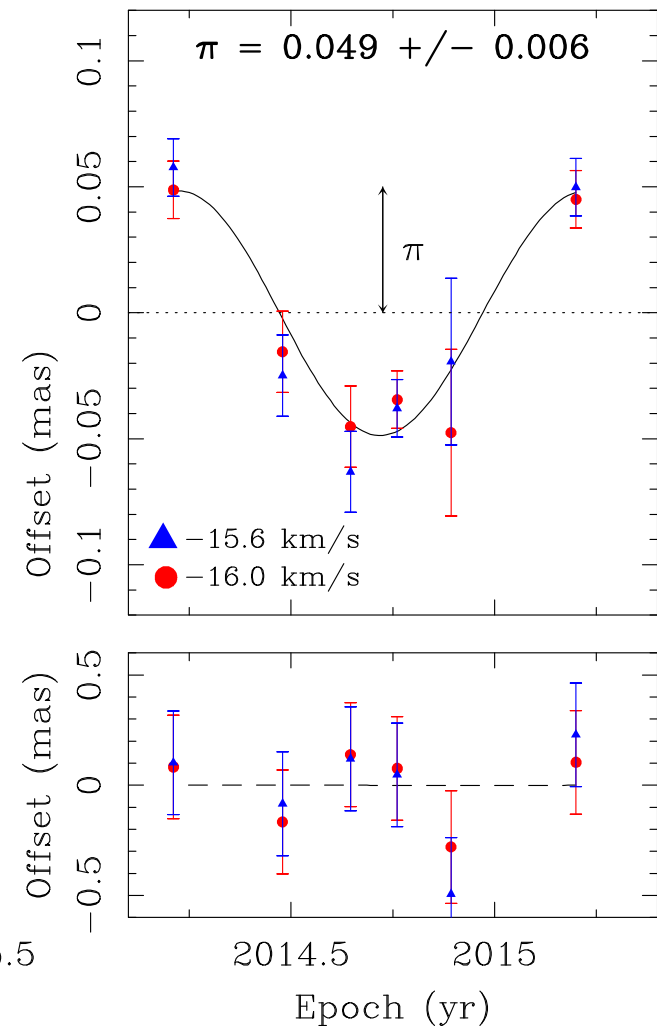
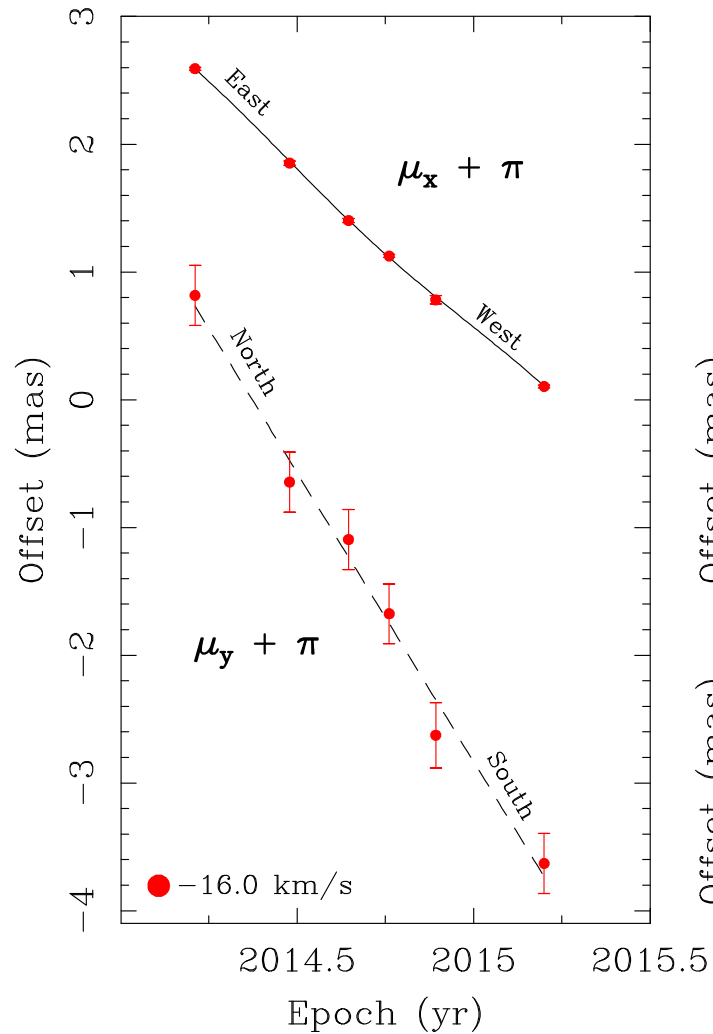
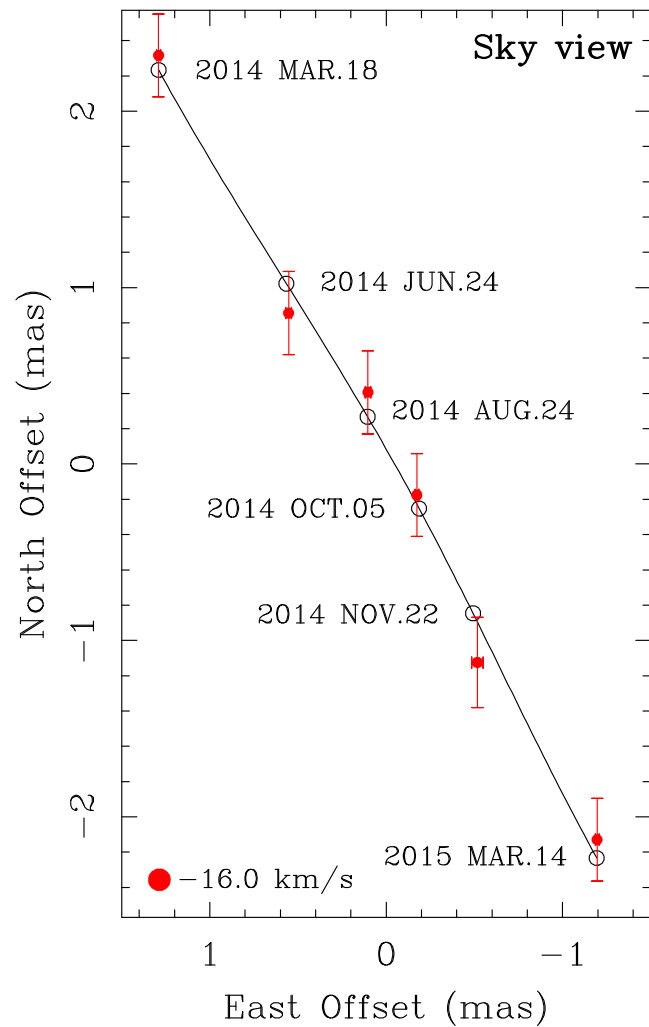


