



# The European Southern Observatory

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**builds and operates a suite of the  
world's most advanced ground-based  
astronomical telescopes**

# The Milky Way Galaxy



2011 © Yuri Beletsky

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ESO, Garching b. München, Germany

# Black Hole in the heart of the MW “weighted” with the ESO telescopes

## ■ BH parameters

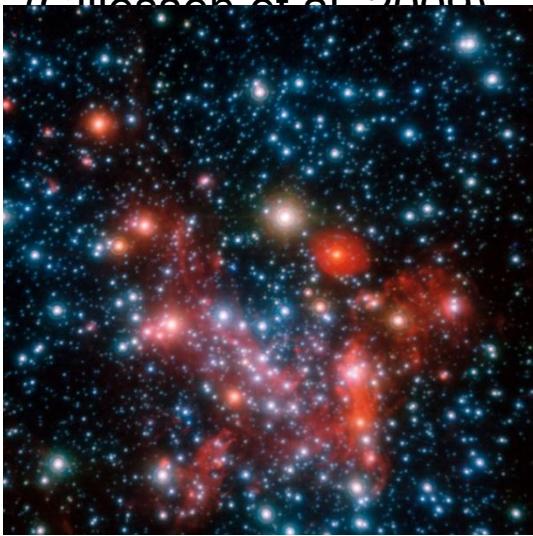
$M_\bullet =$

$$4.30(\pm 0.20)_{\text{stat}}(\pm 0.30)_{\text{sys}} \times 10^6 M_\odot$$

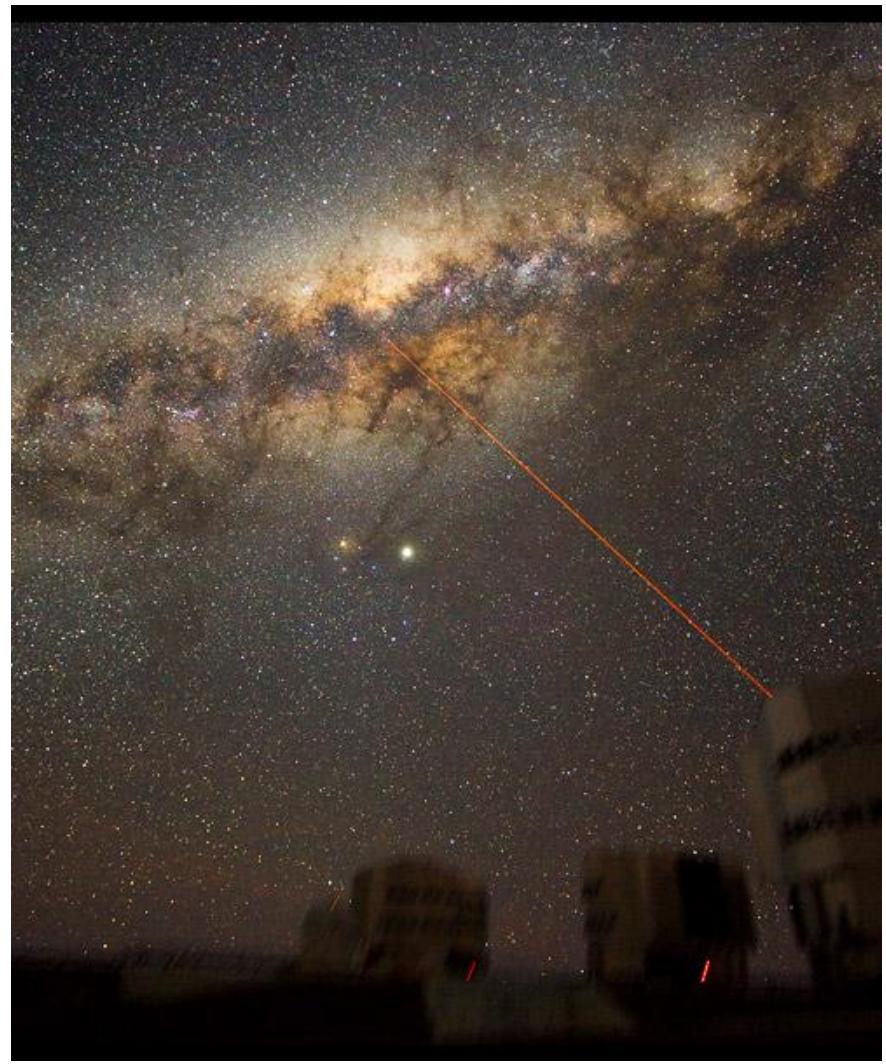
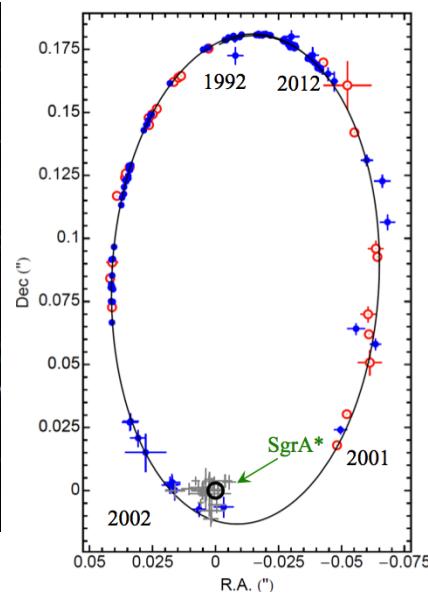
$$R_0 = 8.28(\pm 0.15)_{\text{stat}}(\pm 0.29)_{\text{sys}} \text{ kpc}$$

$$\rho > 10^{19.5} M_\odot \text{ pc}^{-3}$$

(Gillessen et al. 2009)

