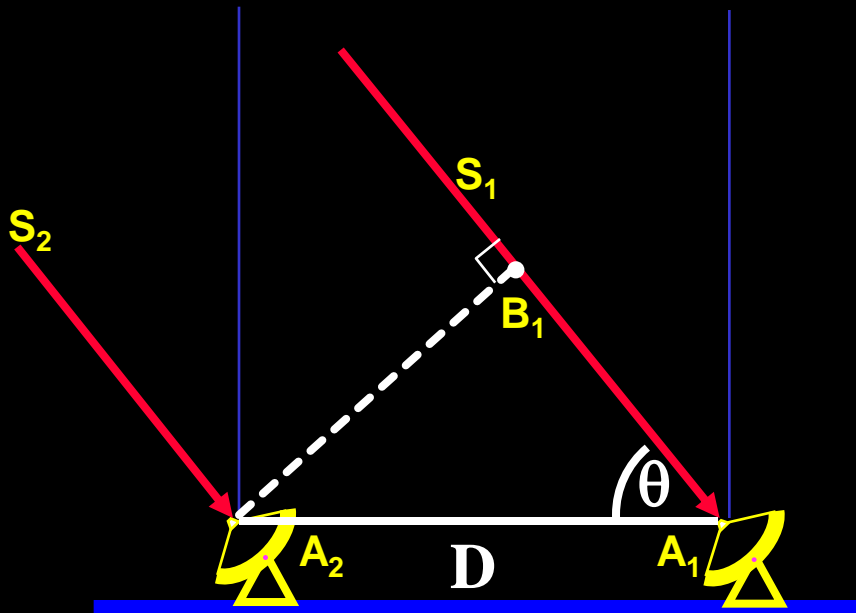


Radio-astronomy

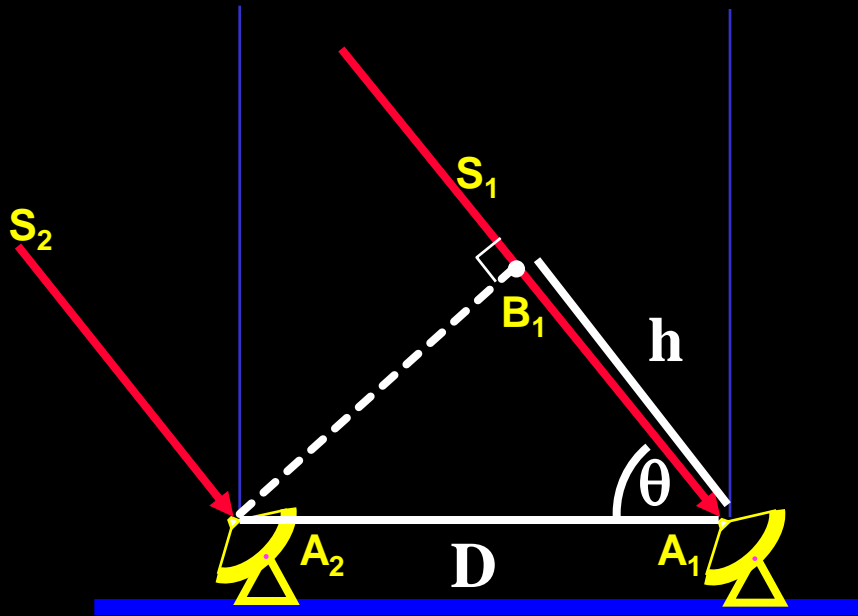
LLAMA+ALMA



The LLAMA Workshop
FAPESP, São Paulo, August 8-9, 2011

R. Teixeira
IAG/USP

Radio – astrometry



- Principle

$$f = \frac{2\rho D}{l} \cos q$$

- Resolution/Precision

$$s \mu \frac{l}{D}$$

- LLAMA+ALMA:

