



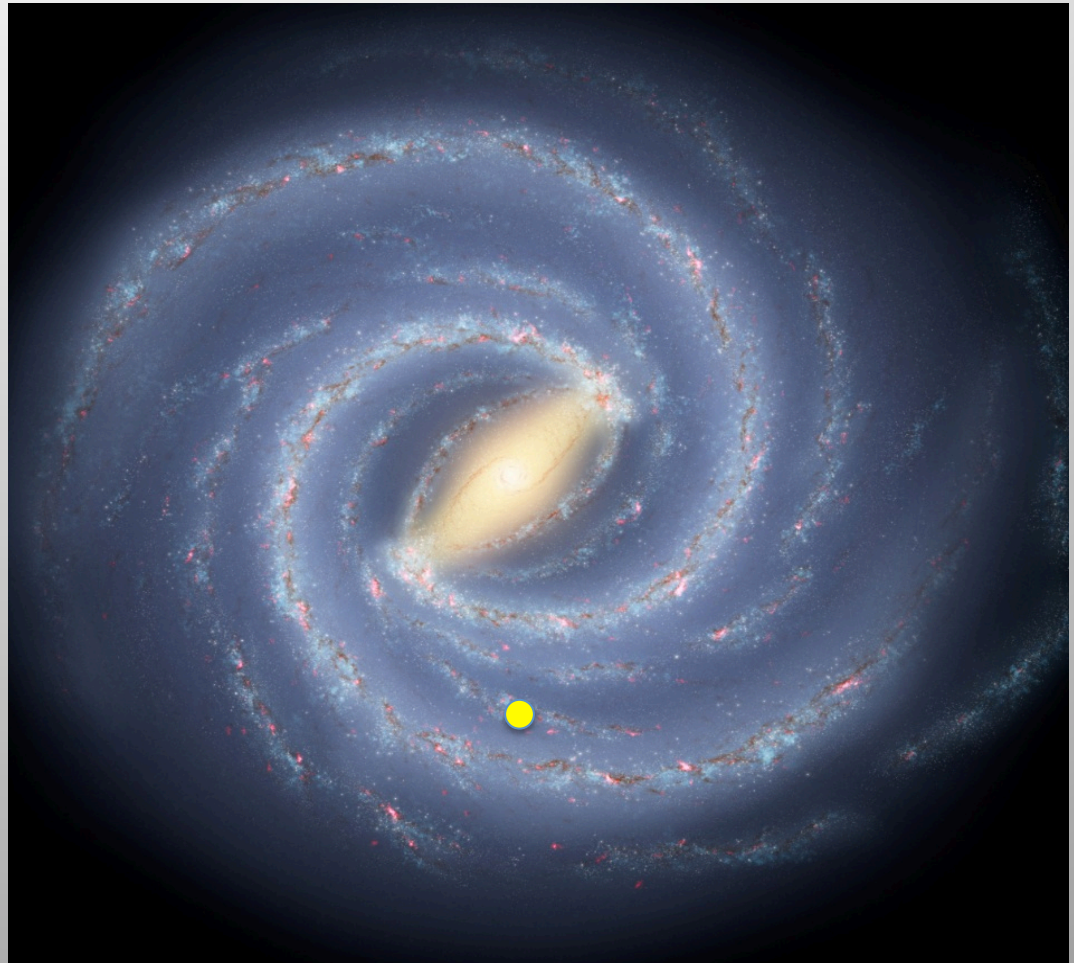
Infrared Windows on Galactic Structure

Sean Carey (IPAC/Caltech)

With lots of help from Bob Benjamin
(but don't hold him accountable)

Motive - Importance of Structure

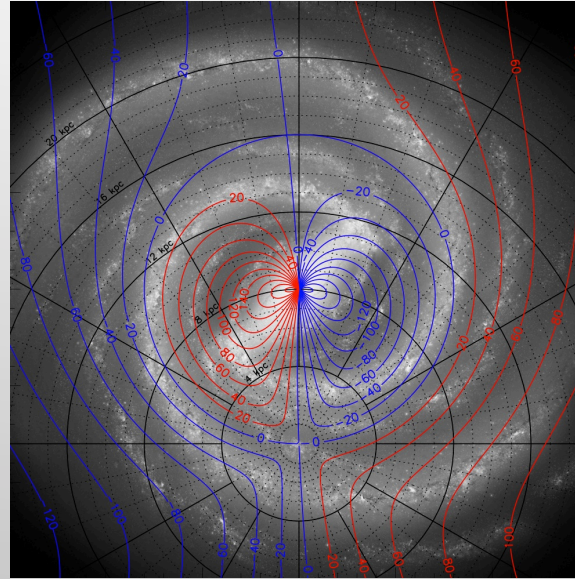
- Milky Way is only galaxy in which we can study star formation and evolution of ISM at sub-parsec scale
- Informs attempts to use direct measurements of star formation rate to global measures (e.g. total FIR, H α emission) for external galaxies
- Validate/test scaling relationships such as **Kennicutt-Schmidt law**