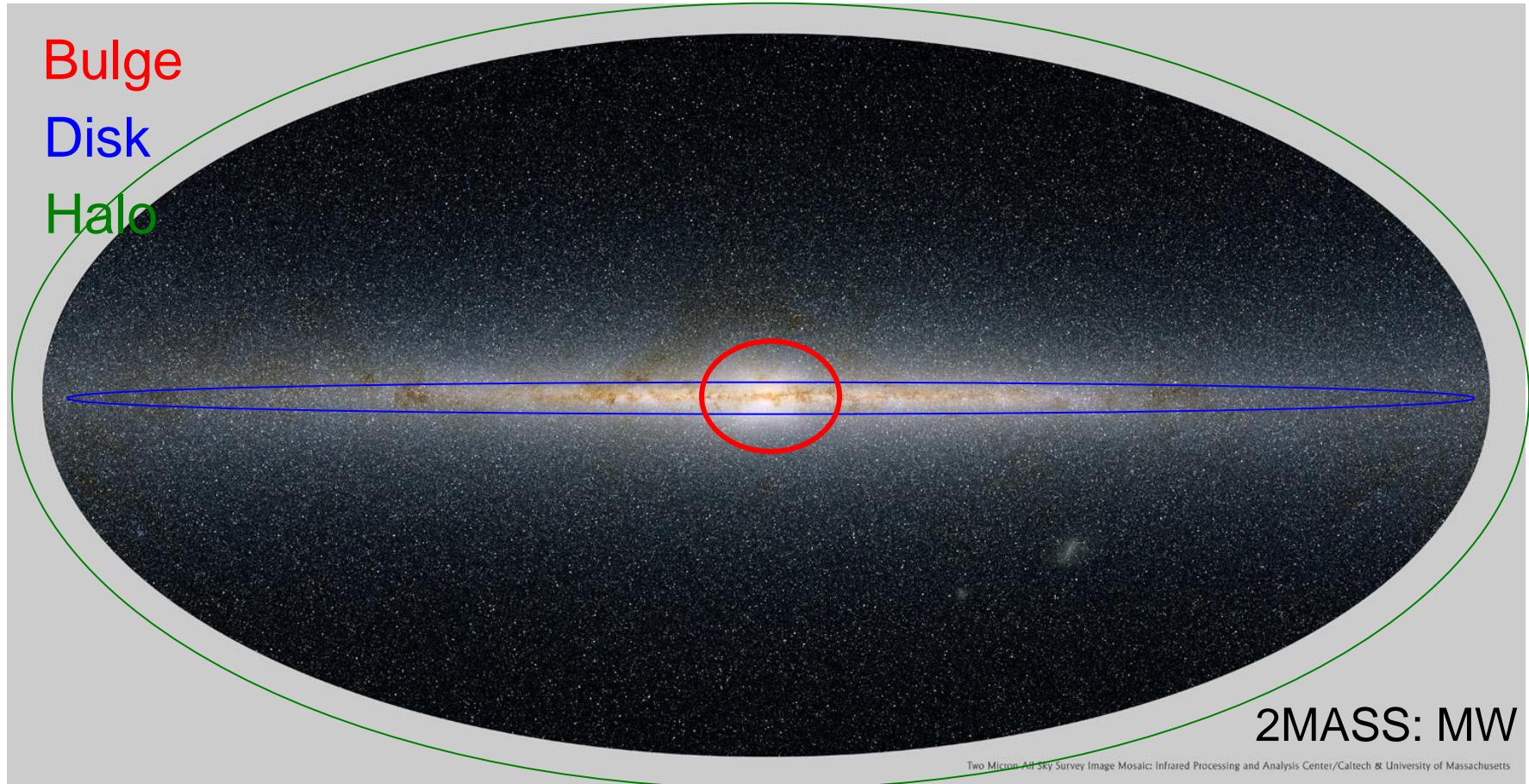


Credit: ESO/S. Gillessen et al.



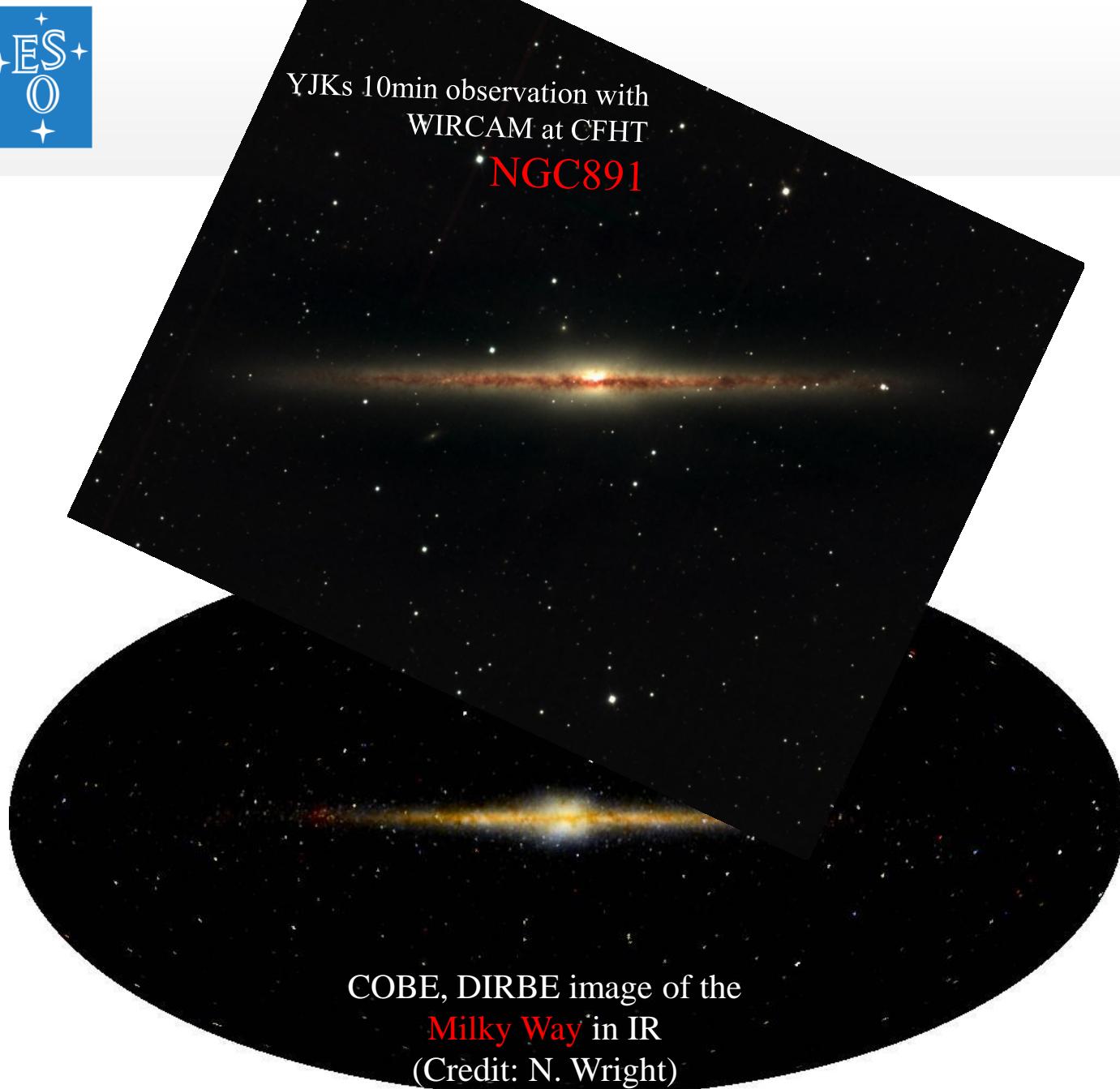


# Milky Way is a Spiral Galaxy





YJKs 10min observation with  
WIRCAM at CFHT  
**NGC891**



COBE, DIRBE image of the  
**Milky Way** in IR  
(Credit: N. Wright)