Advances in VLBI Astrometry

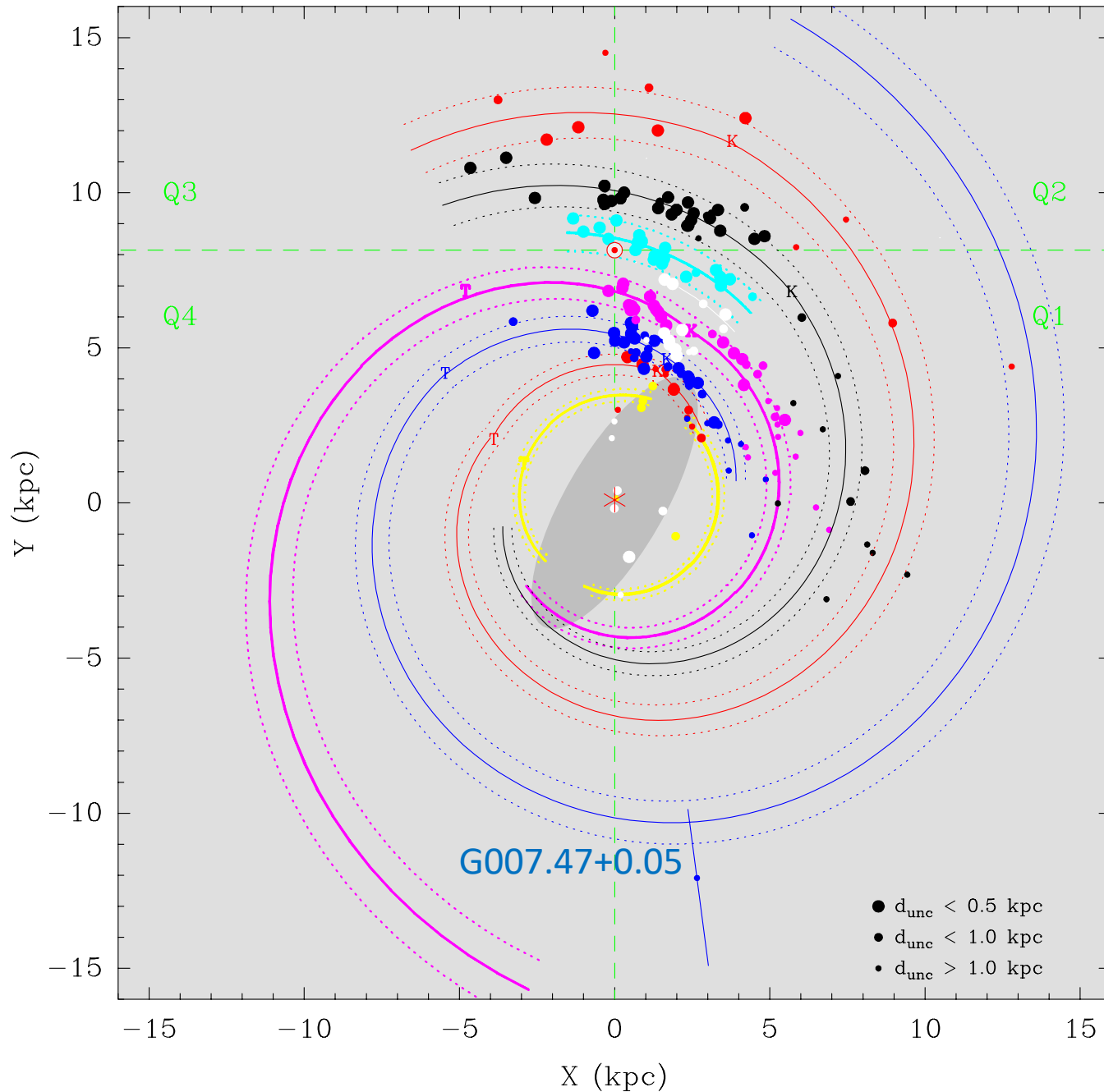
Mark J. Reid

Center for Astrophysics | Harvard & Smithsonian

G007.47+0.05 H₂O Maser Parallax



Sanna et al (2017)



