ADeLA meeting - Santiago - Chile

## Dynamical patterns of the X-shaped Milky Way Bulge

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# SERGIO VÁSQUEZ GODOY

Instituto de Astrofísica, Pontificia Universidad Católica de Chile Instituto Milenio de Astrofísica - MAS

### Dynamical patterns of the X-shaped Milky Way Bulge

#### • Why an X?

- Evidence before 2010
- Actual scenario
- Spatial interpretation

# Kinematical behavior Characterization at (I,b)=(0,-6): RV and PM What say models?









RC stars can be used to trace morphology







Stanek et al. 1994

#### • Evidence before 2010:



Rattenbury et al. 2007



(l,b) = (0,-8)

FIG. 10.—Histogram of the Plaut's window catalog in the *JHK* 2MASS bands for stars with 0.45 < J - H < 0.8. The HB red clump is easily observed as the brighter peak in the histograms. The vertical line marks the mean observed magnitude of the red clump stars. The second fainter peak corresponds to the RGB bump. A Gaussian kernel of 0.2 mag width was used to compute the histograms.

vieira et al. 2007

2010s:

- Nataf et al. 2010
- McWilliam & Zoccali 2010
- Saito at al. 2011

Observational evidence of two RCs a long the minor axis



MCVVIIIam & Zoccail 2010

2010s:

- Nataf et al. 2010
- McWilliam & Zoccali 2010
- Saito at al. 2011

RC stars are good distance indicators

Two overdensities spatially separated



MCVVIIIam & Zoccail 2010

2010s:

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RC stars are good distance indicators

Two overdensities spatially separated



MCVVIIIam & Zoccail 2010



• Why X-shaped Bulge?:



- 2010s:
- Nataf et al. 2010
- McWilliam & Zoccali 2010
- Salito at all 2011 (2MASS)

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Why X-shaped Bulge?:





Why X-shaped Bulge?:





Why X-shaped Bulge?:







Pour study at b=-ô\*: Kinematics

MACS@LCC) = GIRAFFE@VLT spectral>Region (I, 0) = C, -6

> 200 targets Bright Red Clump (BRC)

> -250 targets Faint Reel Clump (FRC)





(l,b) = (0,-6)





(l,b) = (0,-6)

0.25 13 ∆=3.44 ±0.11 mas/yr 0.2  $\mu_1$ =3.31 ±0.11 mas/yr 14  $\sigma = 4.60$ € 0.15  $\mu_{\rm f}$ =-0.12 ±0.03 mas/yr  $\sigma = 3.18$ - 15 0.1 16 0.05 17 0 0 2 3 20 10 0 -10 -20 1 V-I  $\mu_1 \cos(b) (mas/yr)$ 20 20 Δ=1.17 ±0.10 mas/yr  $\mu_{b} = -1.19 \pm 0.10 \text{ mas/yr}$ 10 10  $\sigma = 4.02$  $\mu_{\rm b}~({\rm mas/yr})$ µ<sub>b</sub>=-0.02 ±0.03 mas/yr μ<sub>b</sub> (mas/yr)  $\sigma = 3.04$ 0 0 -10 -10 -20 -20 0.15 0.25 0.2 0.1 0.05 20 10 0 -10 -20 0 N/N<sub>tot</sub>  $\mu_1 \cos(b) (mas/yr)$ 

Full PIVI catalogue from WFI images (time baseline of 11 yr)



Full PM catalogue from WFI images (time baseline of 11 yr)





Spectroscopic largets









T=5000

X-shaped bulges from models:

#### EDGE-ON GALACTIC DISK







Martinez-Valpuesta et al. (2006)





(l,b) = (0,-6)



(*l*,*b*) = (0,-6)









Model form Depattista et al. 2005



#### www.eso.org



First detection of streaming motions along the X-shaped buge, i.e. difference in racial velocity between both red dumps.

Proper motions show differences in galactic longitude, which is bigger when we select the most extreme racial velocities for each dump

 $\rightarrow$  Spatial velocities show that led dump stars in the Bulge are preferentially in more alongated profits (barrana profits)

 SD velocities are creatly consistent with models which form X-Shaped bulges

Proper motions from VVV - spectroscopic surveys as GIBS will provide the 3D kinematics - metallicity distribution for the inner bulge for the first time.



#### **GIBS: The Giraffe Inner Bulge Survey** PI: Zoccali

9

0 Iongitude

+4+2

aphilip

0 -2 -A -6

,8

x8



#### **GIBS: The Giraffe Inner Bulge Survey** PI: Zoccali

+4 +2 -2 -4

0

9

x8

aphiliter

0 Jongitude