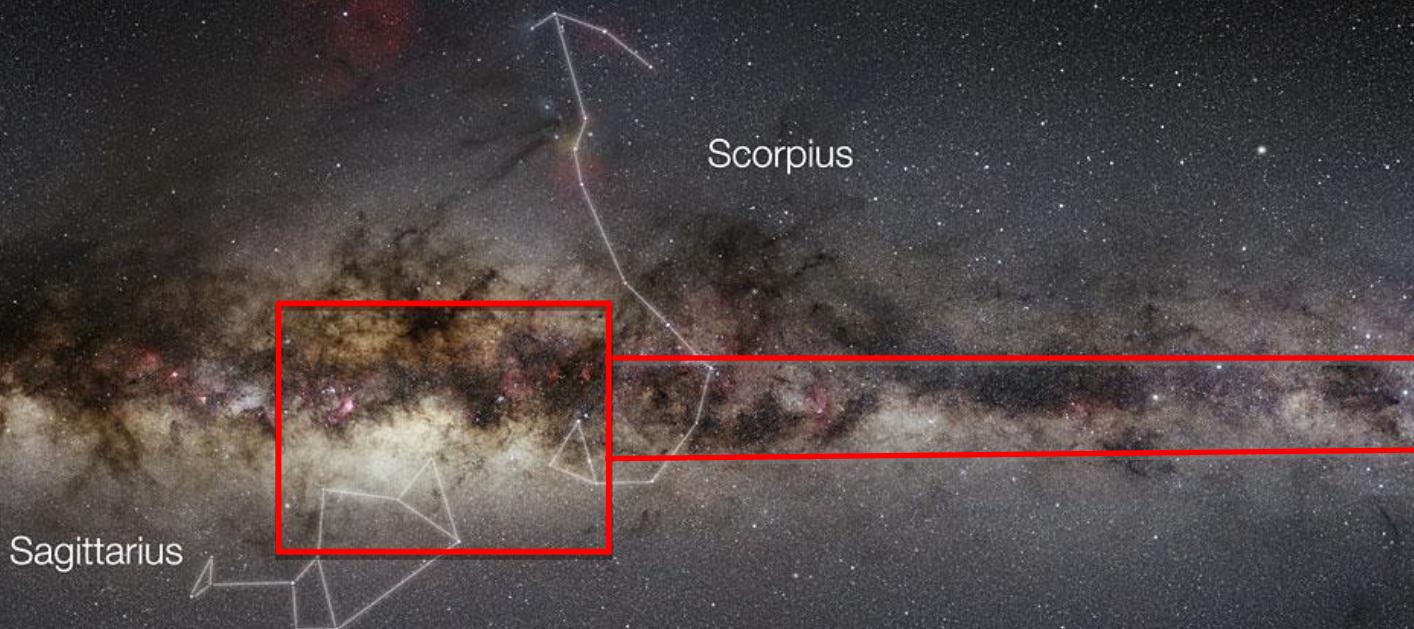
# VVV: The VISTA Variables in the Via Láctea

ESO VISTA Public Survey

PIs: D. Minniti, P. Lucas

DR1: <http://archive.eso.org/cms/eso-data/eso-data-products> (Saito et al. 2012)

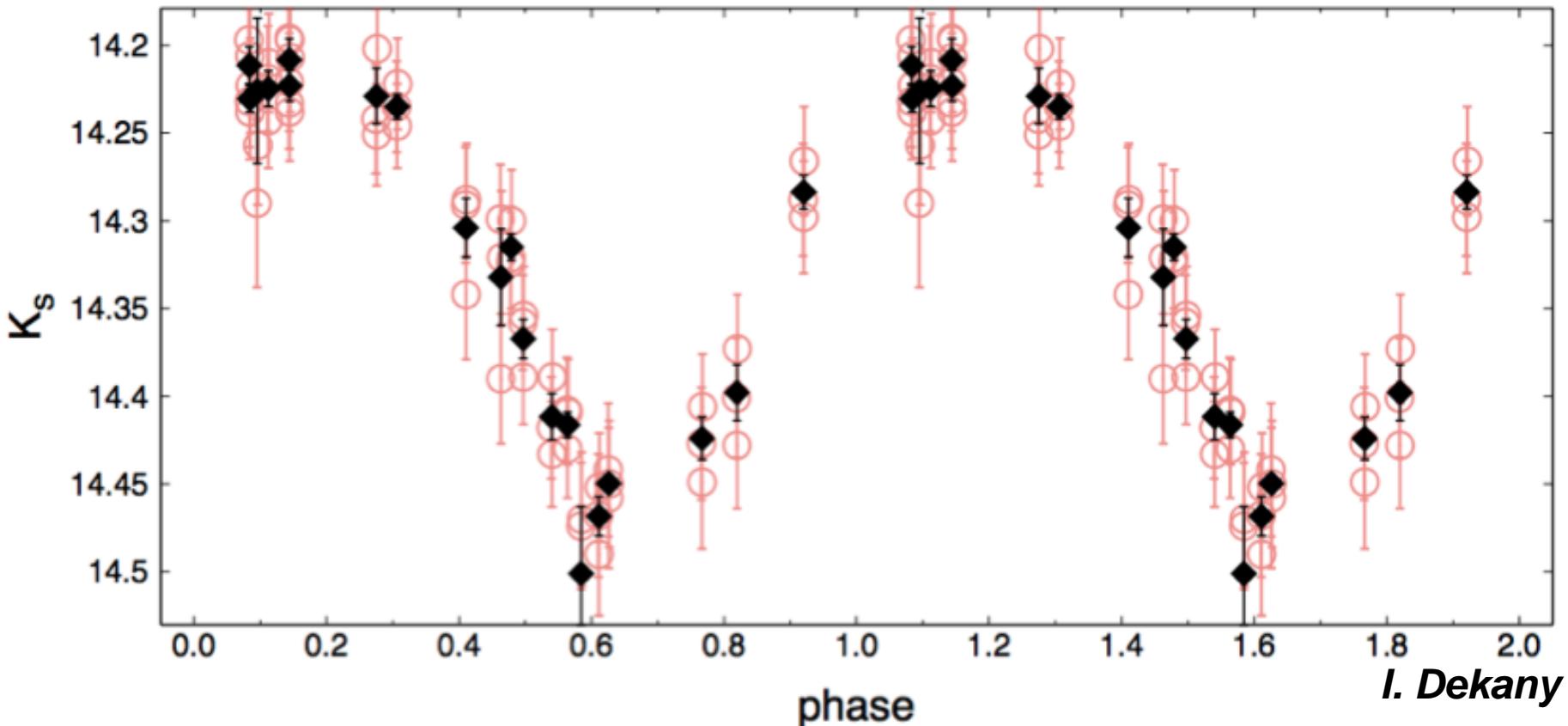
- ▶ 300 deg<sup>2</sup> bulge + 220 deg<sup>2</sup> disk