Milky Way spiral structure:

- Dots are newly formed O-type stars
- Colored by spiral arm
 - Red = Norma-Outer arm
 - Blue = Scutum-Centaurus-OSC arm
 - Purple = Sagittarius-Carina arm
 - Black = Perseus arm
- Cyan is Local arm "segment"
- Milky Way is a 4-arm spiral (with some extras)

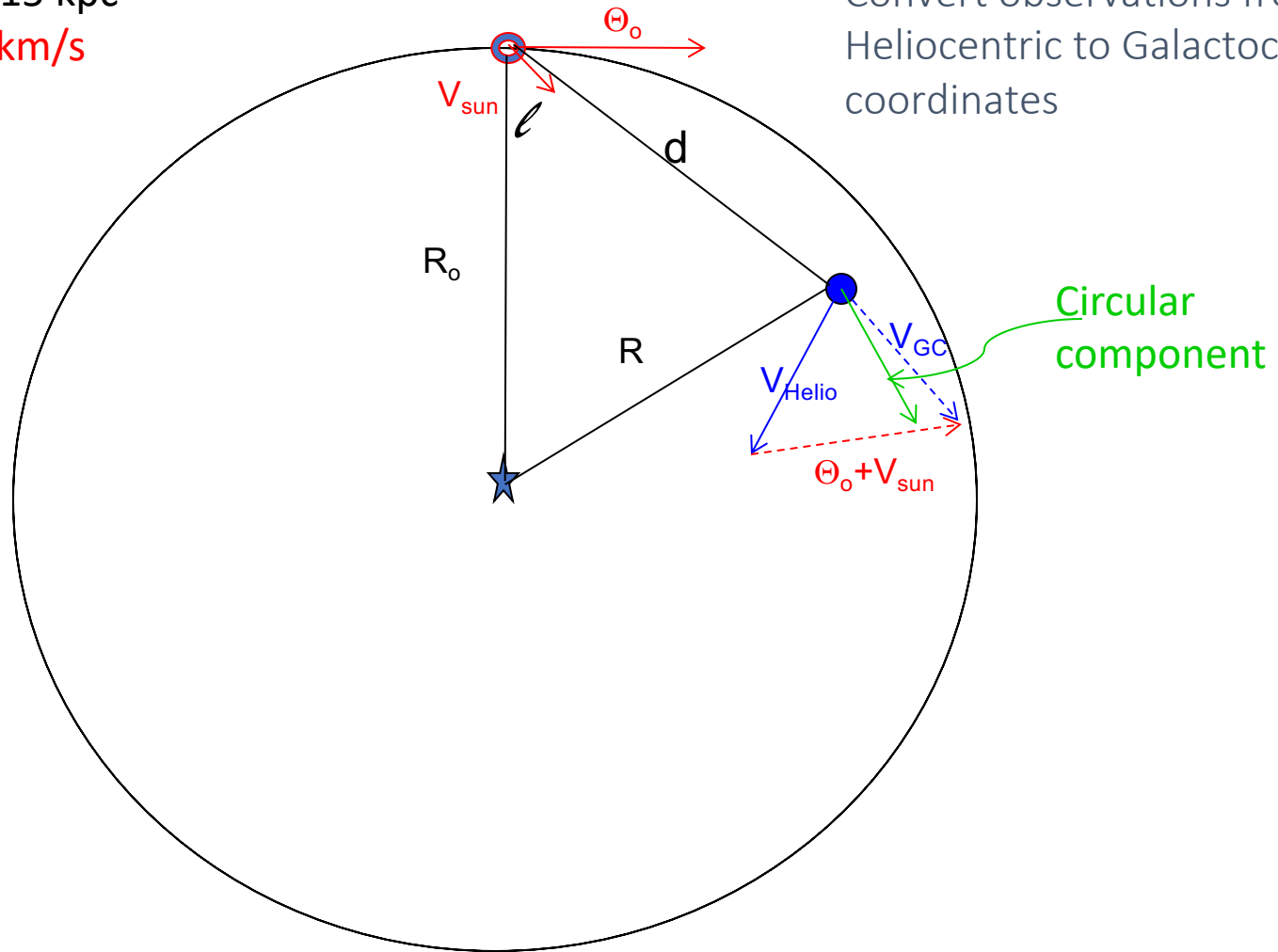
Reid et al (2019)