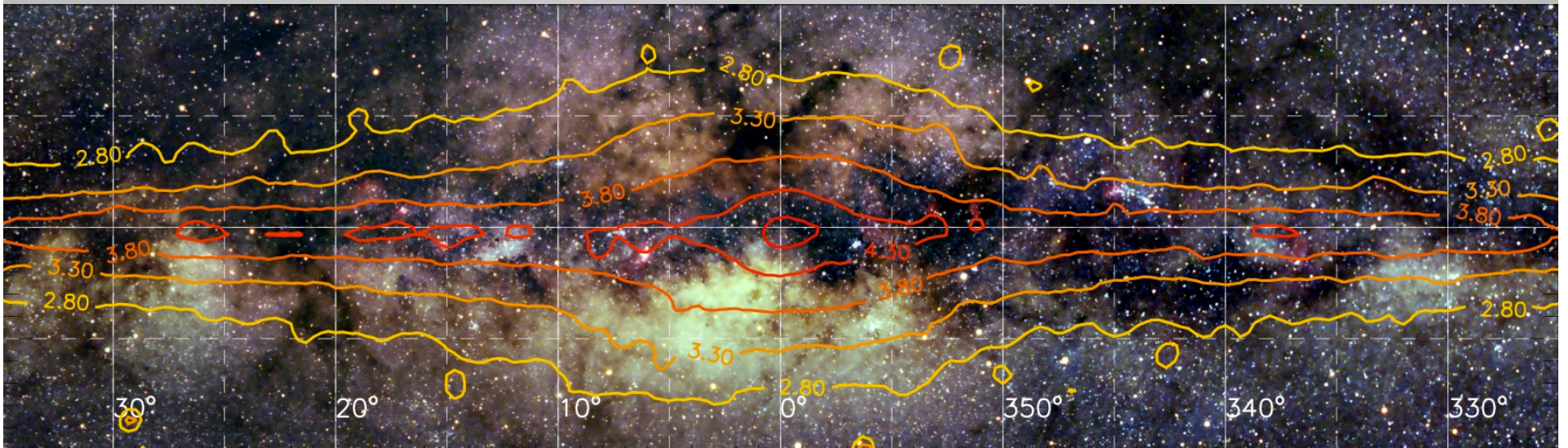
Model of Milky Way Galaxy by Robert Hurt, Bob Benjamin and a host of others

