Solar distance from the galactic plane by means of OB stars

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Torino, 6 ottobre 2015


The Milky Way

Milky Way

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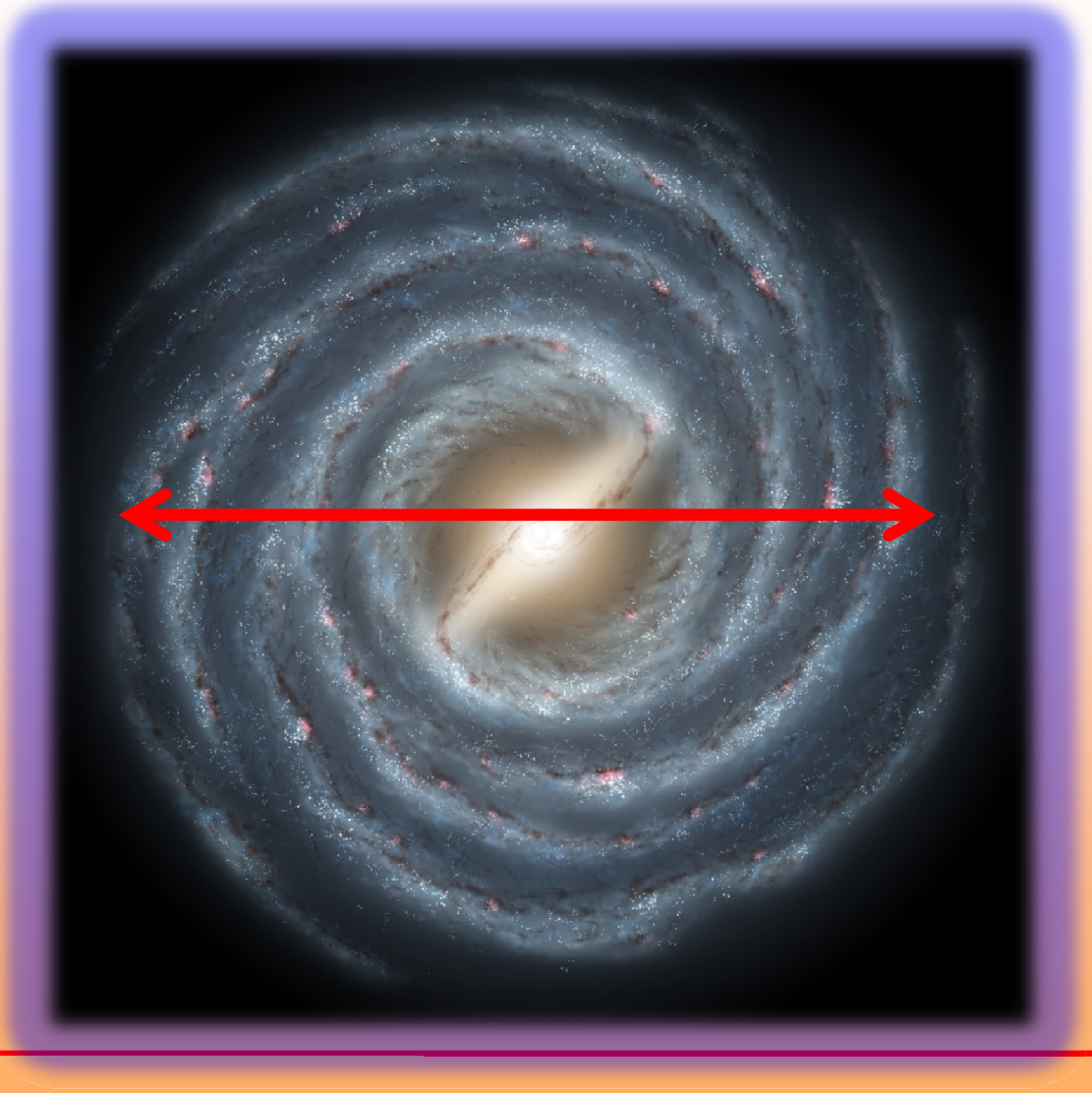

Disk size:
30 kpc

(100,000 light years)

Milky Way

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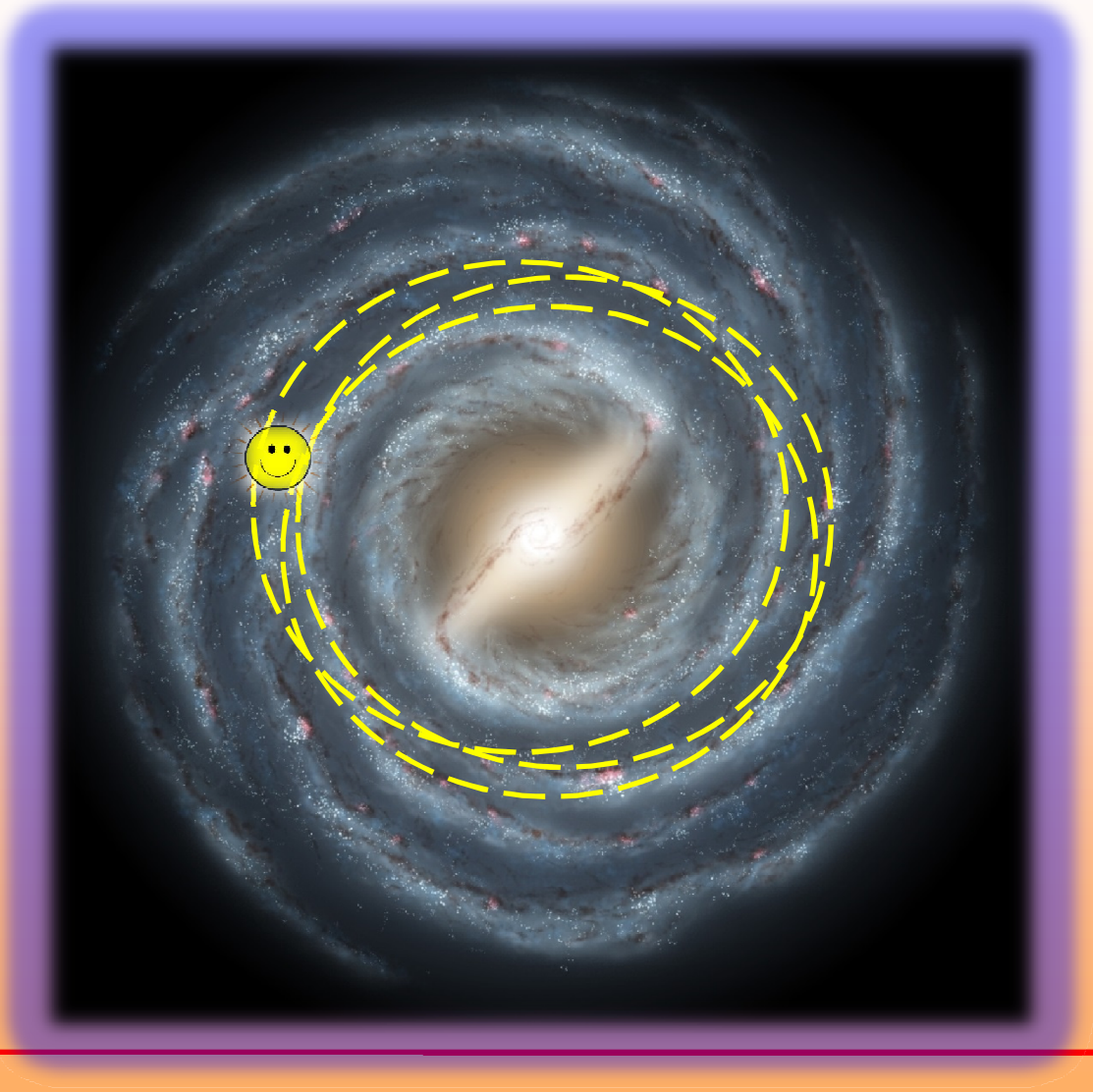
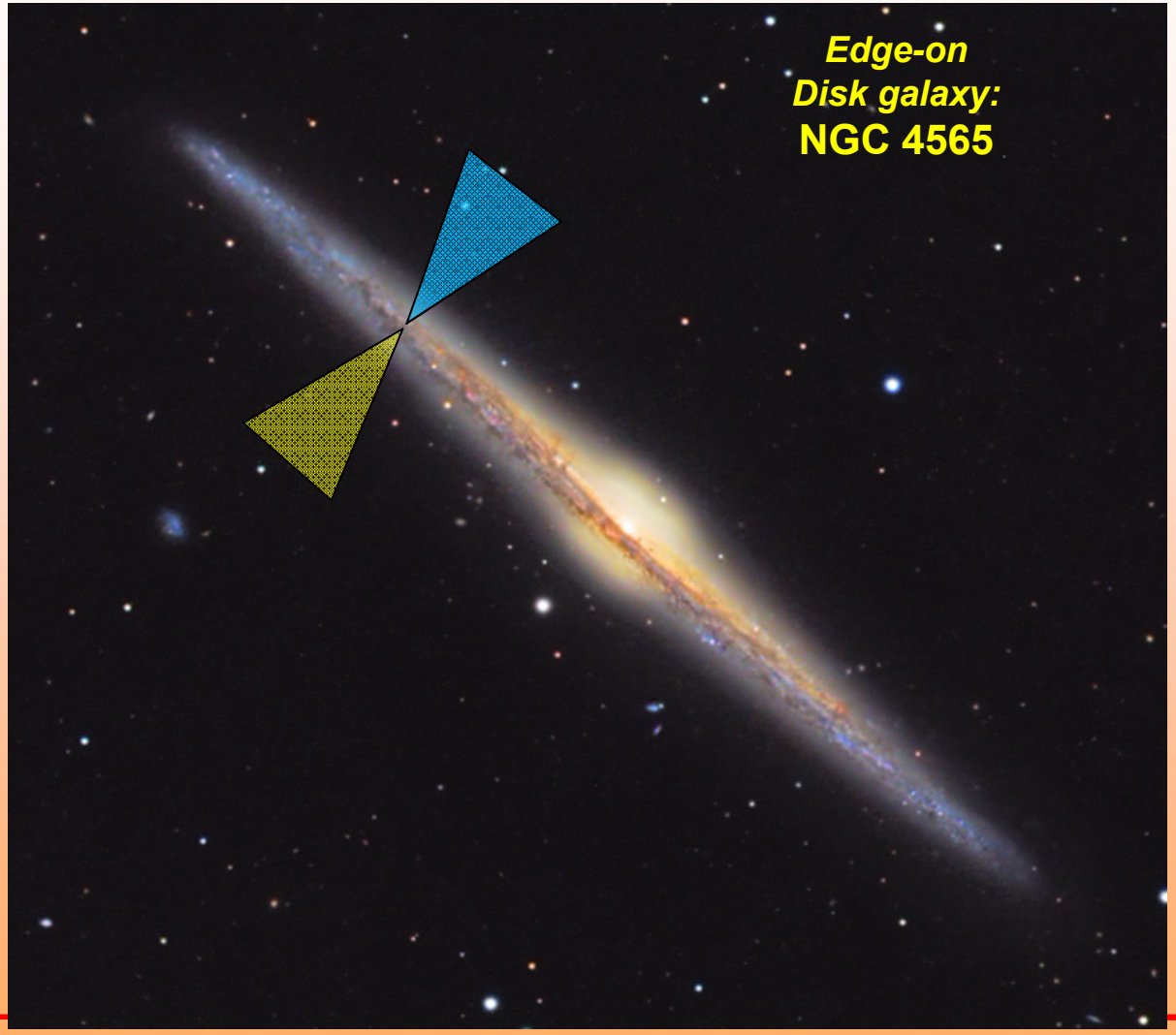