- ▶ 5 filters: 0.88, 1.02, 1.25, 1.65, 2.15 μm (Z, Y, J, H, Ks)
- ▶ ~100 epochs in Ks – variability campaign ongoing

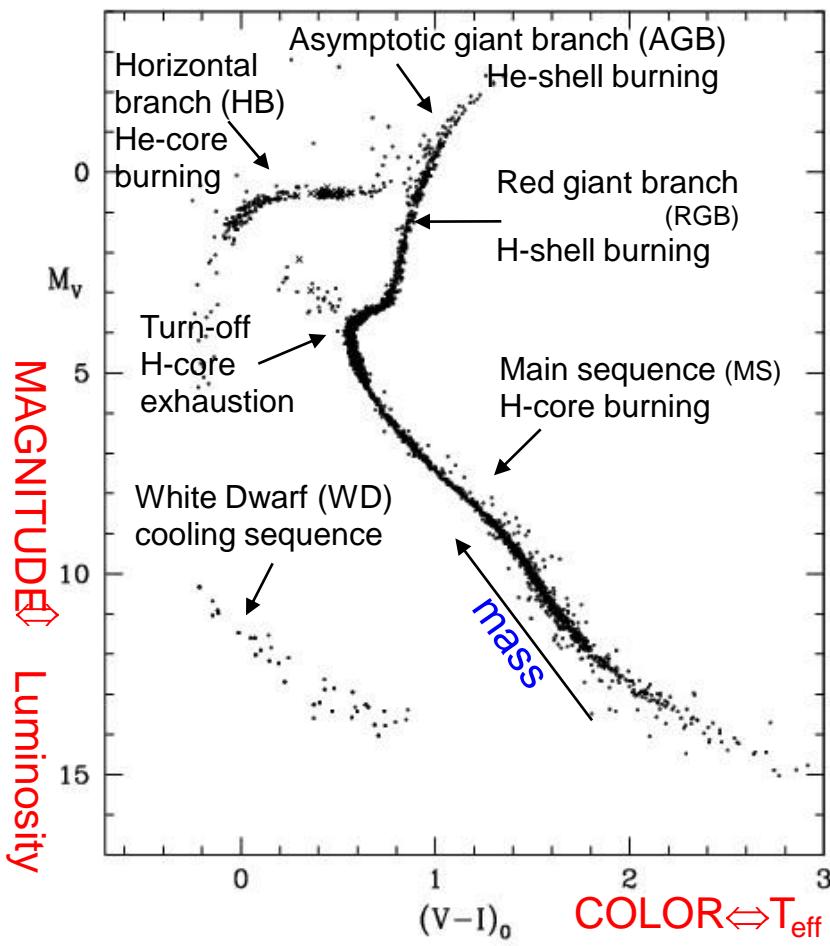
# What is the 3D structure of the Milky Way?

- RR Lyr variables are numerous in the bulge
  - standard candles – well understood period-luminosity relation used to determine distances to individual stars



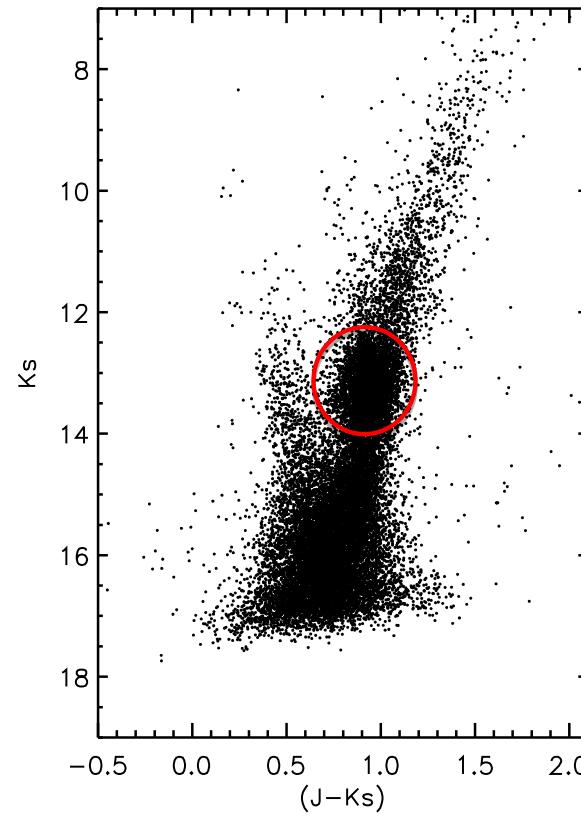
# Tool: color magnitude diagram

## Simple stellar population



Template globular cluster (Harris 2000)