Difficulties in Determining Structure

- Vantage point
- Extinction
- Distance ambiguity



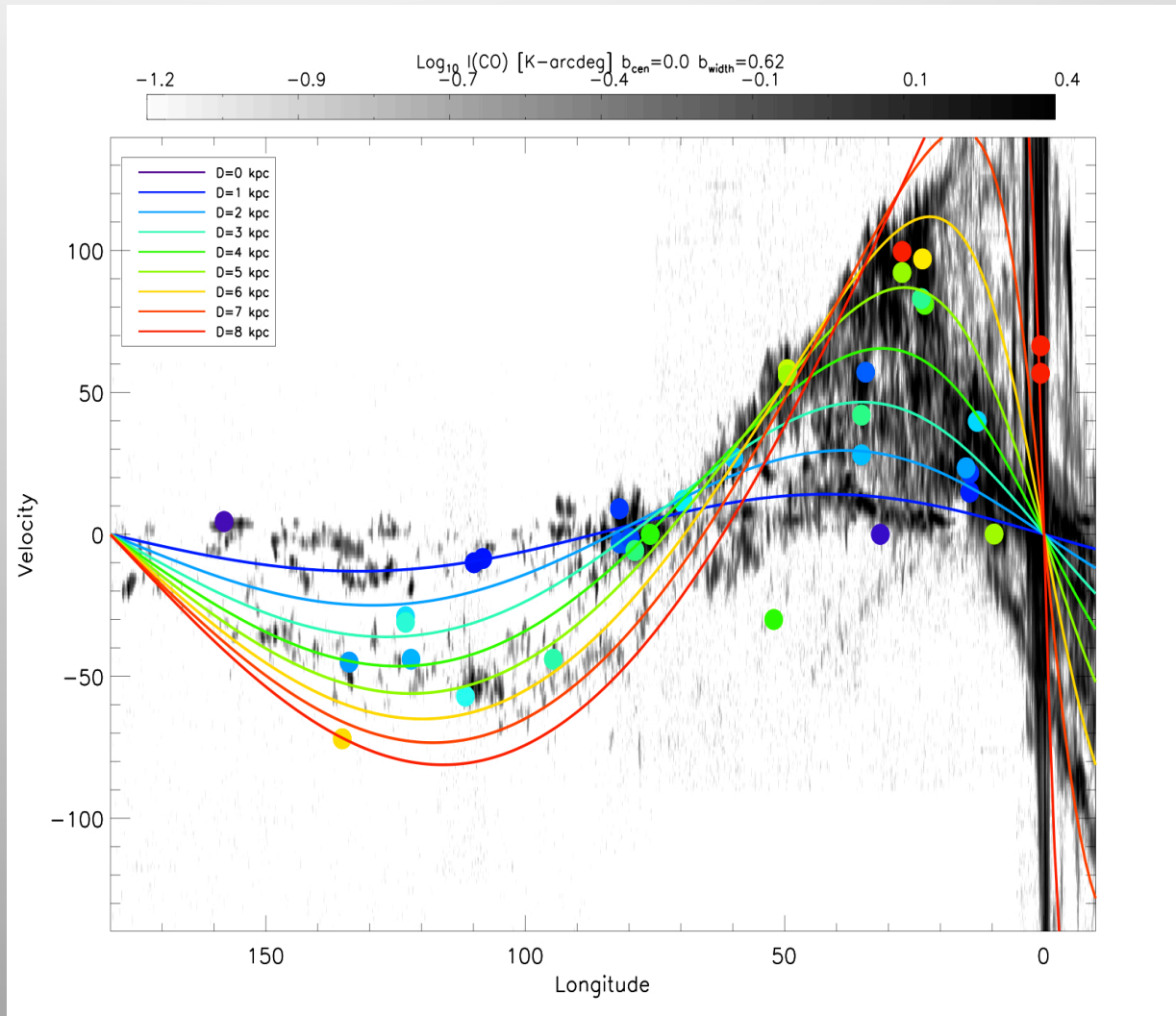
Line of sight velocity contours for Galactic rotation



Optical panorama by Axel Mellinger with with COBE/DIRBE (0.7 deg beam) contours

Tracers of Gas Structure

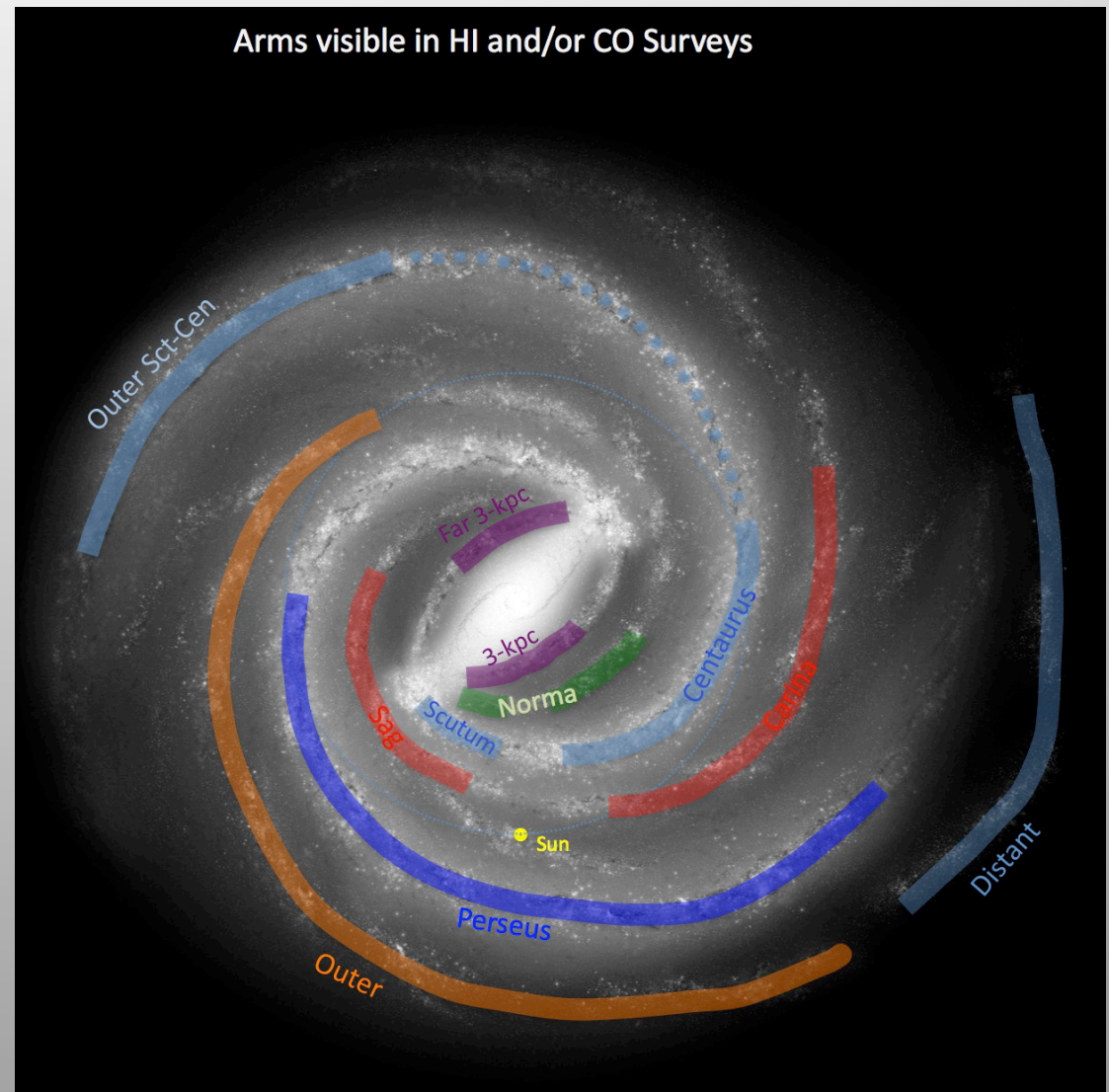
- Kinematic distances
 - HI
 - CO
- Maser parallax
- Extinction
 - IRDCs (e.g. Marshall et al. 2009)
 - Tie gas and stars together