Sun position:

R ≅ 8 kpc

Starcounts: North vs. South



Starcounts: North vs. South

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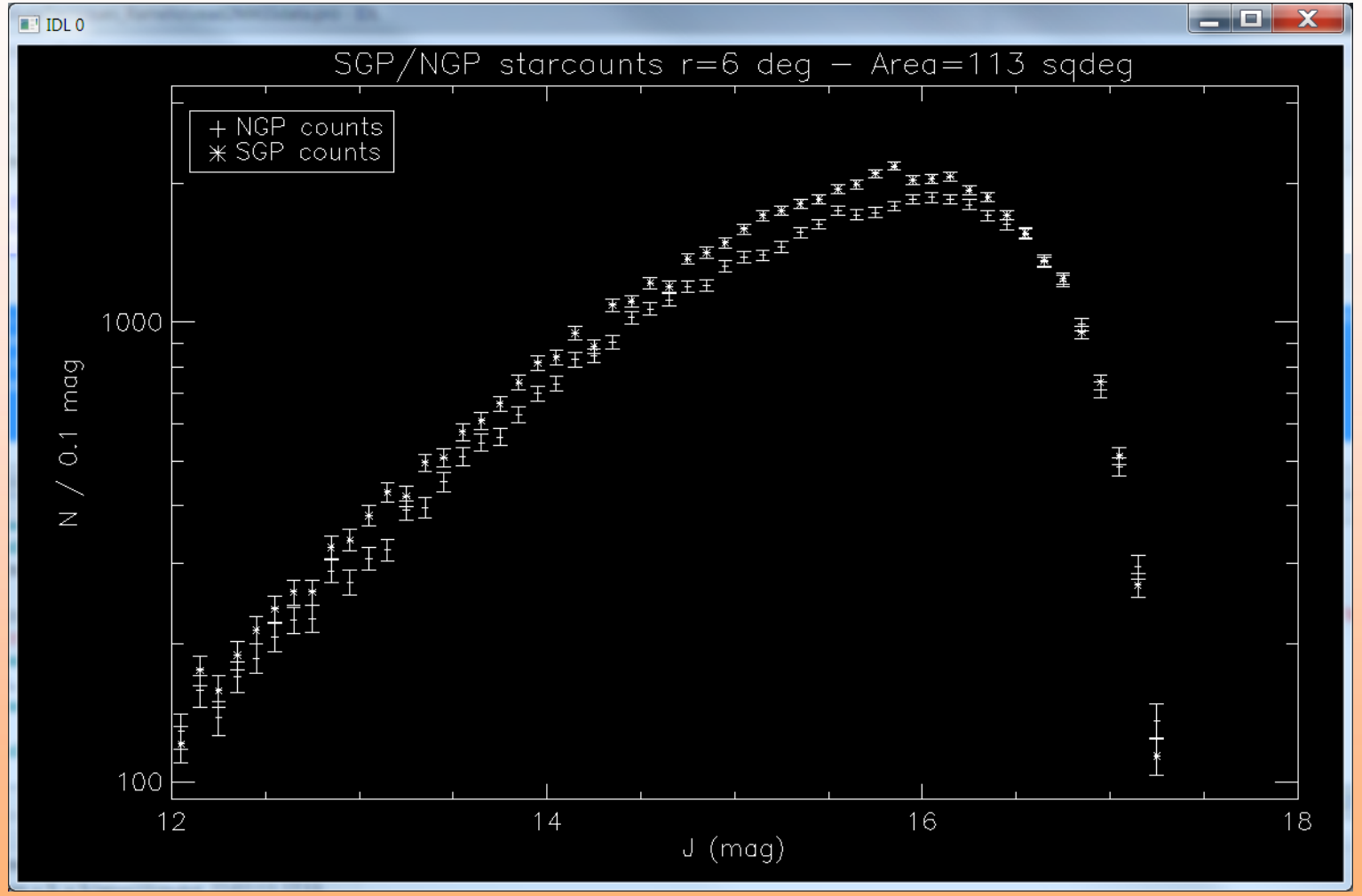
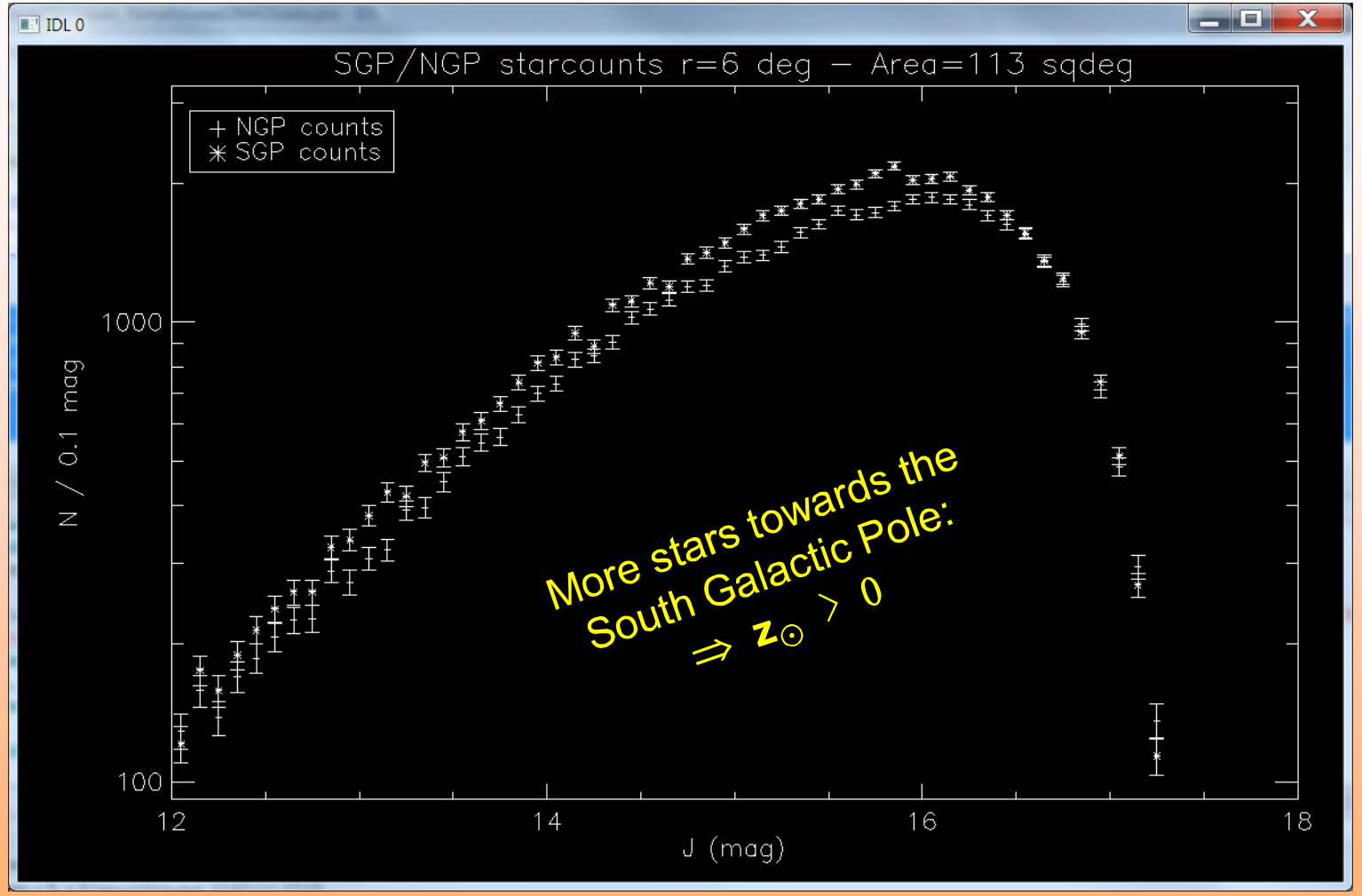