## VVV tile b278



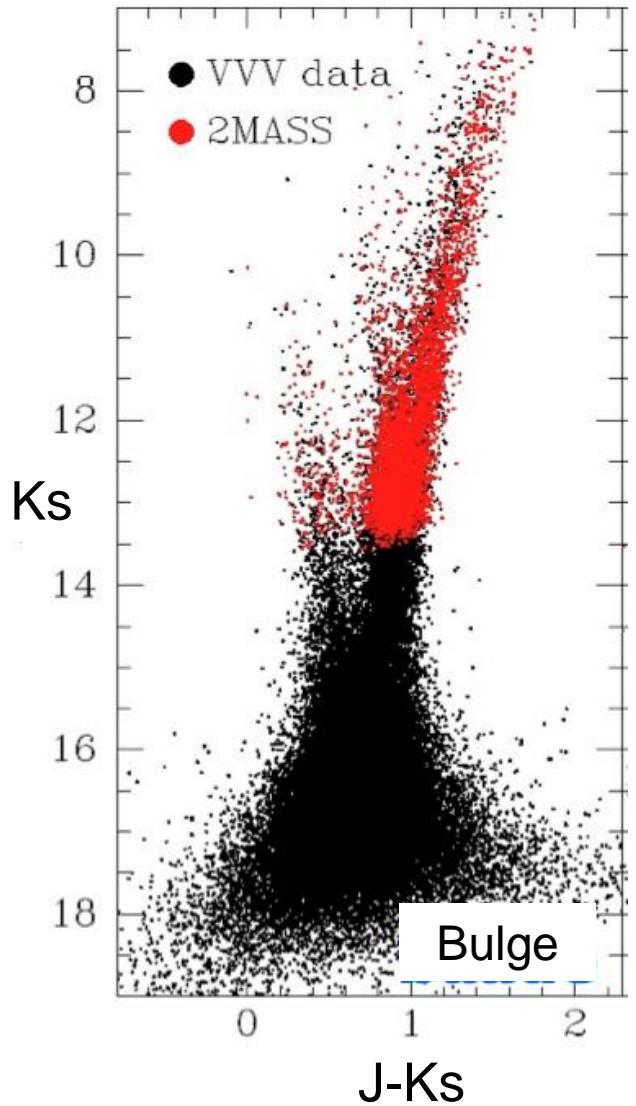
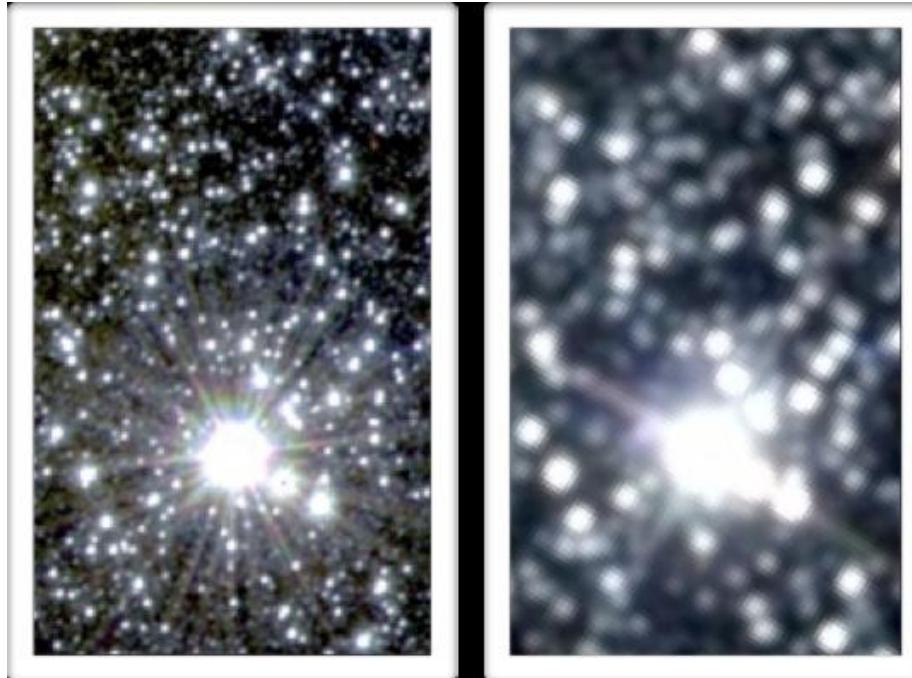
Red Clump:  
Giant stars  
burning He in  
the core