D~200Km, λ~1mm, SNR~15

$\sigma_{\alpha, \delta} \sim 30 \mu\text{as}$

Radio x Optical

- **Precision**

LLAMA+ALMA: $30 \mu\text{as} - d (10\%) \sim \text{Kpc}$

optical (ground): $10^3 \mu\text{as} - d (10\%) \sim 0.1 \text{ Kpc}$

Gaia (optical): $\sim 10 - 100 \mu\text{as} - d (10\%) \sim \text{Kpc}$

- **Transparency**



Radio x Optical

- **Precision**

LLAMA+ALMA: $30 \mu\text{as} - d (10\%) \sim \text{Kpc}$

optical (ground): $10^3 \mu\text{as} - d (10\%) \sim 0.1 \text{ Kpc}$

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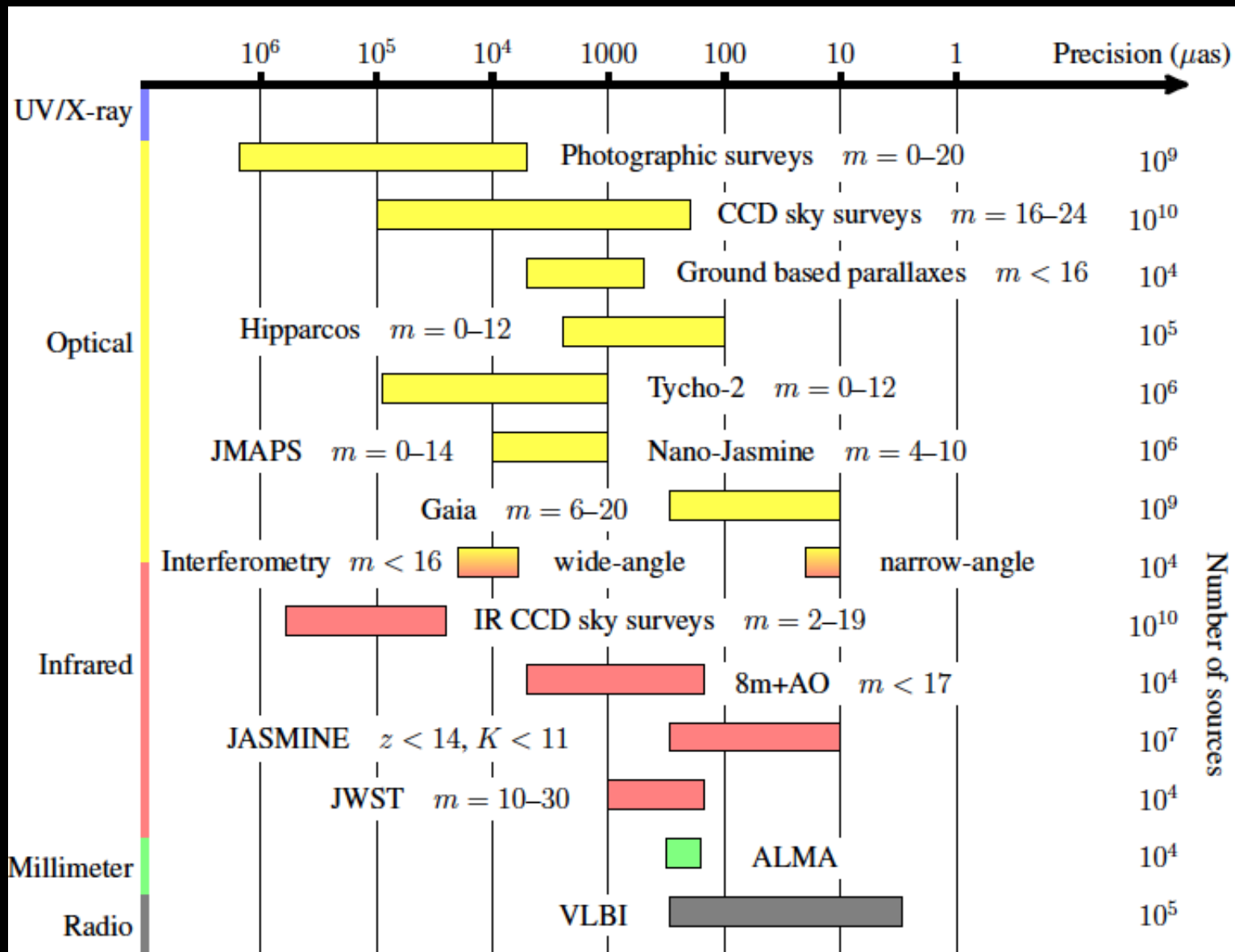
- **Transparency**