Selected tracers: 0.5<J-K<0.7 mag

Starcounts: North vs. South



Selected tracers: 0.5<J-K<0.7 mag

Starcounts

What surveys can do: *Count the objects!*

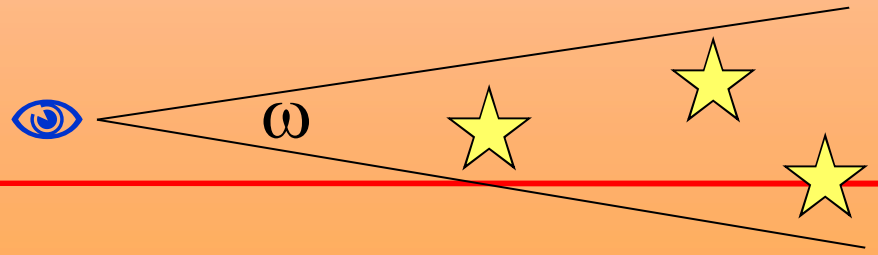
$$A(m) = \omega \int_0^{\infty} \psi(M_r, r) \cdot D(r) \cdot r^2 dr$$

Fundamental Equation of the Stellar Statistics
(Integral Fredholm's equation of the first kind).

Ψ(M)=Luminosity function D(x,y,z)=density distribution

$$M = m + 5 - 5\log r - a(r)$$

Distance Modulus



Galaxy mode by W. Herschel - 1785

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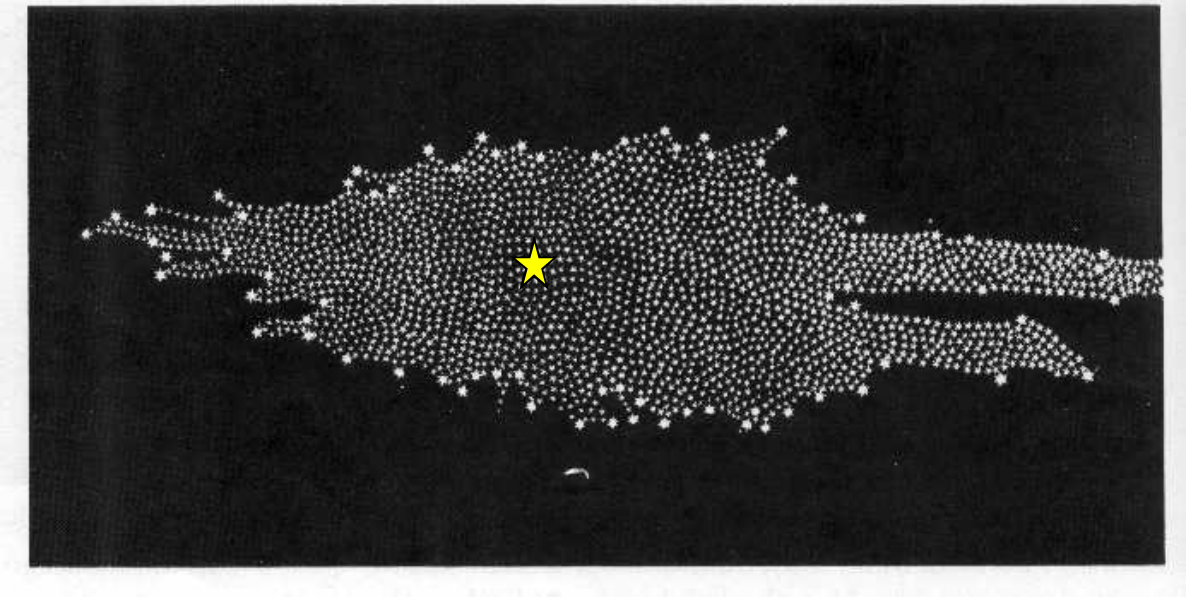


Conteggio delle stelle in 683 regioni di cielo fino alla mag. limite

Assunzione

stelle distribuite uniformemente

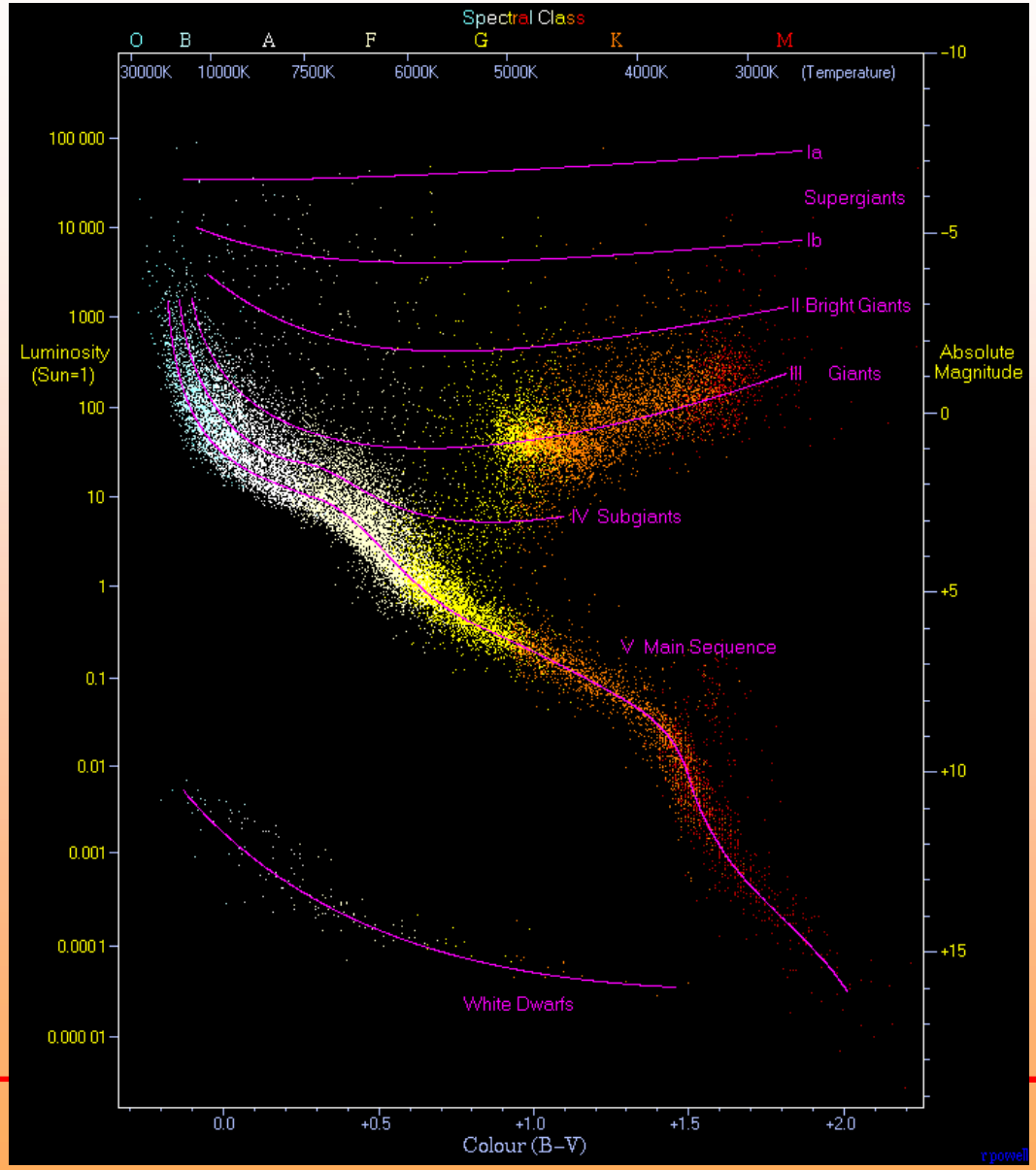
stelle con medesima luminosità intrinseca

