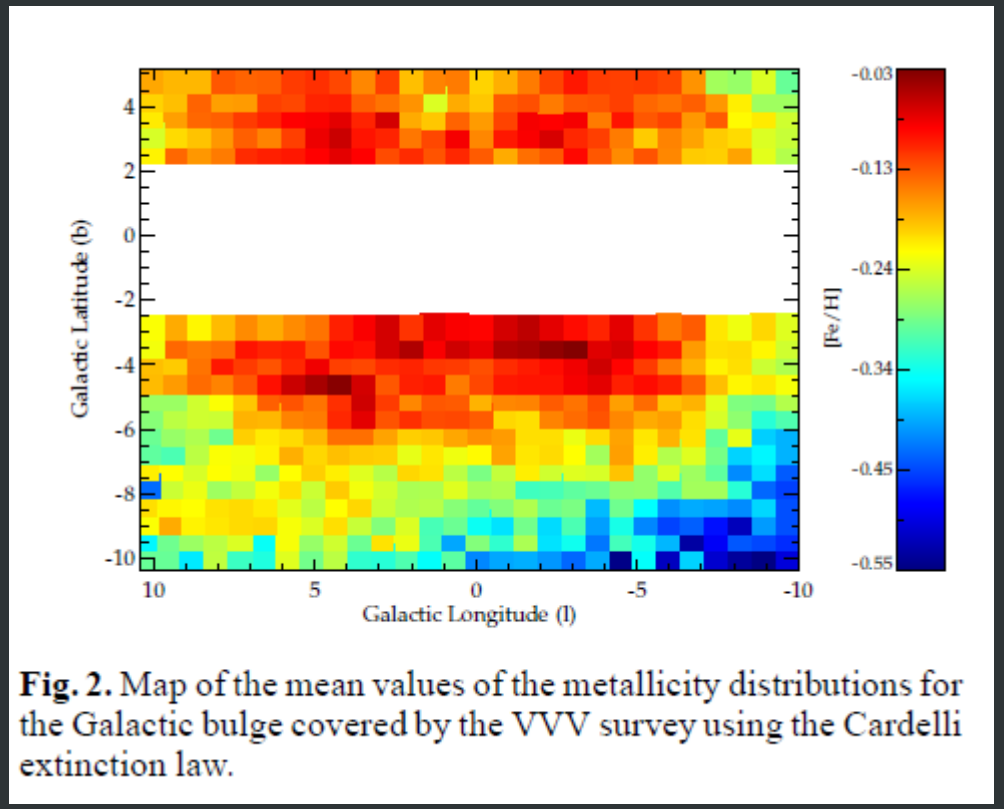


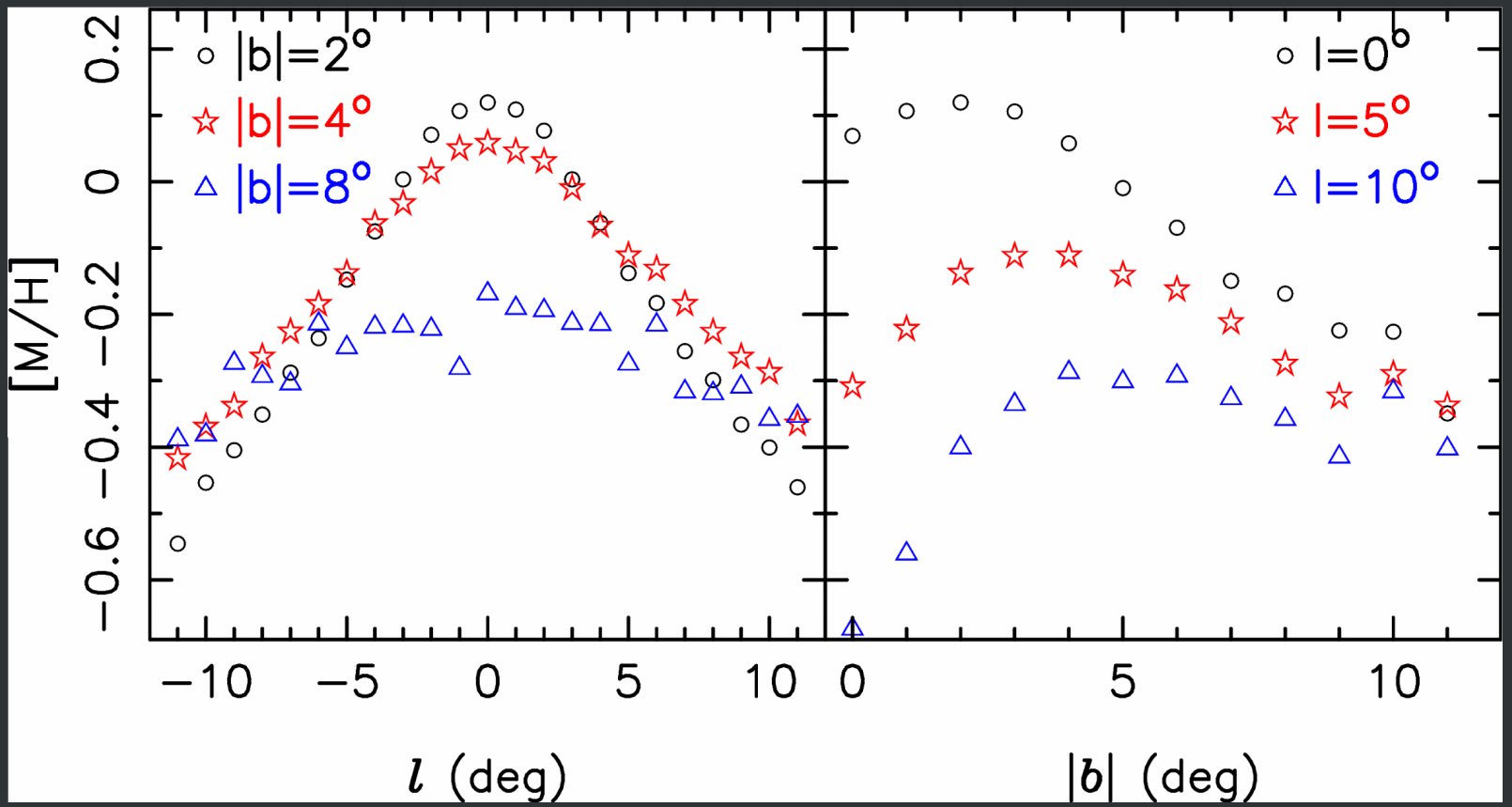
Fig. 2. Map of the mean values of the metallicity distributions for the Galactic bulge covered by the VVV survey using the Cardelli extinction law.