clouds in star-forming regions

- **Number of objects**

relatively small number of galactic objects

Brown 2011



Extragalactic objects

- **Reference System**

International Celestial Reference Frame – ICRF2

~ 3400 compact radio-sources

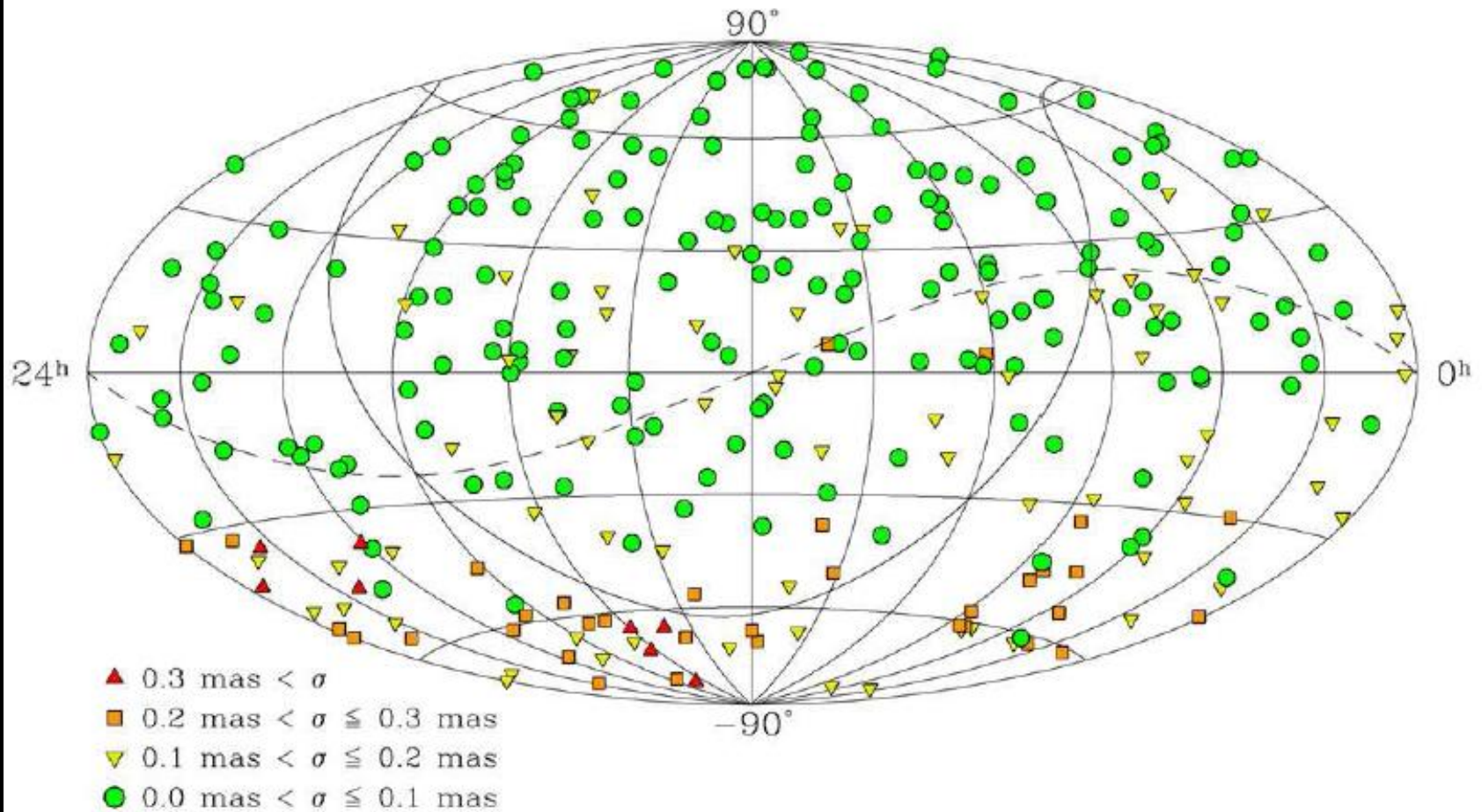
295 defining sources

mean $\sigma_{\alpha,\delta} \sim 40\mu\text{as}$

definition $\sim 10\mu\text{as}$

ICRF2 – defining sources

(Ma 2010)



Extragalactic objects

- **Reference System**

 - International Celestial Reference Frame – ICRF2**

 - ~ 3400 compact radio-sources

 - 295 defining sources

 - mean $\sigma_{\alpha,\delta} \sim 40\mu\text{as}$

 - definition $\sim 10\mu\text{as}$

 - Hipparcos**

 - ~120000 objects ($V \leq 10$)