non esiste l'Assorbimento Interstellare

Risultato

Struttura ellissoidale schiacciata con Sole quasi al centro

HR Diagram



22,000 Hipparcos stars + 1000 stars from the Gliese catalog

(plot by R. Powell)

Thin disk & thick disk

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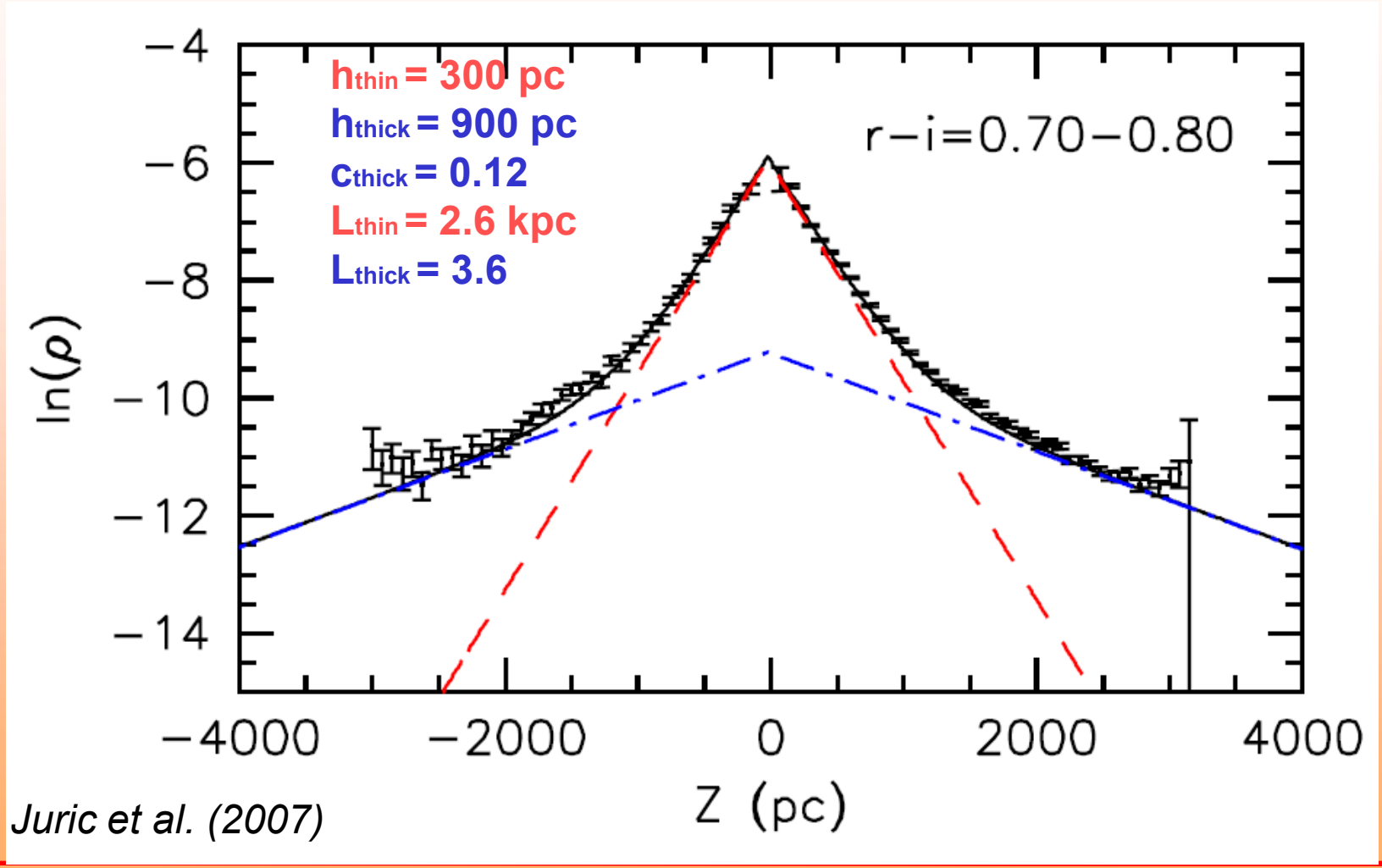
Vertical distribution



Juric et al. (2007)

Stellar density distributions

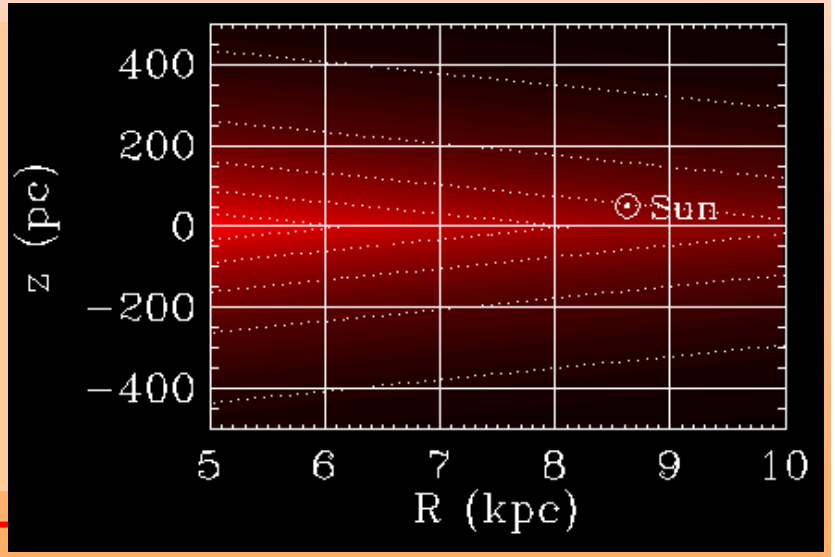
The space distributions (**n.ro stars/pc^3**) of the various stellar populations are well represented by axi-symmetric functions:

(a) **Exponential distribution - *Thin/thick disk***

$$\rho(R,z) = \rho_0 \cdot e^{-|z|/h_z} \cdot e^{-(R-R_0)/h_R}$$

- $h_z \cong 250$ pc *vertical scale height* -**Thin disk**
- $h_z \cong 1000$ pc *vertical scale height* - **Thick disk**
- $h_R \cong 3.5$ kpc *radial scale-lenght*

- $z_0 \cong 10$-20 pc *Sun position above the plane*
- $R_0 \cong 8.0$ kpc *Solar galactocentric distance*



The disk flare

Flared exponential distribution (Thin/thick disk)