Ando, K. et al 2011; Bartkiewicz et al 2008; Brunthaler et al 2009; Choi et al 2008; Hachisuka et al 2009; Hirota, T. et al. 2011, Honma et al 2007, Honma, M. et al. 2011; Kurayama, T. et al 2011; Menten et al 2007; Moellenbrock et al 2009; Moscadelli et al 2009; Motogi, K. et al 2011; Nagayama, T. et al. 2011; Niinuma, K. et al. 2011; Oh et al 2010; Reid et al 2009; Rygl et al 2010; Rygl et al 2011; Sanna et al 2010; Sanna, A. et al 2011; Sato et al 2008 ; Sato et al 2010; Xu et al 2009; Xu, Y. et al 2011; Zhang et al 2009

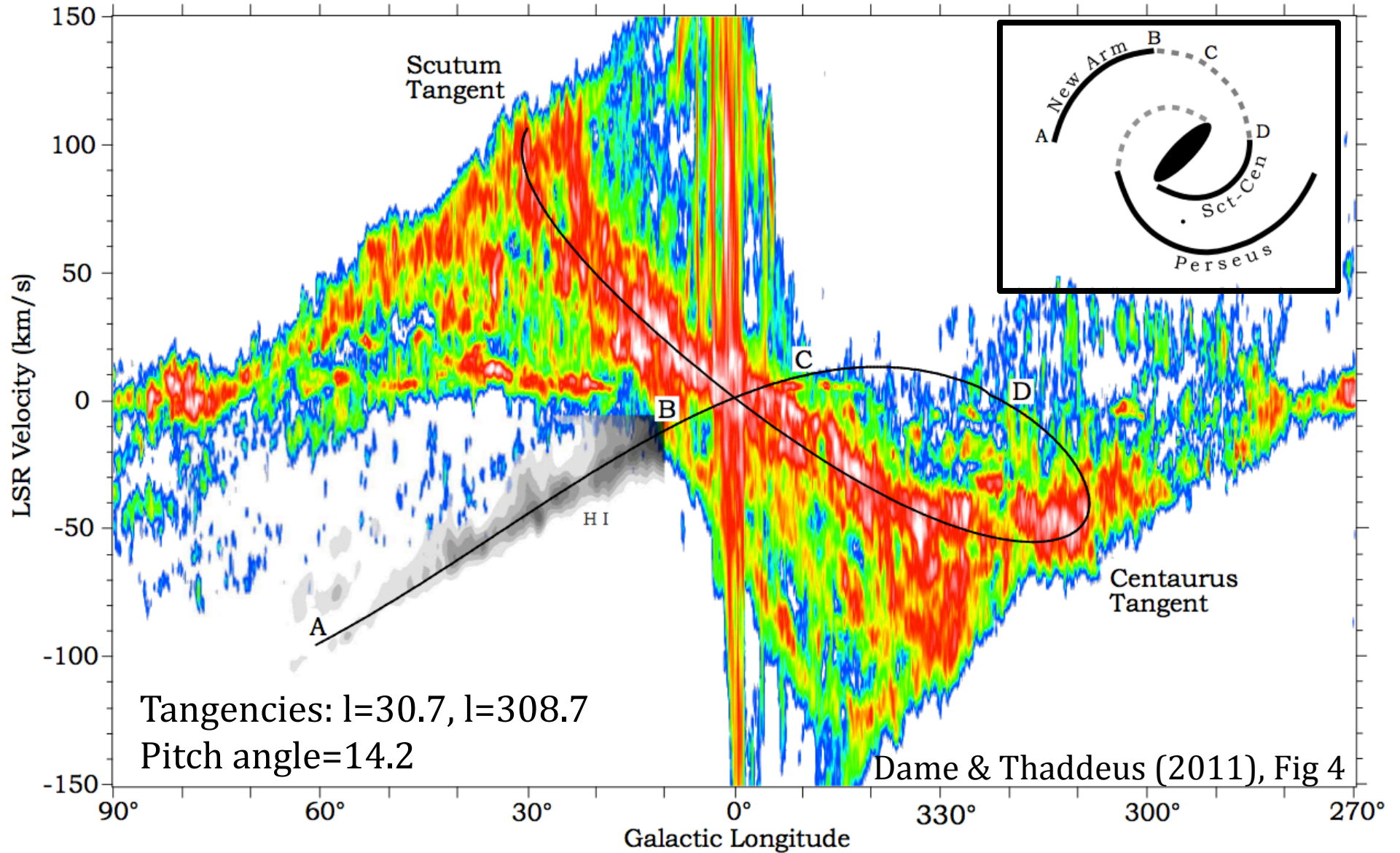
Recent Gas Structure Results

- “Distant” molecular arm (McClure-Griffiths et al. 2004)
- Far 3kpc arm (Dame & Thaddeus 2008)
- Outer Scutum-Centaurus Arm (Dame & Thaddeus 2011)



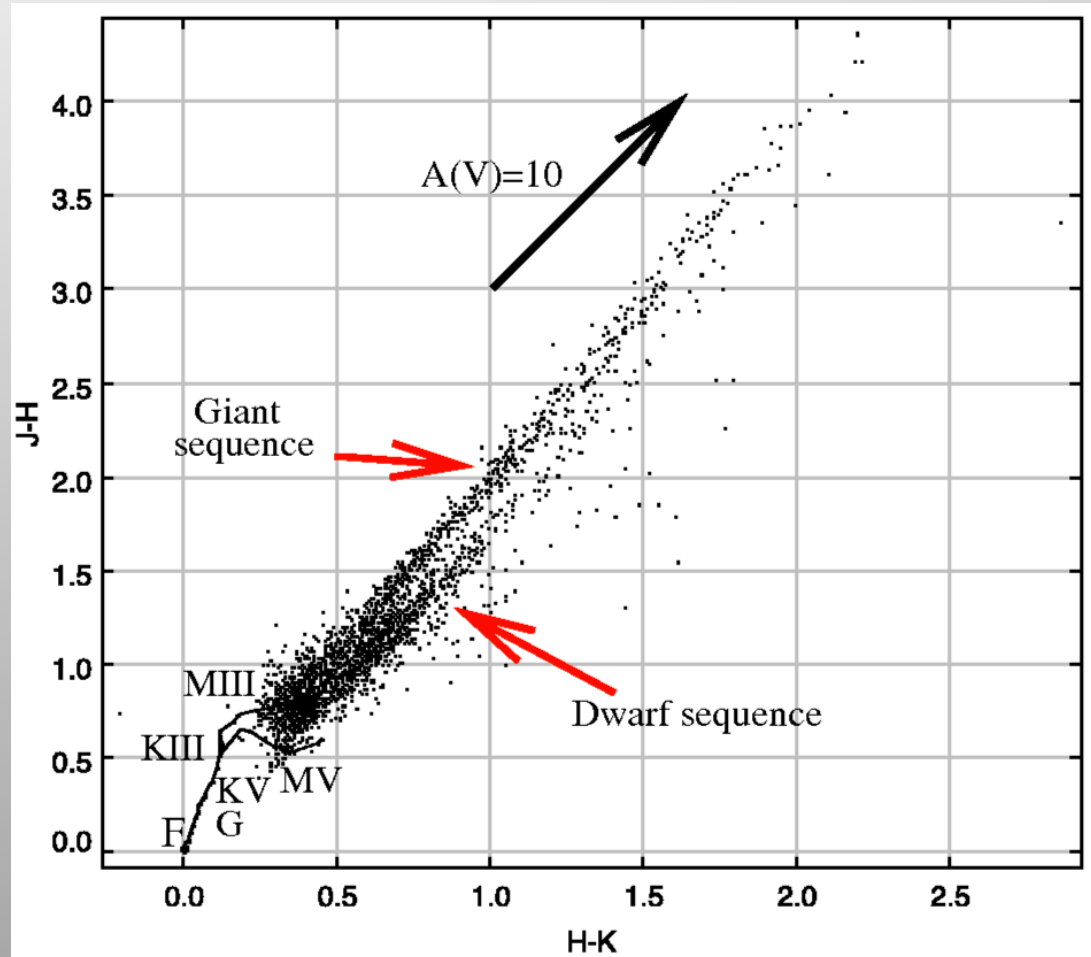
Arm identifications from Benjamin (2012)