Galactic Dynamics

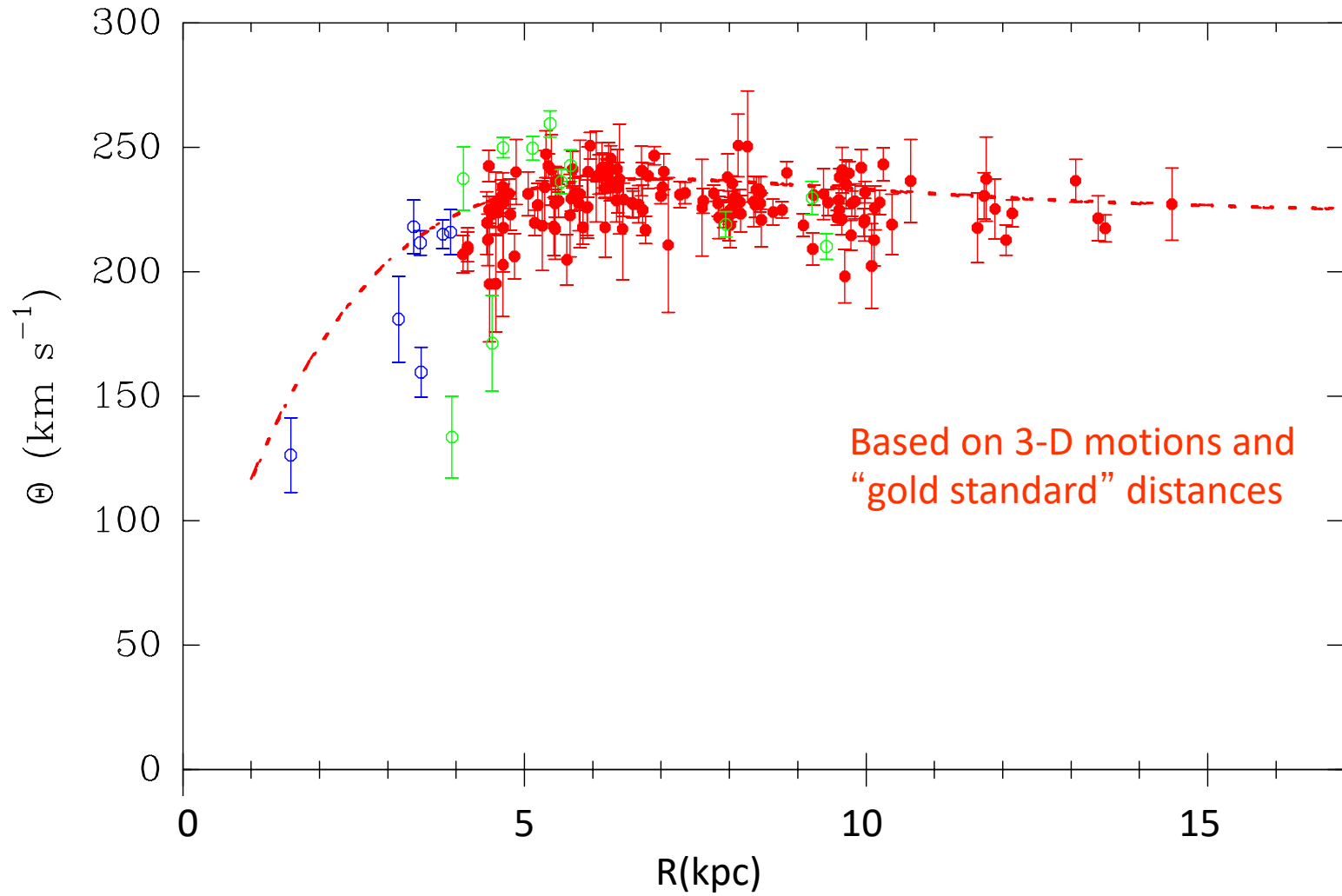
$$R_o = 8.15 \pm 0.15 \text{ kpc}$$

$$\Theta_o = 236 \pm 7 \text{ km/s}$$

Convert observations from