The space distributions (**n.ro stars/pc^3**)

$$\rho(R,z) = \rho_0 \cdot e^{-|z|/h_z} \cdot e^{-(R-R_0)/h_R}$$

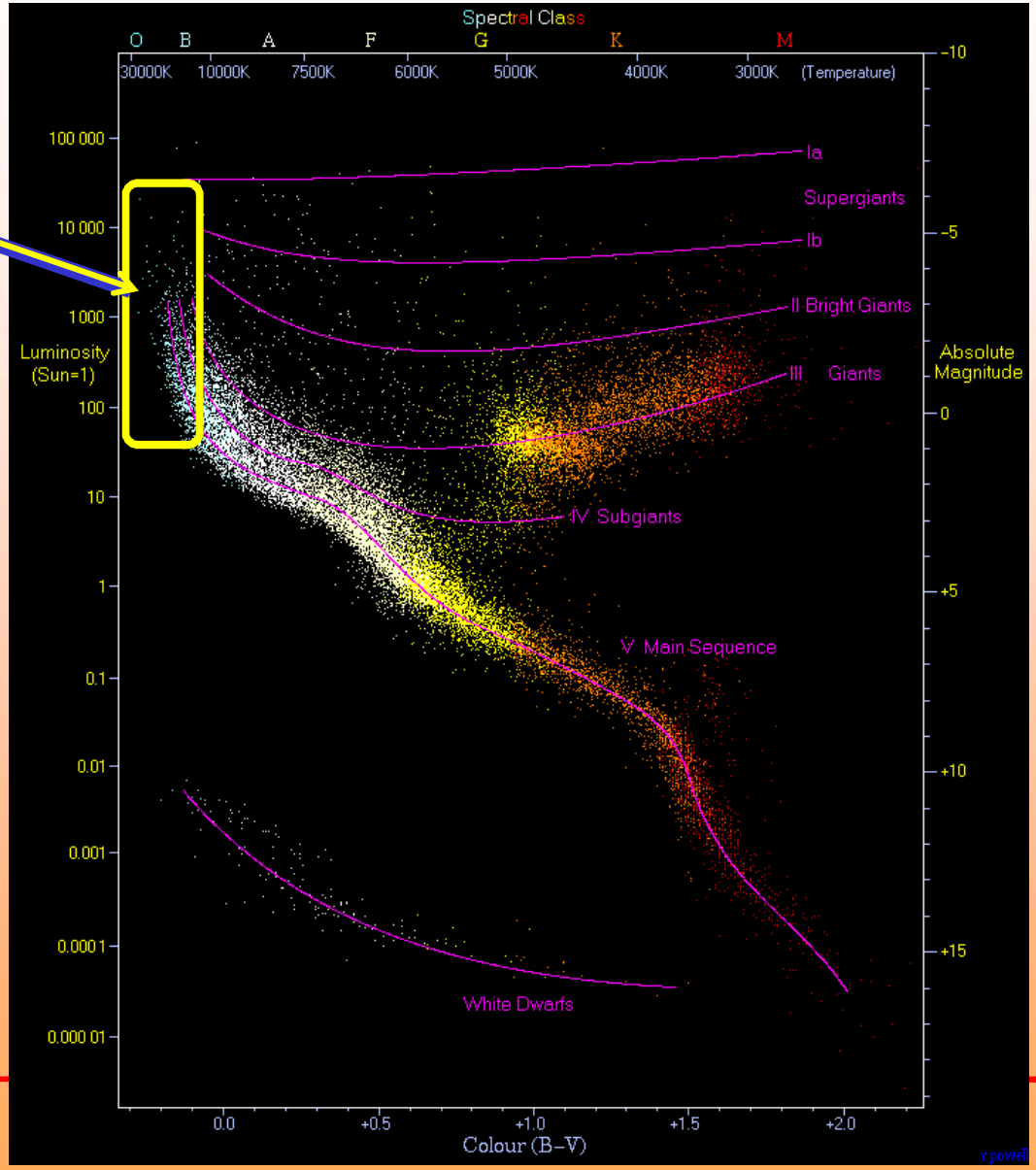
$$h_z(R) = h_z(R_0) \cdot e^{(R-R_0)/h_f}$$

Thin disk	Thick disk
•$h_z \cong$ 193 pc *vertical scale height at Ro*	•$h_z \cong$ 611 pc *vertical scale height at Ro*
• $h_R \cong$ 2 kpc *vertical scale height at Ro*	•$h_R \cong$ 3 kpc *vertical scale height at Ro*

•$h_f \cong$ 23 kpc flare characteristic radius (Sollima *et al.* 2011 *ApJ* **730** L6)

HR Diagram

OB stars as tracers



22,000 Hipparcos stars + 1000 stars from the Gliese catalog

(plot by R. Powell)

Accuracy level

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Trigonometric distance

$$d = 1/\pi$$

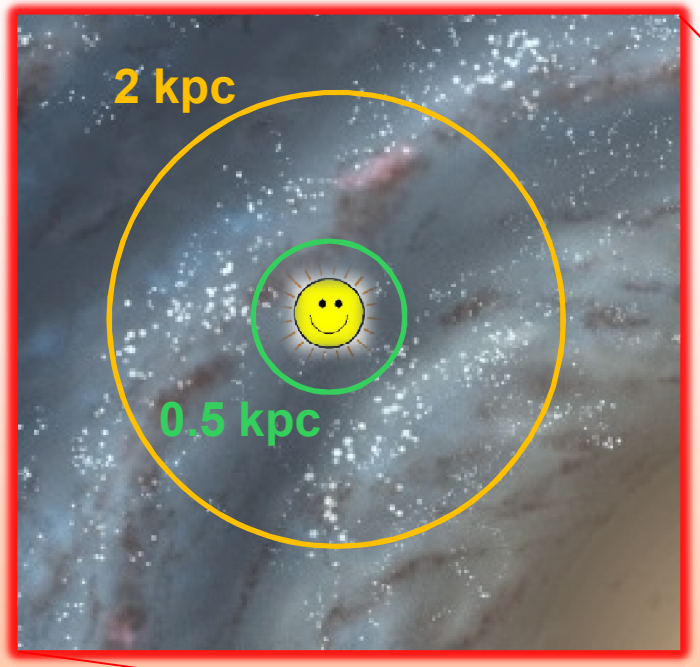
$$\sigma_d / d = \sigma_\pi / \pi$$

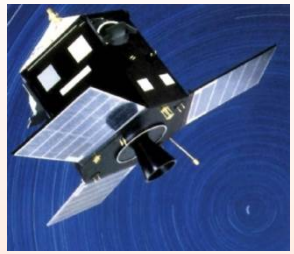
Examples:

σ=1 mas, d=1 kpc $\Rightarrow$ σ_d/d = 1

σ=10 μas, d=10 kpc $\Rightarrow$ σ_d/d = 0.10

Trigonometric parallaxes: Hipparcos's horizon





σ_π = 0.001 arcsec

distance	σ_d / d
100 pc	10%
200 pc	20%
500 pc	50%

Accuracy level

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Photometric distance

m – M = 5 log d – 5 + A (distance modulus)

$$d = 10^{(m-M)/5+1}\ pc$$

$$\sigma_d = \frac{\ln 10}{5} d \cdot \sigma_{(m-M)} \cong 0.46 \cdot d \cdot \sigma_{(m-M)}$$

Example:

σ = 0.2 mag $\Rightarrow$ σ_d/d = 0.10

σ = 0.6 mag $\Rightarrow$ σ_d/d = 0.30

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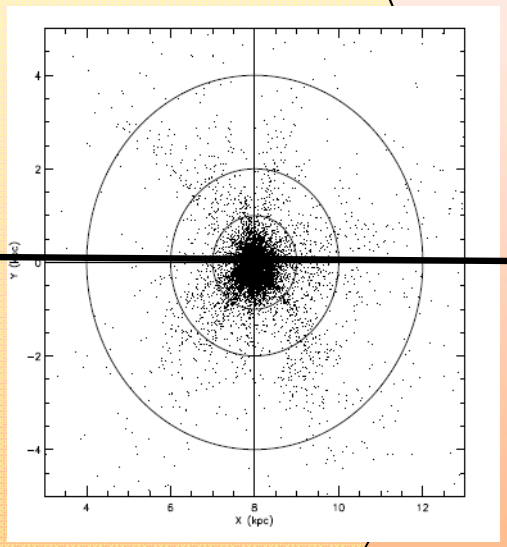
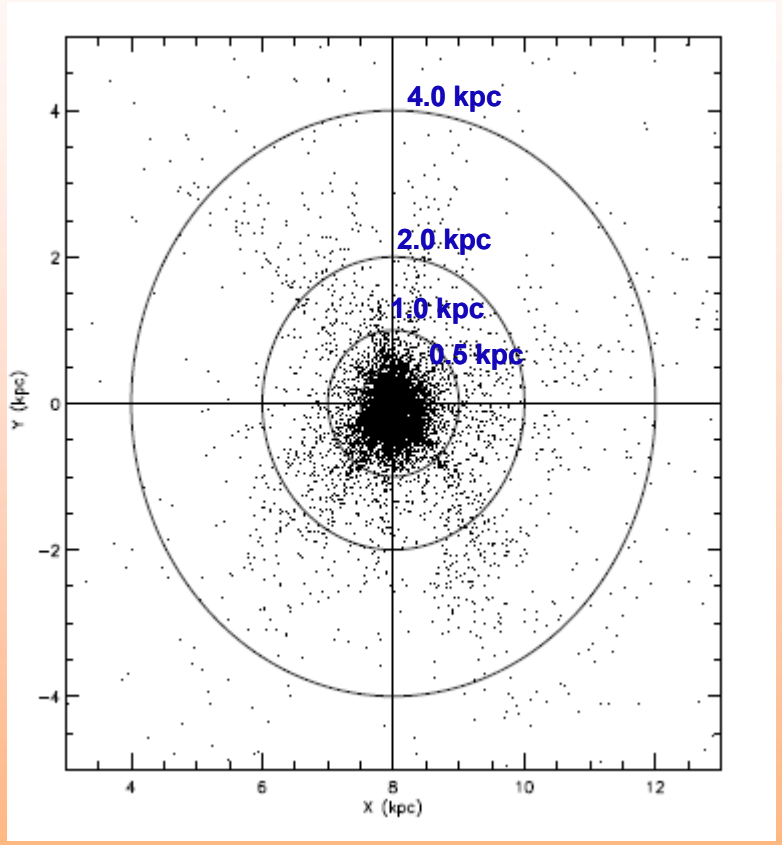
Y