**PhD project  
by Oscar  
Gonzalez**

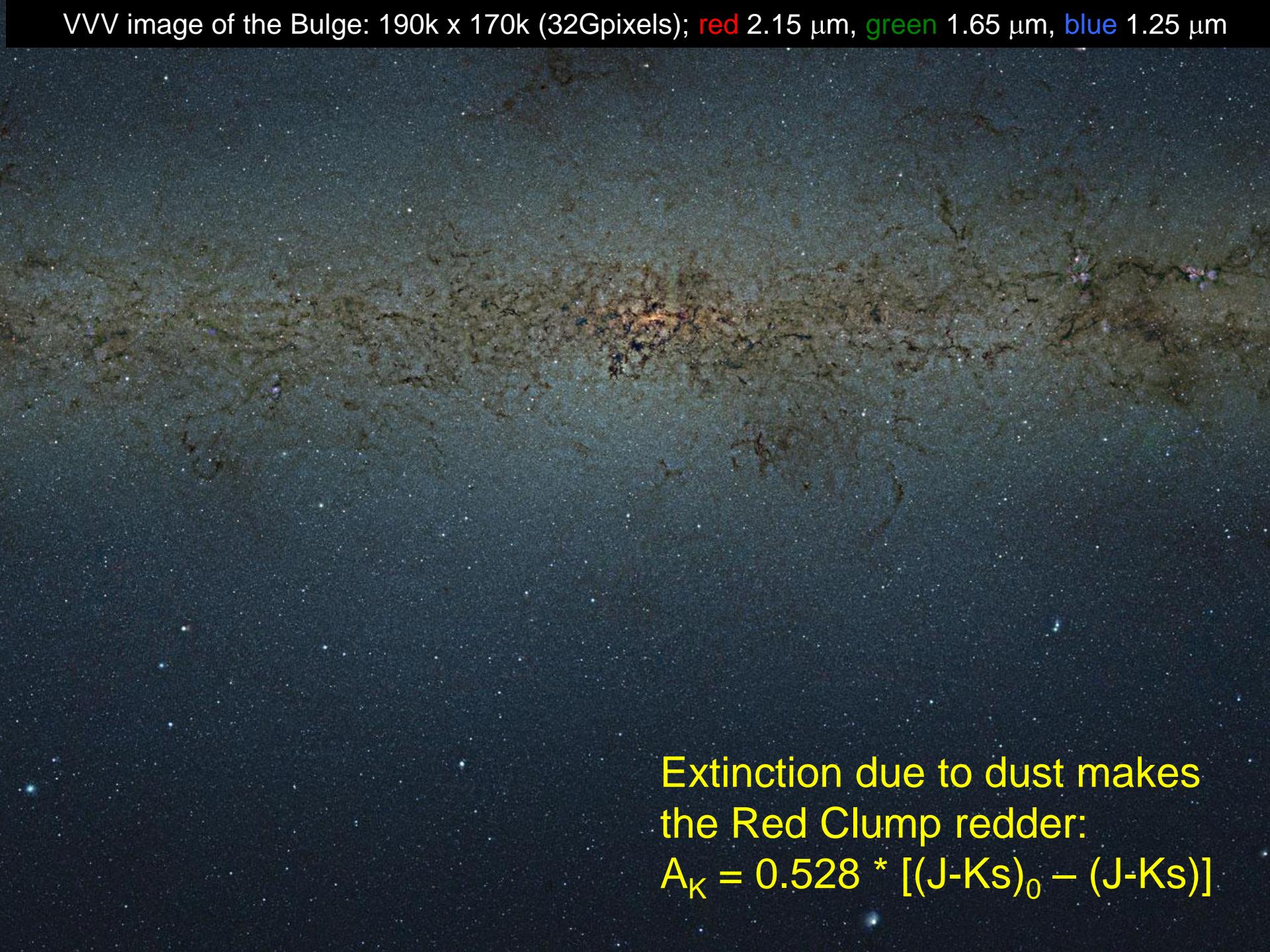


# VVV vs. 2MASS

- Sky coverage: 2MASS complete sky
- Depth: VVV is ~4mag deeper
- Resolution: VVV <1", 2MASS~4"
- VVV has time dimension – multi-epoch



VVV image of the Bulge: 190k x 170k (32Gpixels); red 2.15  $\mu\text{m}$ , green 1.65  $\mu\text{m}$ , blue 1.25  $\mu\text{m}$

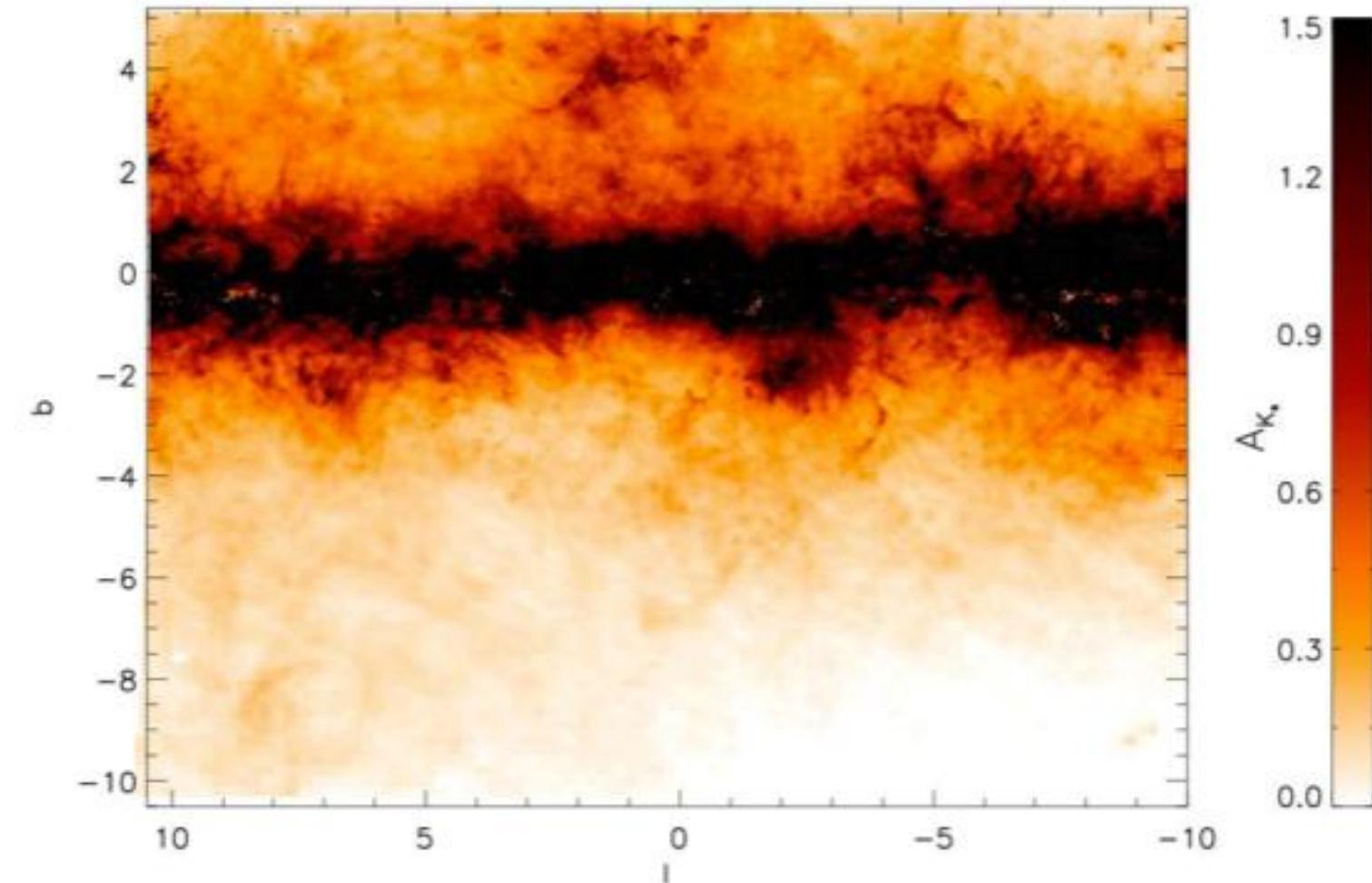


Extinction due to dust makes  
the Red Clump redder:  
 $A_K = 0.528 * [(J-Ks)_0 - (J-Ks)]$