Heliocentric to Galactocentric
coordinates

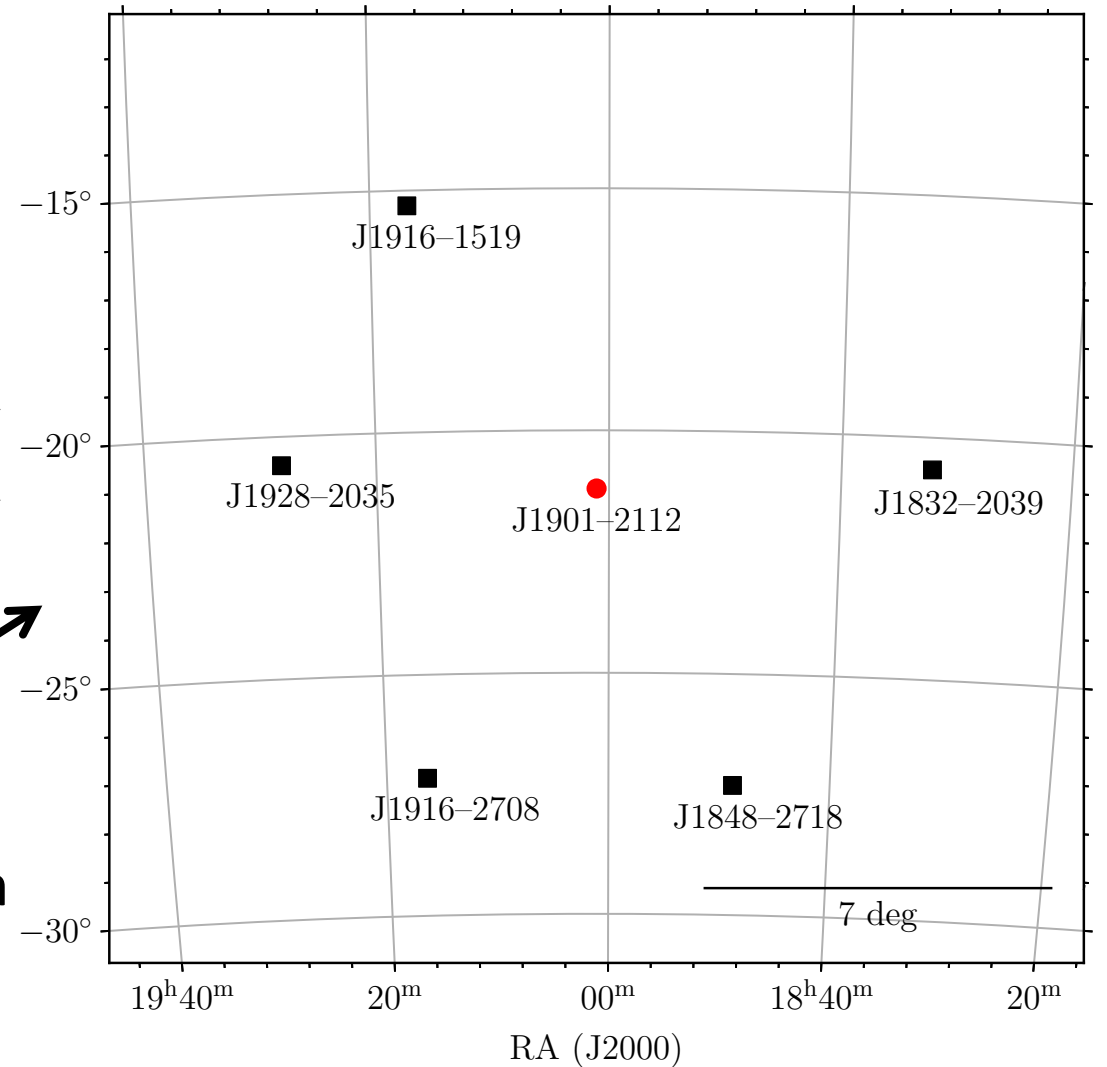
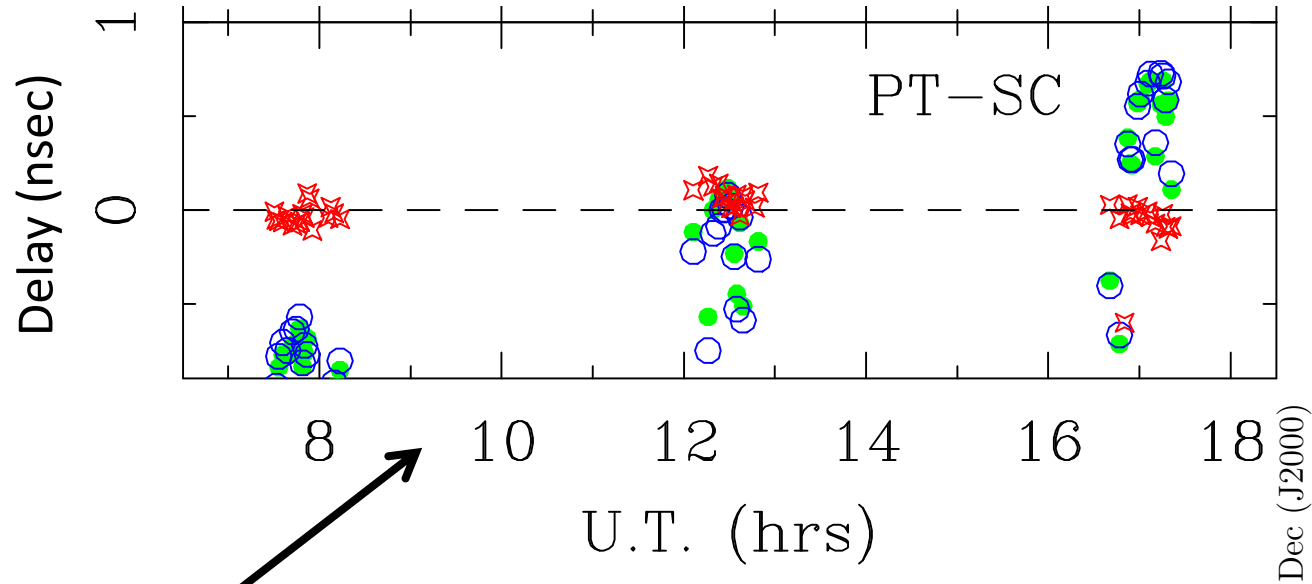


Milky Way's Rotation Curve



Reid et al (2019)