 - 1 quasar e 11 radio-star

 - $\sigma_{\alpha,\delta}$ and $\sigma_{\mu} \sim 10^3\mu\text{as}$

 - Gaia**

 - 5×10^5 quasars

 - $20\text{-}50 \times 10^3$ defining sources

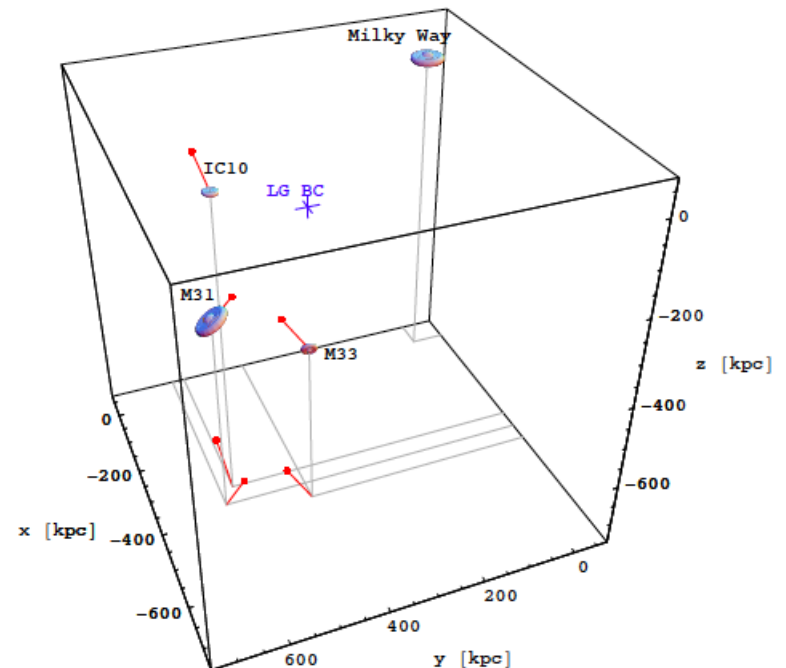
Extragalactic objects

- **Densification**
- **Displacements of the photocentre**
- **Proper motion**
- **Local Group**

Satellite galaxies

Andromeda

Reid et al. 2010



Young stars in star-forming regions

- **Individual properties**
- **Characterization of the
star-forming regions**
- **Gould Belt**

Galactic objects

Reid et al. 2008

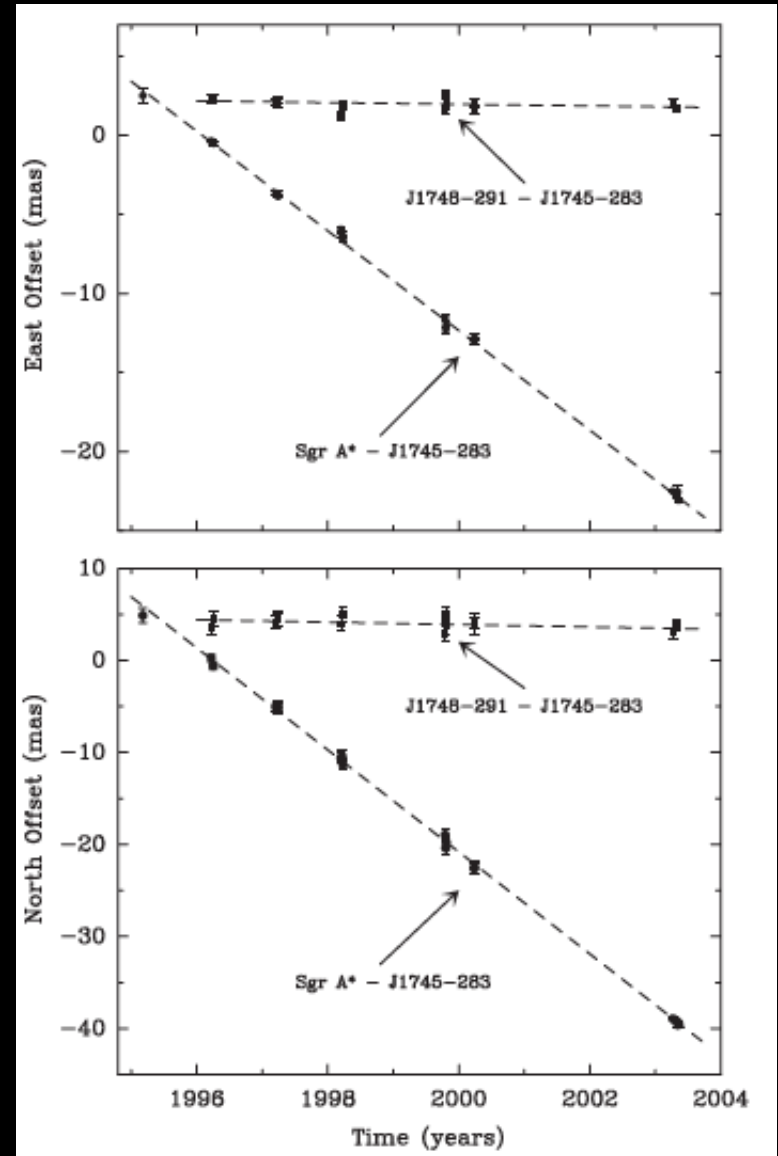
- **Movimiento espacial Sgr A***

$$m = 6.379 \pm 0.024 \text{ mas/yr}$$

$$q = 209.60^\circ \pm 0.18^\circ$$



SMBH



Radio-astronomy in Brazil

*Thank you
for your attention!*