Galactic
Center

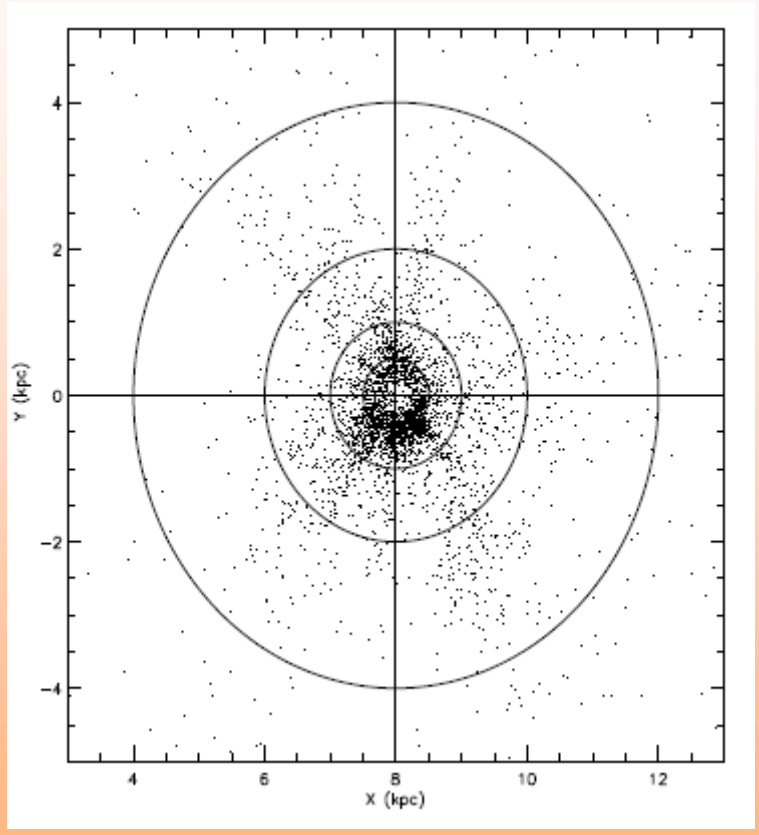
X



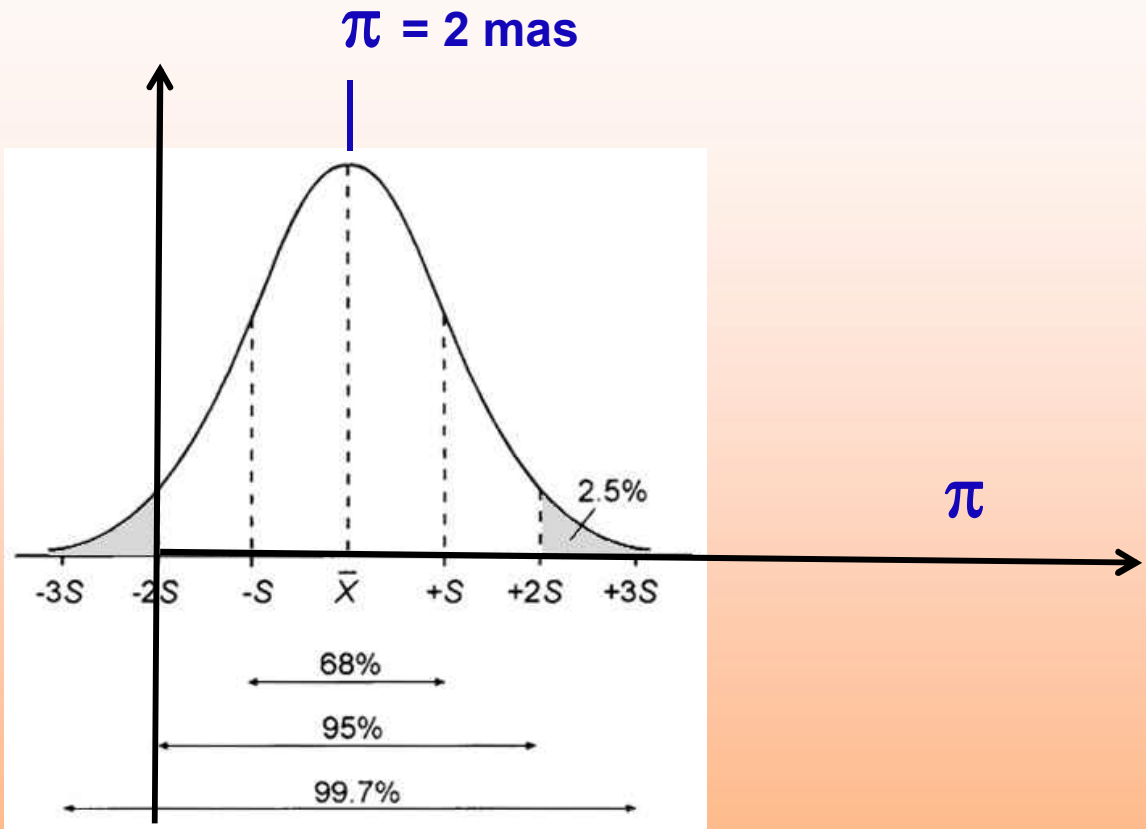
OB stars
from Hipparcos catalog



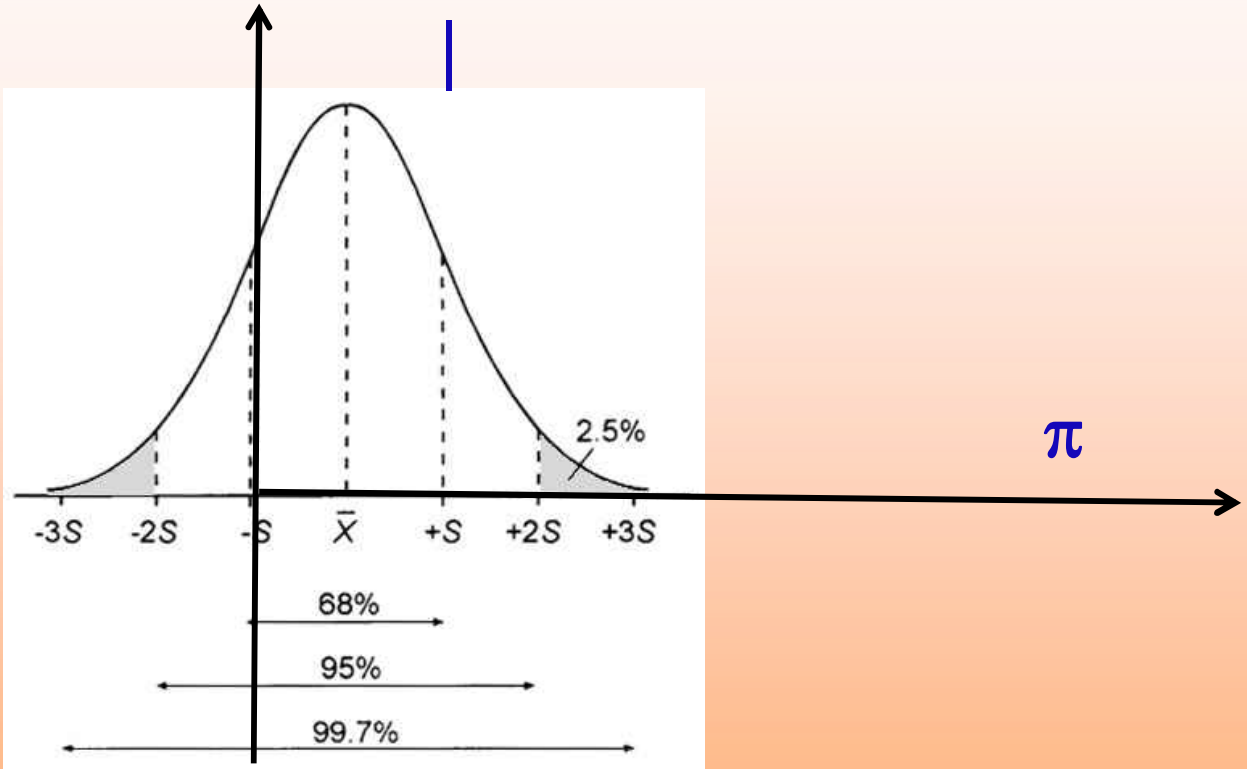
All (9372 OB stars)