# VVV Bulge Extinction Map

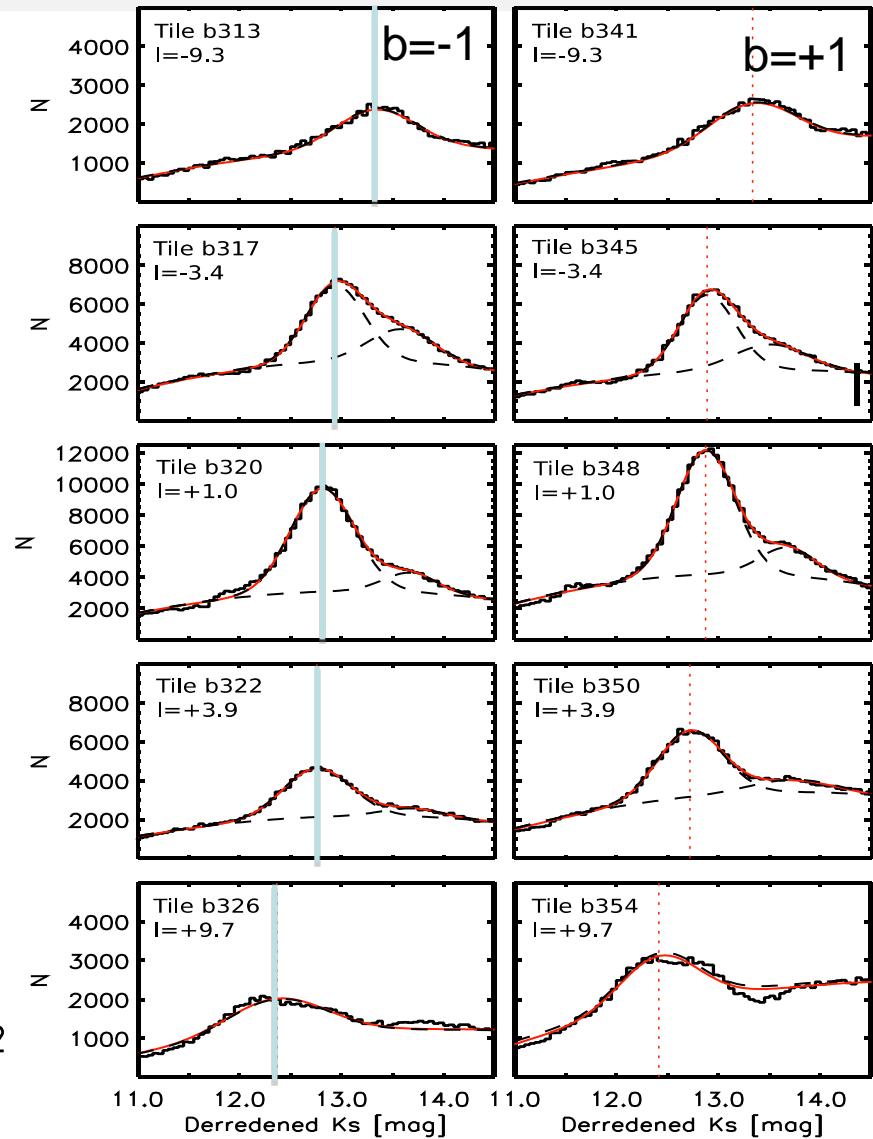
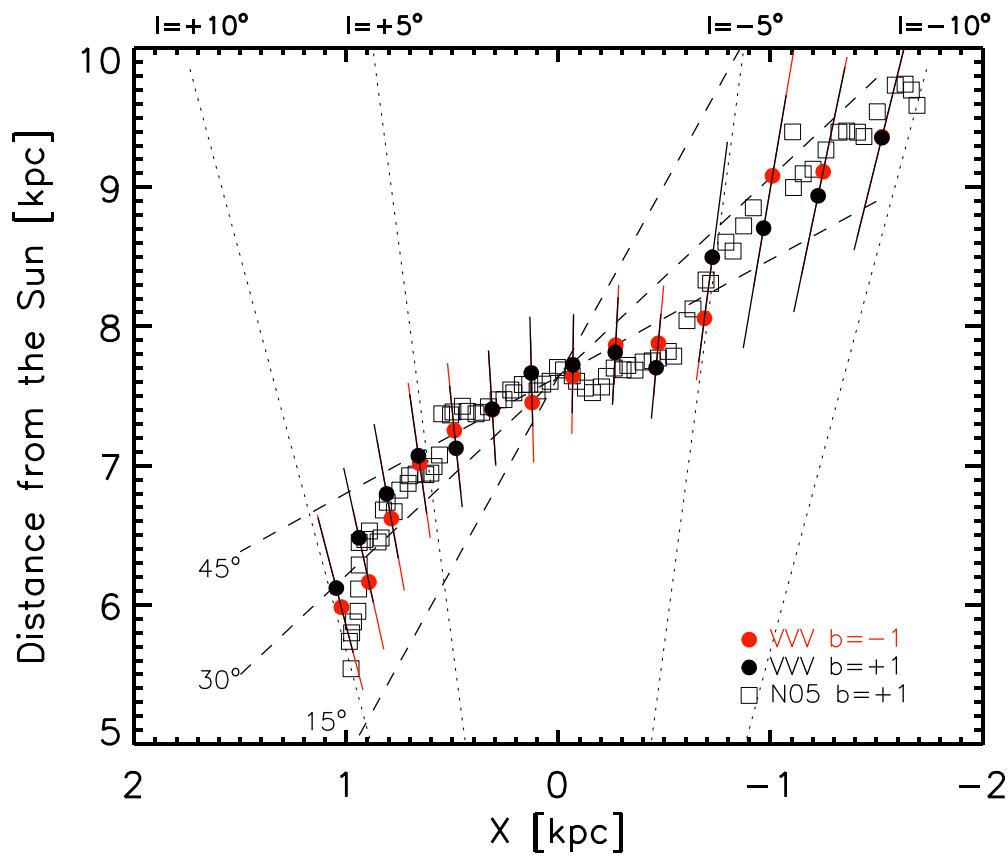
Bulge Extinction And Metallicity (BEAM) Calculator:  
<http://mill.astro.puc.cl/BEAM/calculator.php>