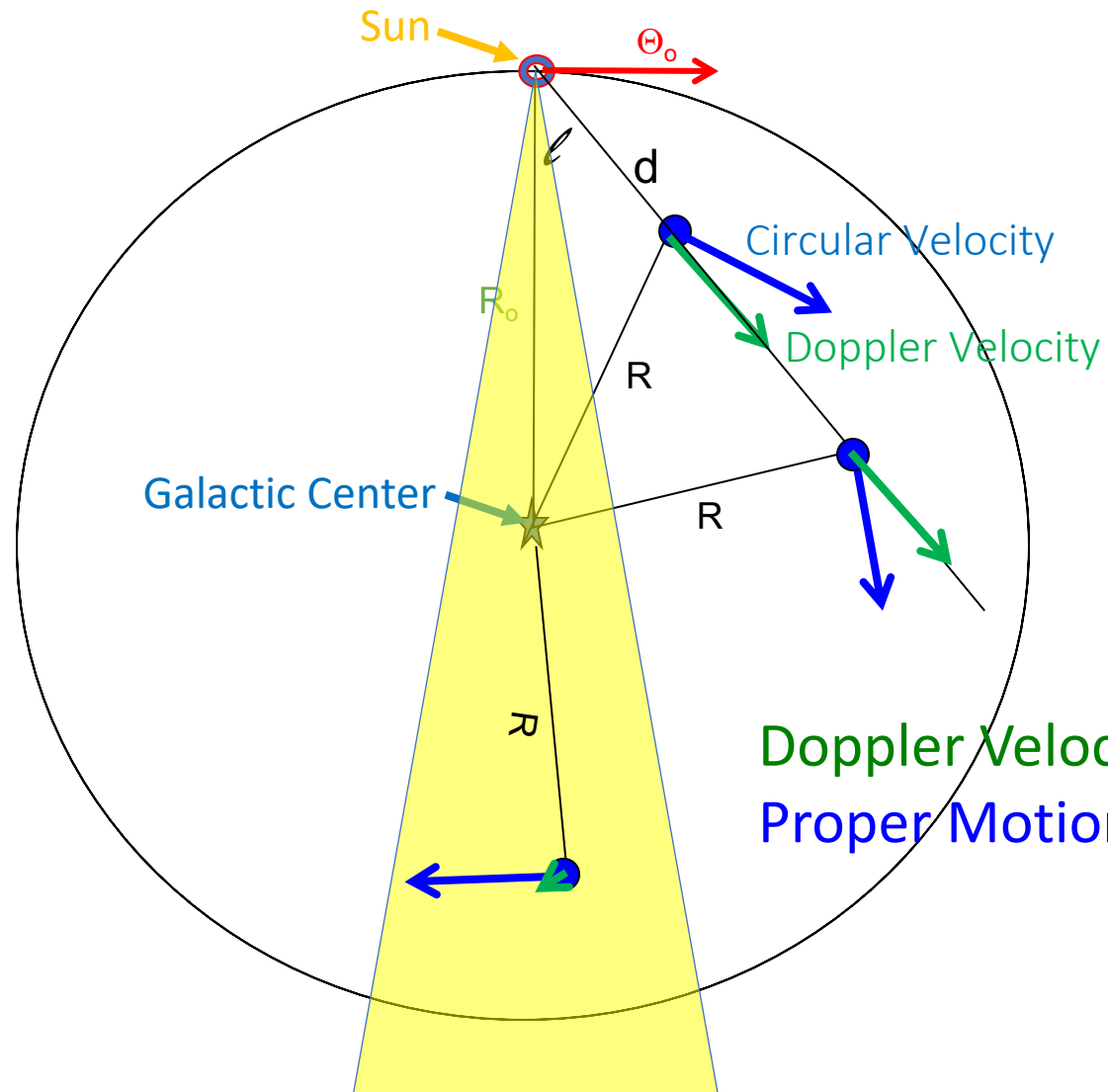
Advanced VLBI Astrometric Calibrations



Tropospheric (H₂O) calibration
(Reid et al 2009)

"MultiView" Ionospheric "wedge" calibration
(Rioja & Dodson 2017; Hyland et al 2022)