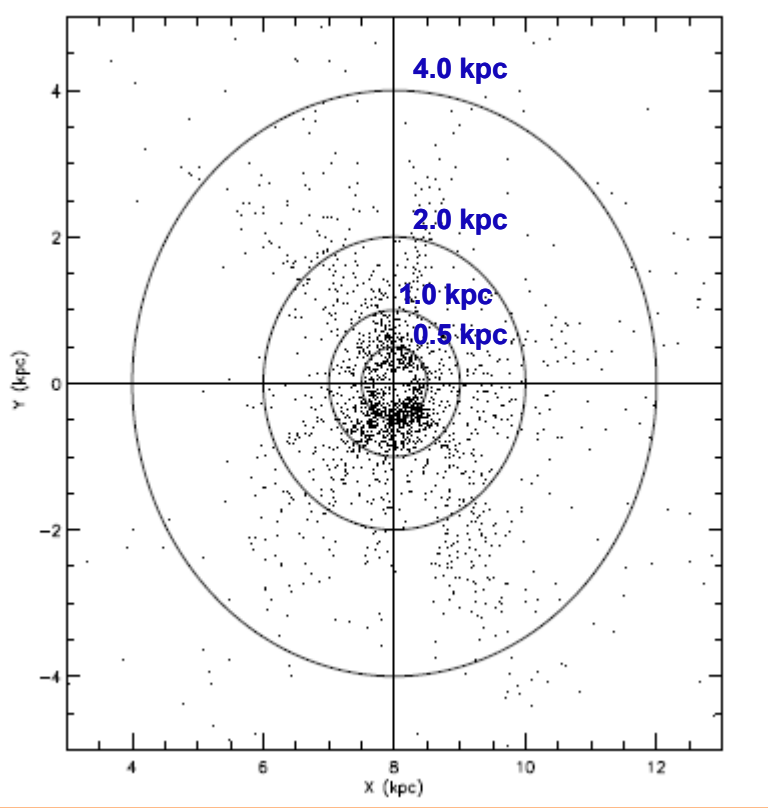
π **< 2 mas** $\Rightarrow$ *Pr* [d> 0.5 kpc] > 50%
3828 OB stars

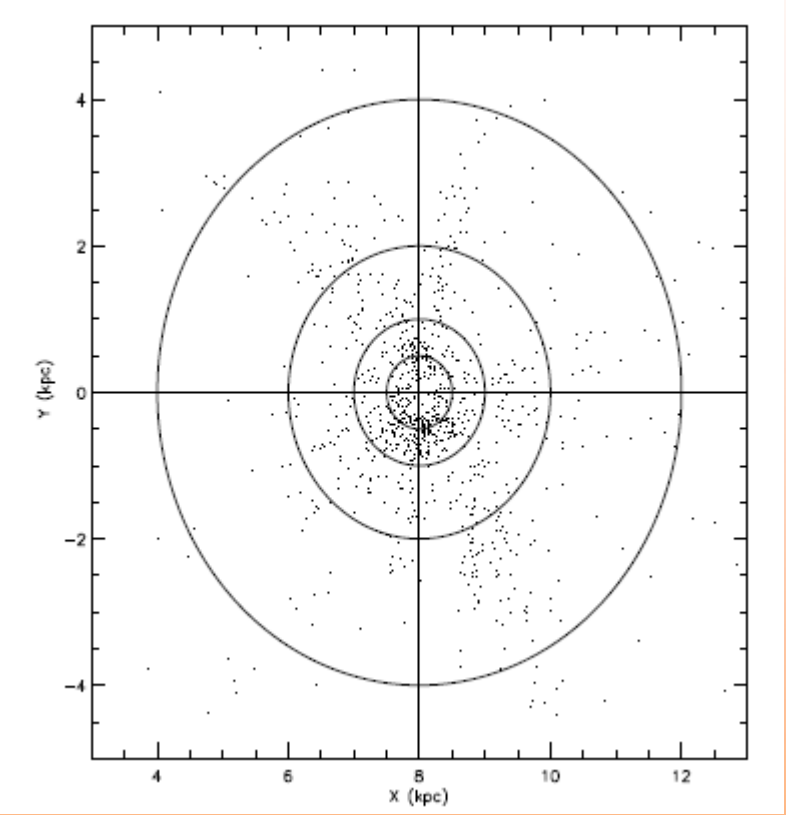

π = 2 mas
π
2.5%
-3S
-2S
-S
X̄
+S
+2S
+3S
68%
95%
99.7%

$\pi+1\sigma$ = 2 mas



OB stars
from Hipparcos catalog

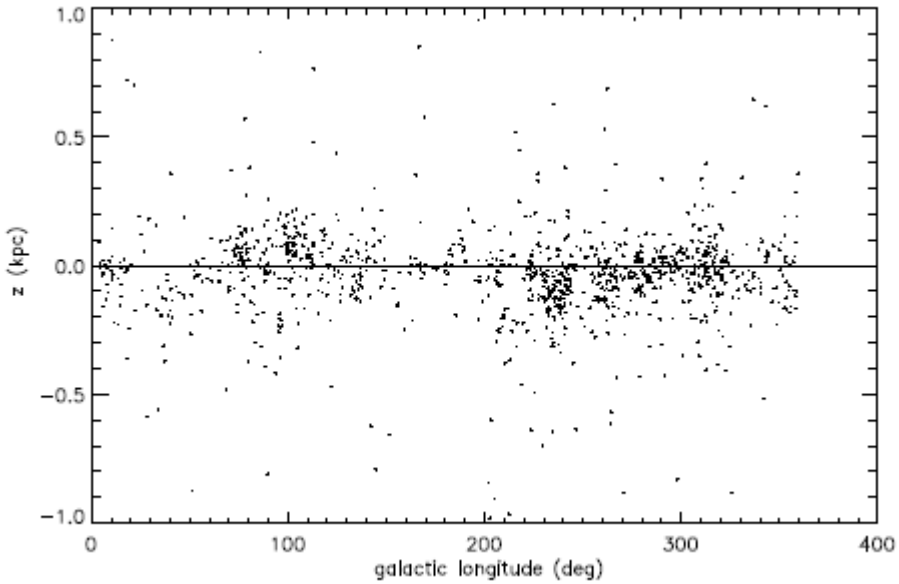




$\pi+\sigma_\pi$ **< 2 mas** $\Rightarrow$ *Pr* [*d* > 0.5 kpc] > 84%
1152 OB stars

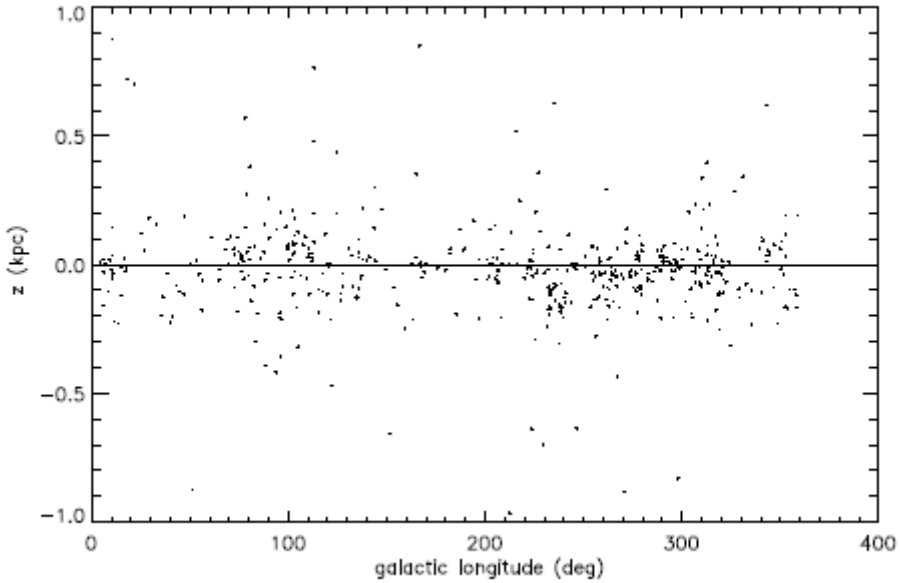
$\pi+2\sigma_\pi$ **< 2 mas** $\Rightarrow$ *Pr* [*d* > 0.5 kpc] > 97.5%
991 OB stars