Outer Scutum - Centaurus Arm



Red Clump Giants Trace Stellar Structure

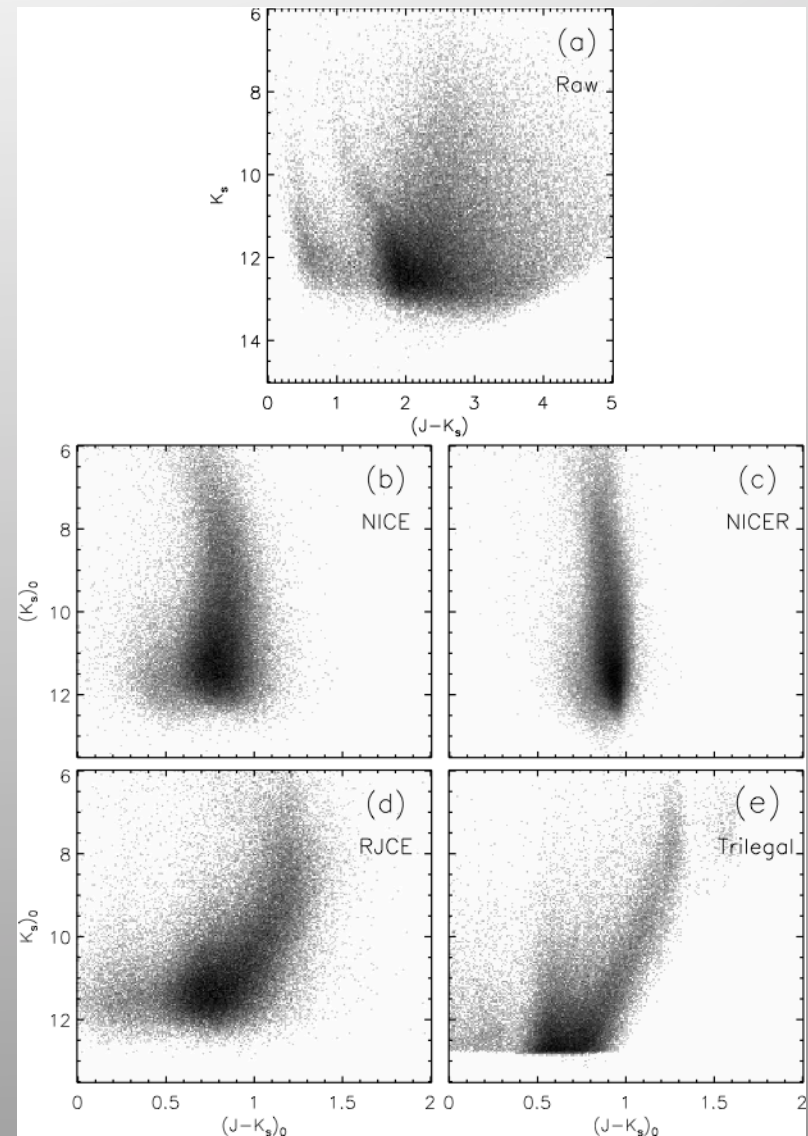
- Spectral Types: G8III – K2III
- $M_K = -1.54 \pm 0.04$ (Groenewegen 2008)
- Well separated in several color-magnitude diagrams