# The Galactic Bar

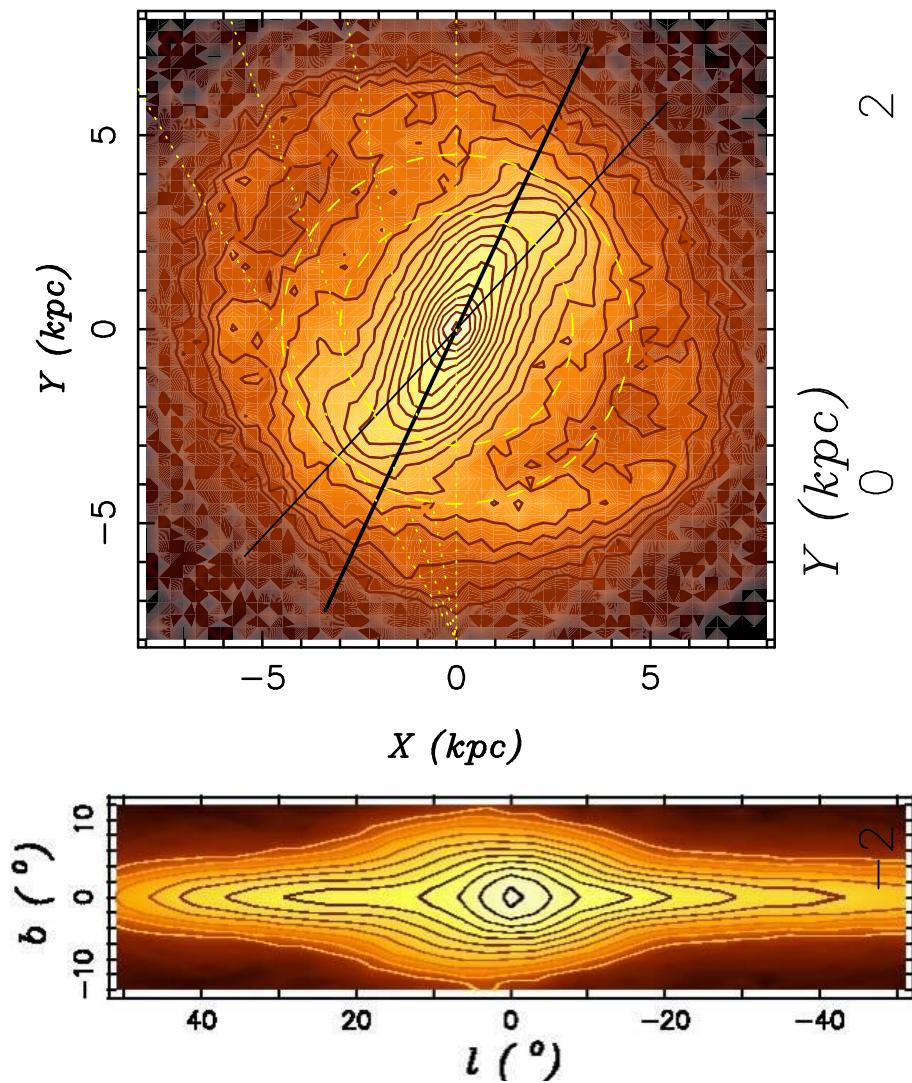
RC stars are brighter (closer) at positive longitudes

$$5\log(D) - 5 = (m - M)_{0,\text{target}} = m_K^{\text{RC}} - M_K^{\text{RC}} - A_K$$

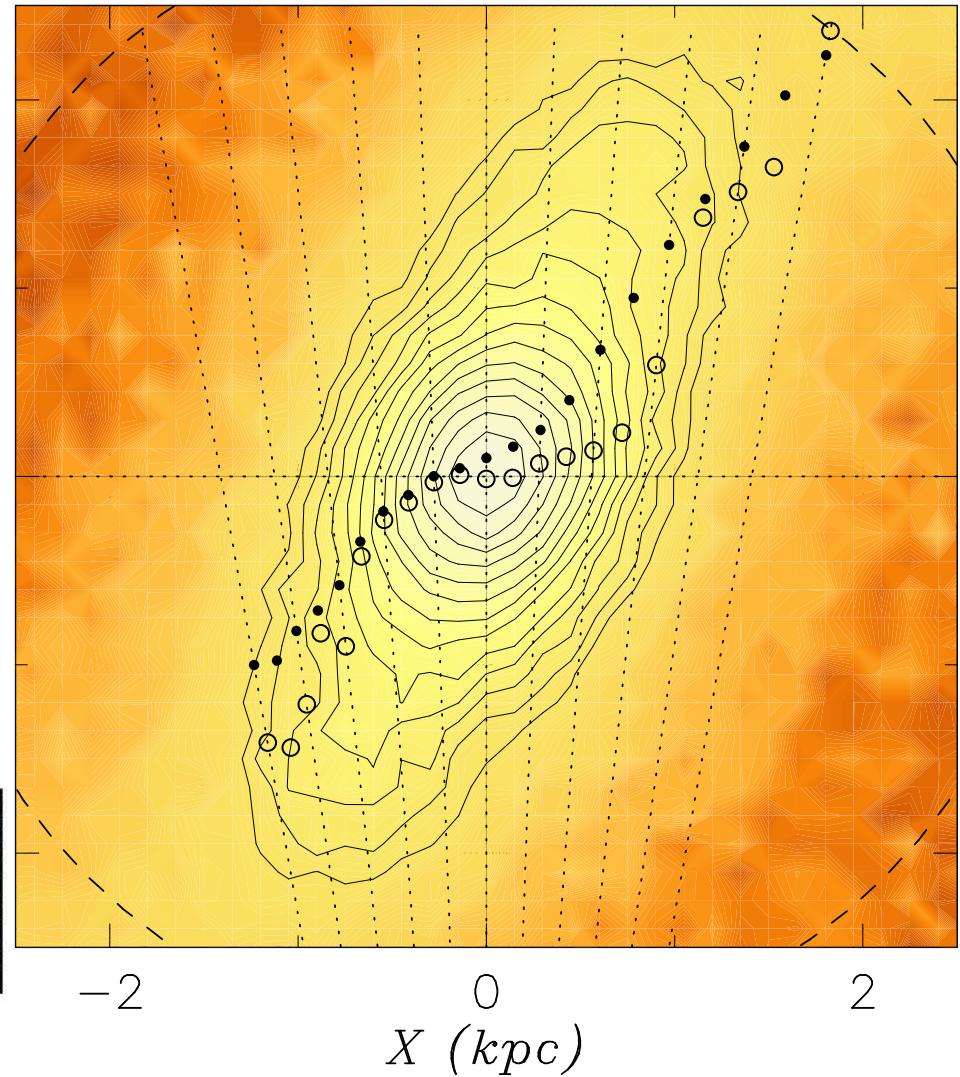




# Inner bar flattening



Model: Martinez-Valpuesta & Gerhard 2011



Gerhard & Martinez-Valpuesta 2012

2MASS vs VVV limit for

Clump Giant

[vvvsurvey.org](http://vvvsurvey.org)