Kinematic Distances



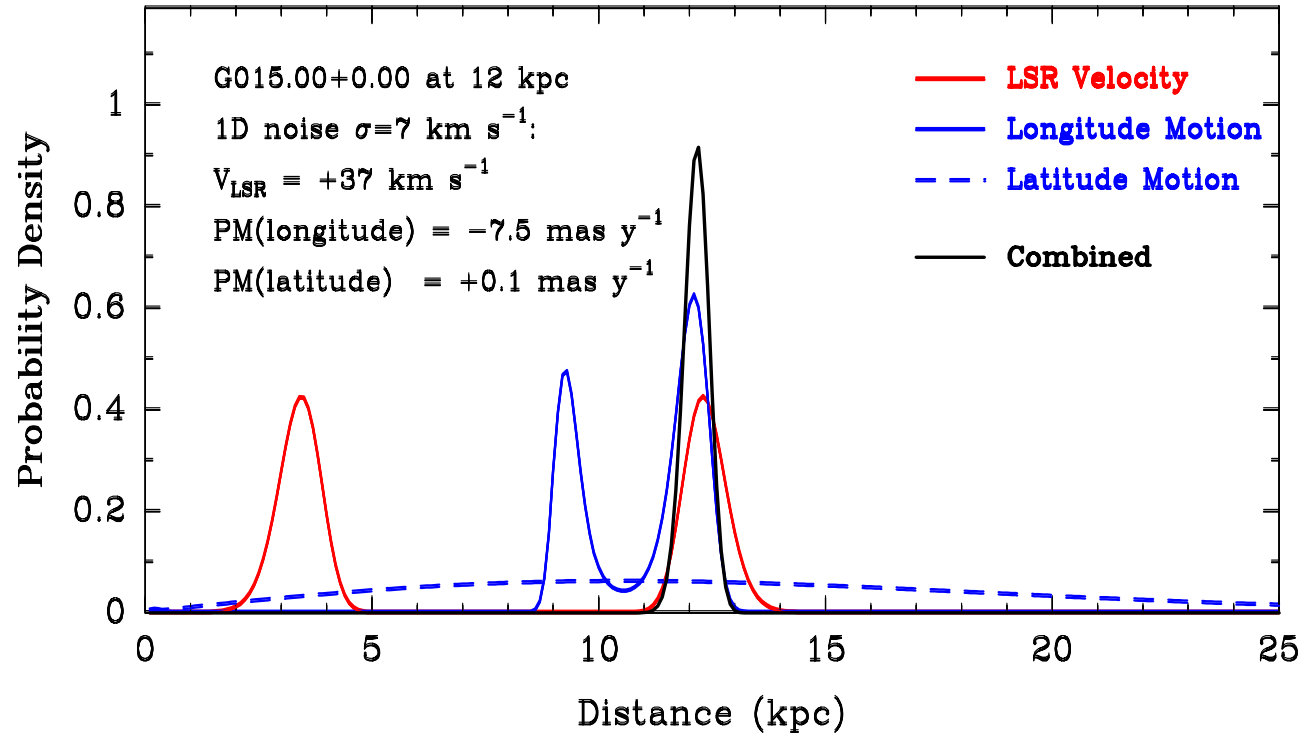
Doppler Velocity = 0

Proper Motion = $2 \Theta_0 = 470 \text{ km/s}$

$\sim 10 \text{ mas/yr}$

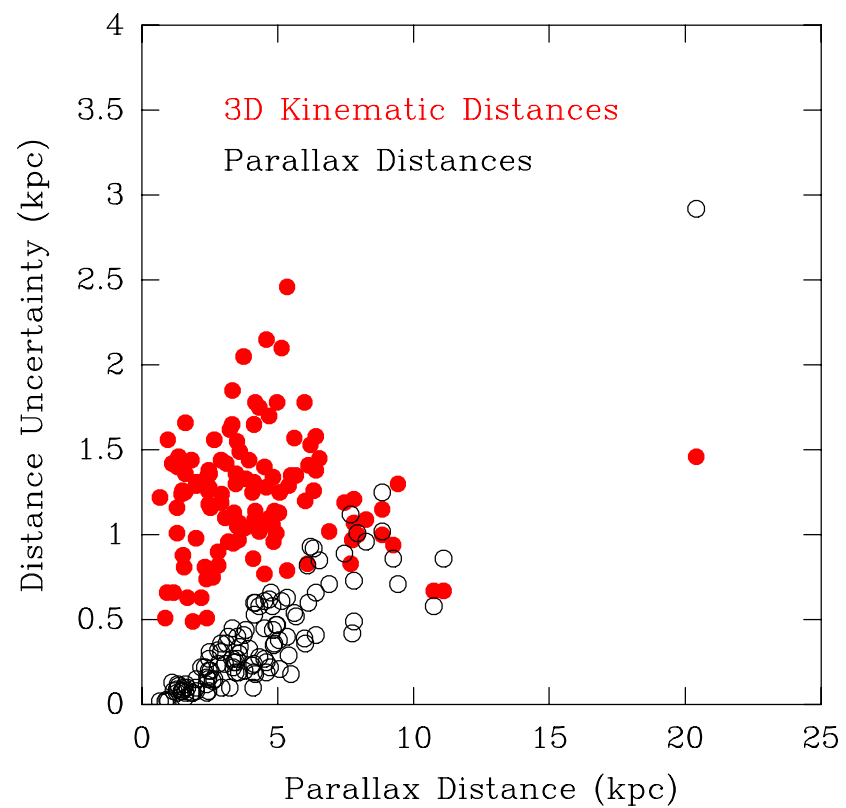
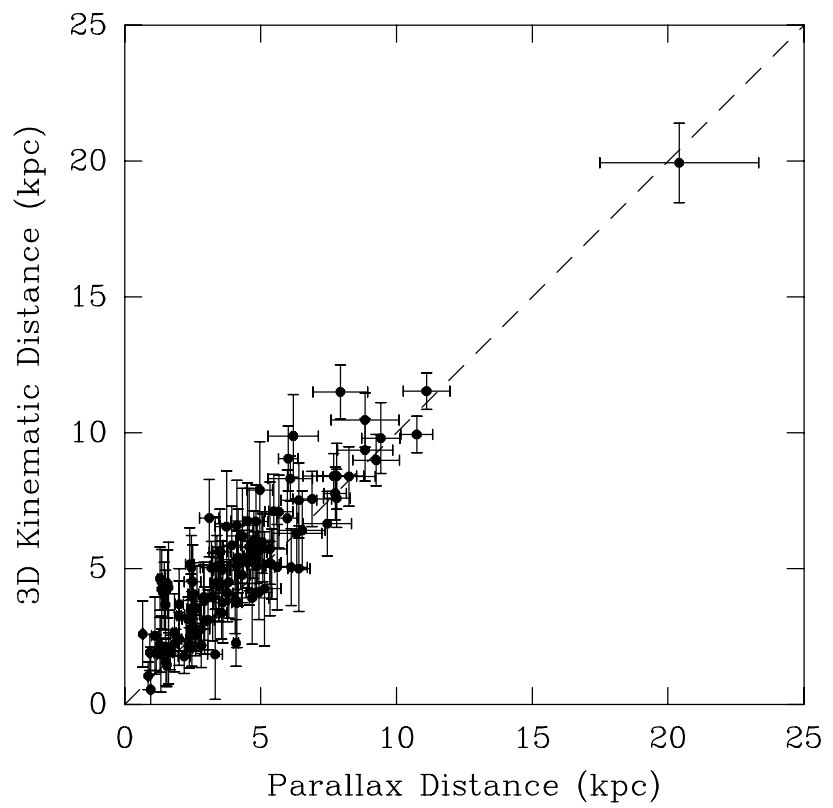
Parallax $< 0.1 \text{ mas}$