Lucas et al. (2008)

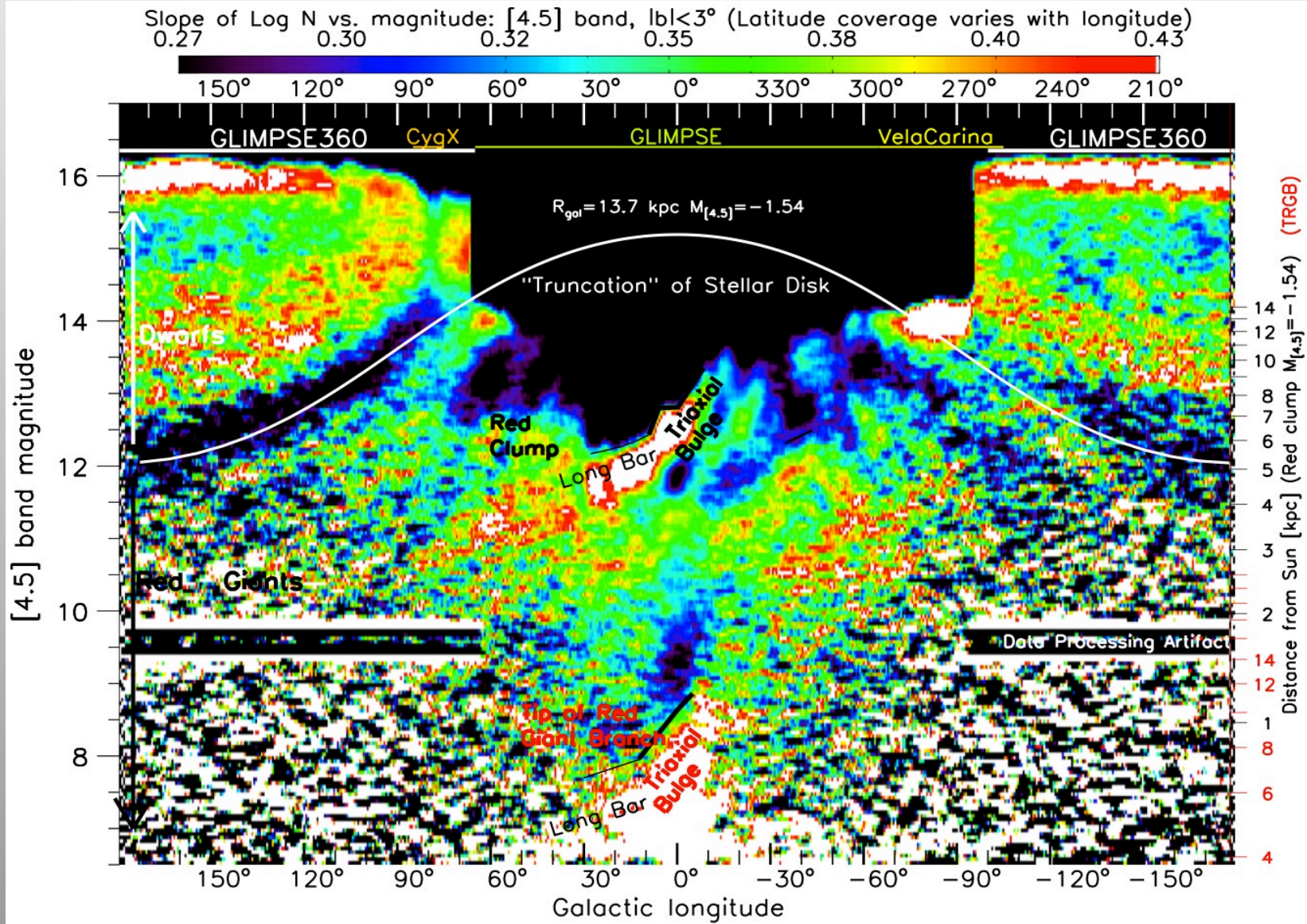
Improvement with L and/or M band

- IRAC [3.6],[4.5] (or L, M) almost extinction free (Zasowski et al. 2009)
 - $A_{[3.6]} \sim 0.5 A_K$
 - $A_{[4.5]} \sim 0.4 A_K$
- Clear improvement in dereddening using $\lambda > 3 \mu\text{m}$