Gonzalez + 2013

Martinez-Valpuesta & Gerhard 2013

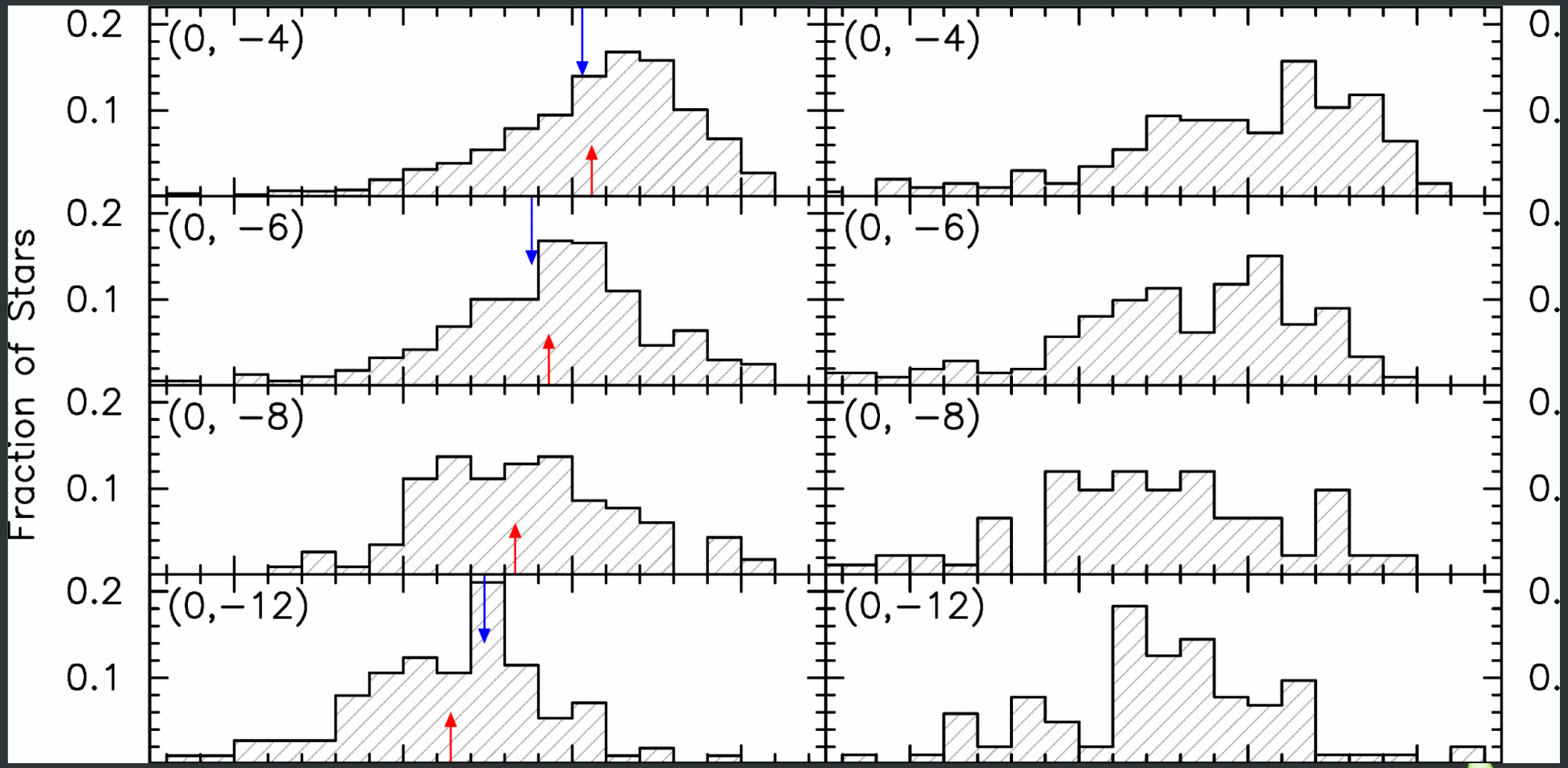
Final metallicity gradient III

- To be directly compared with observations:

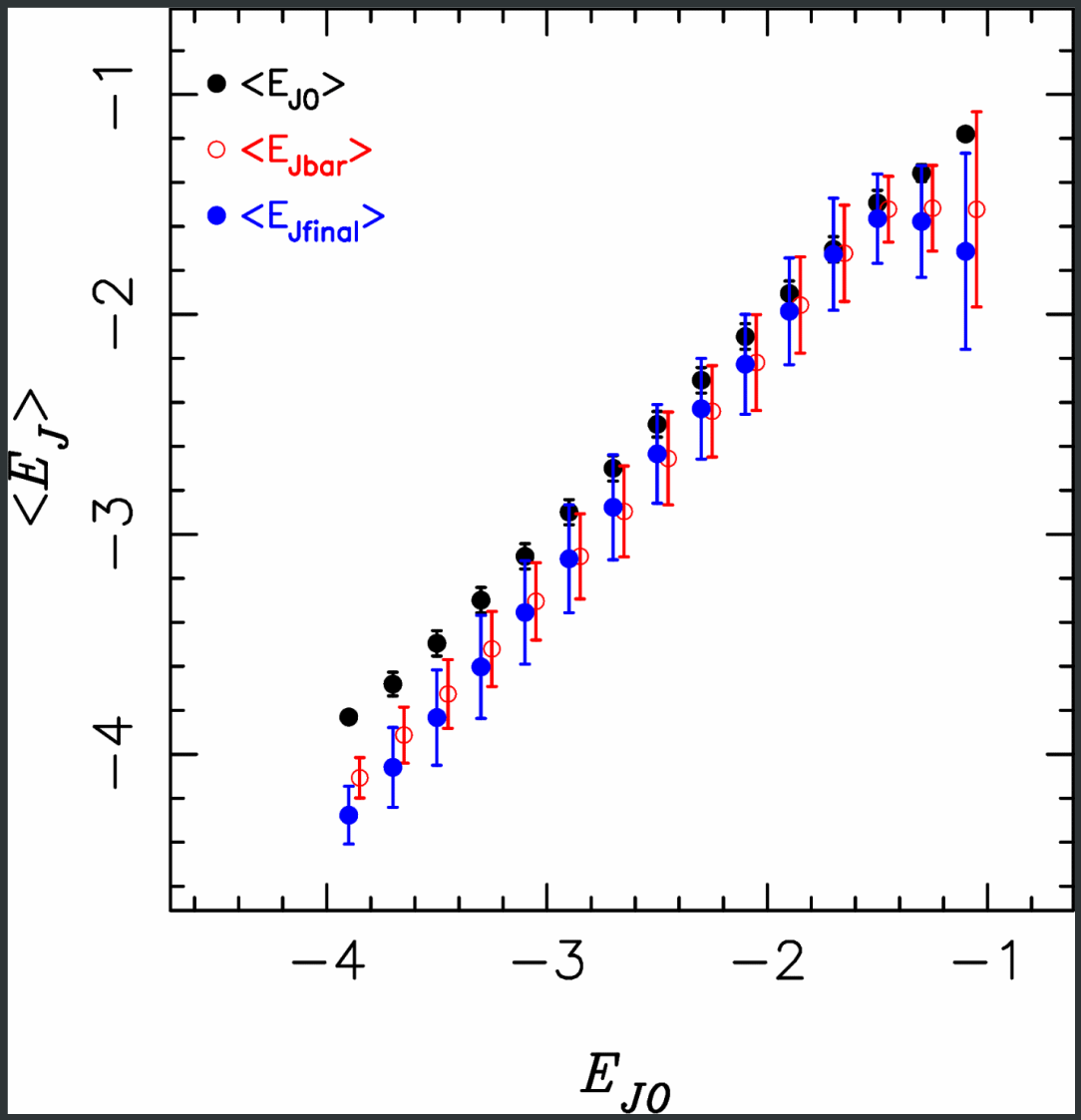


Final metallicity gradient IV

- MDF Model and data



Why?



Metallicity gradients in a few words

- For a more detailed explanation see Martinez-Valpuesta & Gerhard (2013), ApJL
- The bar/buckling instabilities are able to transform the initial radial metallicity gradient into a vertical gradient.
- In summary, stars born before the buckling instability stay aprox at the same radius if born within the vertical inner resonance, stars born within the final bar length are able to populate certain orbits and therefore contribute with low metallicity at high latitude.

Future:

More realistic models including star formation and feedback.

Detail comparisons with data taking into account selection effects.

Thanks!!