OB stars
from Hipparcos catalog



π < 2 mas
and $0.5 < d_{ph} < 2$ kpc

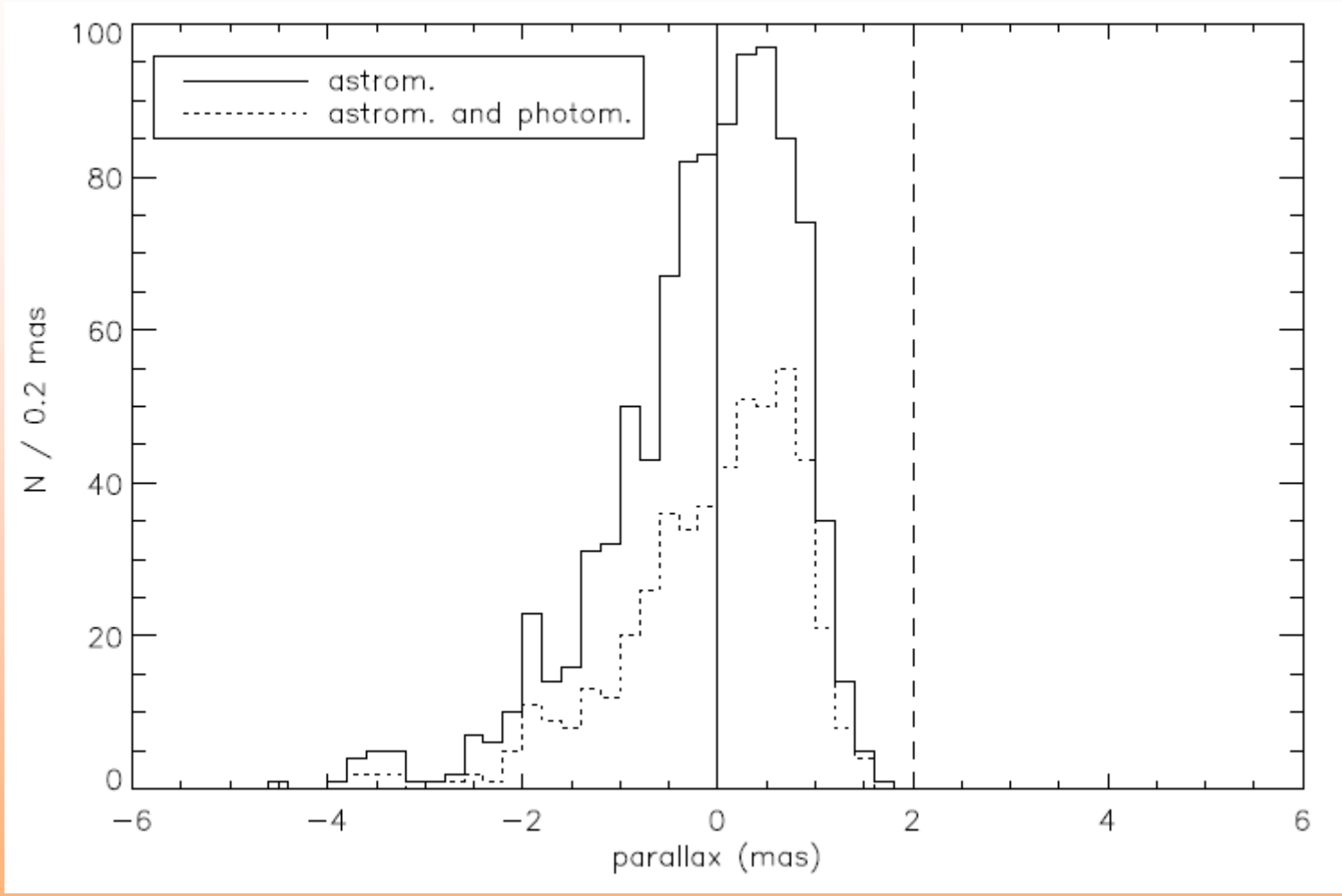
N_{OB} = 1991



$\pi+2\sigma_\pi$ **< 2 mas**
and $0.5 < d_{ph} < 2$ kpc

N_{OB} = 503

OB stars
from Hipparcos catalog



$\pi+2\sigma_\pi$ **< 2 mas** and $0.5 < d_{ph} < 2$ kpc

OB stars
from Hipparcos catalog

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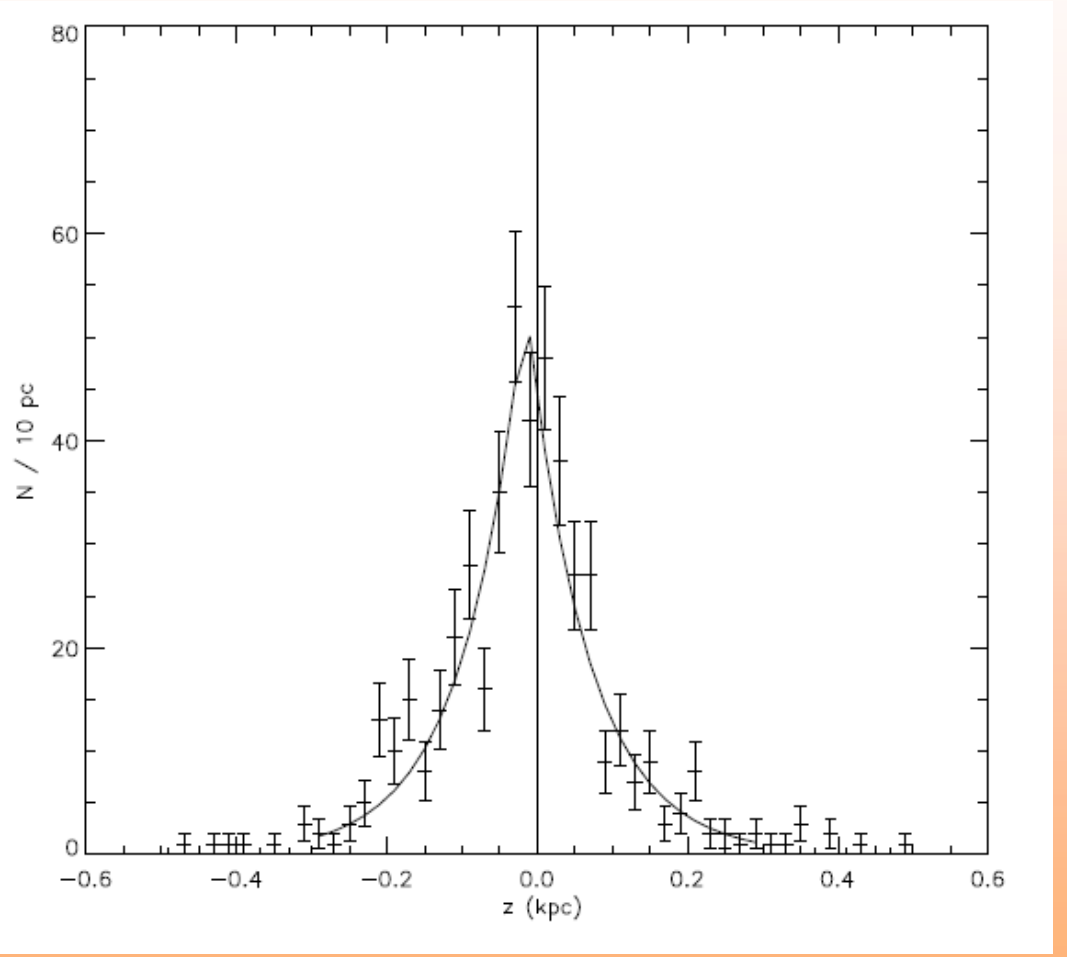
$\pi+2\sigma_\pi$ **< 2 mas**
and $0.5 < d_{ph} < 2$ kpc
and $|z| < 0.3$ kpc

$N_{OB} = 465$ (of 503)

$\chi^2 / \nu = 1.55$

$h_z = 80 \pm 3$ pc

$z_\odot = 16 \pm 3$ pc (sys. 3 pc)



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Thank’you

Acknowledgements: data from E. Poggio