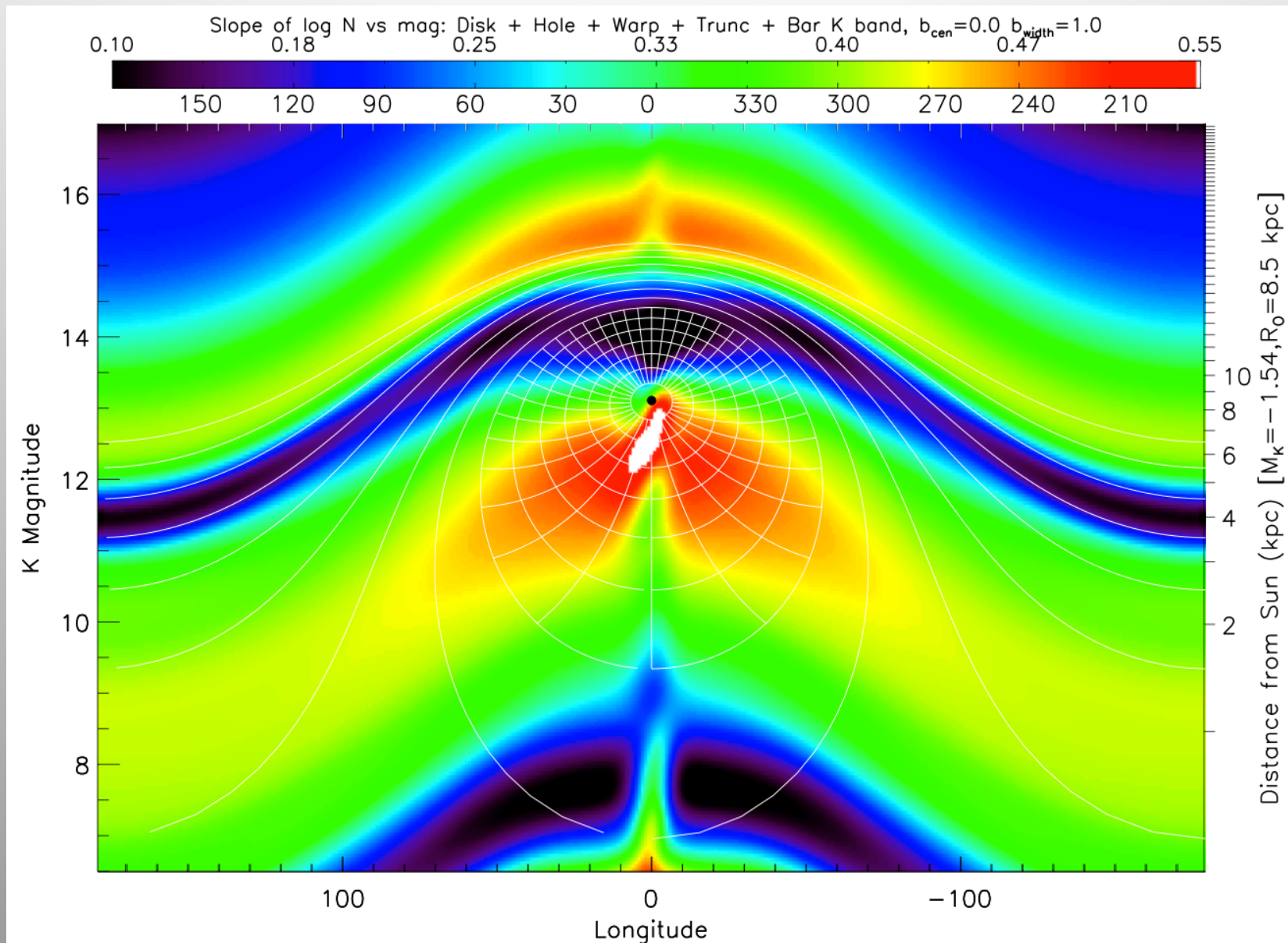
Majewski et al. (2011)

Evidence - Galactic Structure from Red Clump Giants



Data and analysis (Benjamin 2012)

Expert Testimony - Galactic Structure Models



Density model (Freudenreich 1998) + LF (Girardi et al 2005)

Closing Arguments – WFIRST Will Enable Galactic Structure Studies

- Probe far side of Galaxy
- Pierce extinction in Galactic mid-plane
- Improved statistics
- Test symmetry of Galaxy
- Tie together kinematic information and stellar distances
 - Dynamics of ISM
 - Distribution of Star Forming Regions

WFIRST sensitivity estimate vs. UKIDSS

	UKIDSS	WFIRST
J	19.2	21.0
H	17.5	20.4
K	16.7	20.3

$l = 30^\circ, b = 0^\circ$