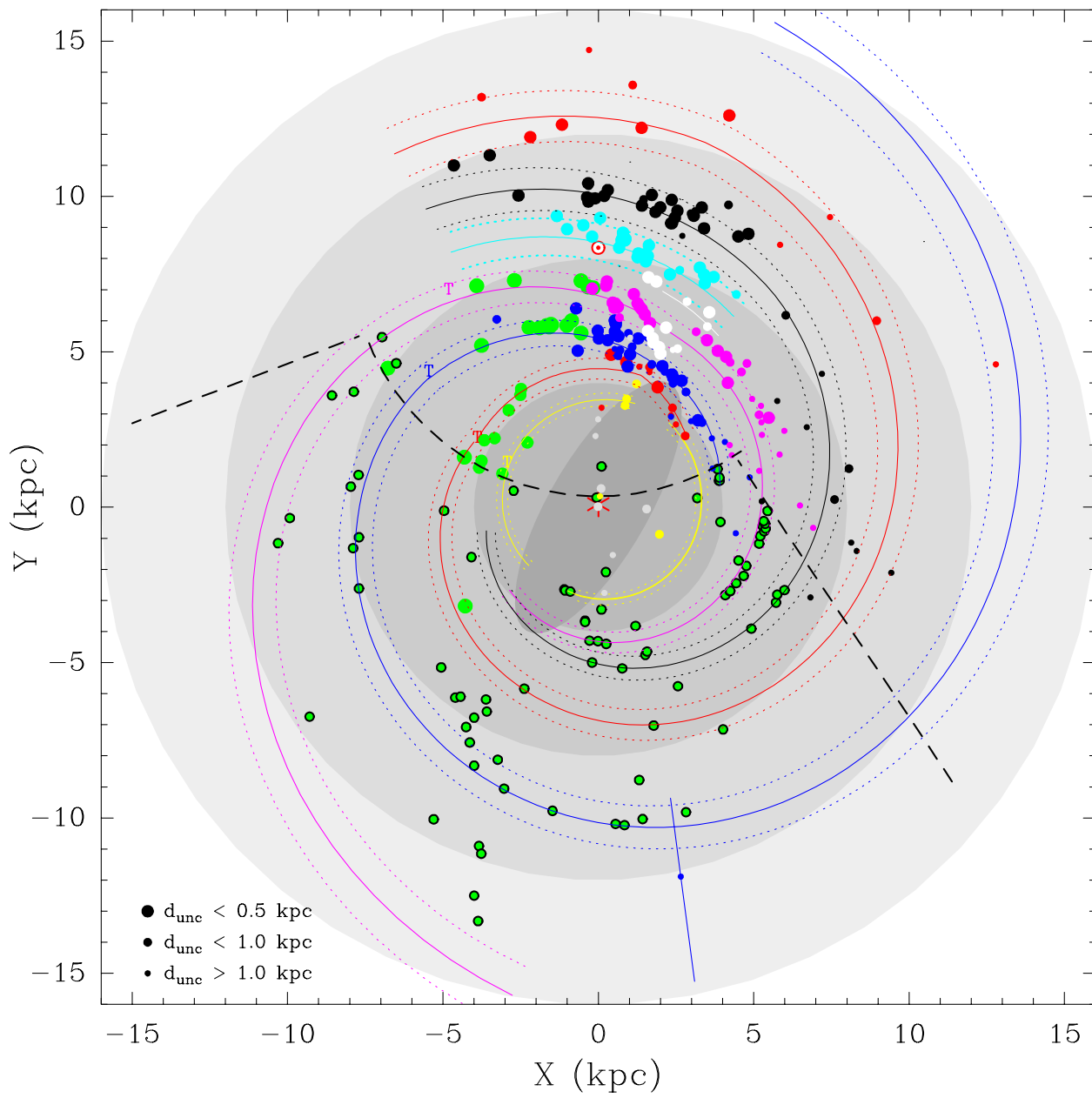
3D Kinematic Distances



[Reid 2022 \(arXiv220506903\)](#)

3D Kinematic vs Parallax Distances





Completing the Milky Way map:

- Parallax in progress (Australia-New Zealand)
- 3D Kinematic distances (soon)

