Structure and Dynamics of the Long Bar of the Milky Way

Jayender Kumar[1], M. J. Reid[2], S. P. Ellingsen[1], A. Brunthaler[3], K. M. Menten[3], X. W. Zheng[4], A. Sanna[5], L. J. Hyland[1], Gabor Orosz[6]

[1]School of Natural Sciences, University of Tasmania, Hobart, Australia
[2]Harvard–Smithsonian Centre for Astrophysics, Harvard University, USA
[3]Max-Planck-Institut für Radioastronomie, Bonn, Germany
[4]Nanjing University, Nanjing 20093, China
[5]INAF, Osservatorio Astronomico di Cagliari, Selargius, Italy
[6]Joint Institute for VLBI ERIC, Oude Hoogeveensedijk 4, 7991, PD Dwingeloo, Netherlands

OUTLINE

PART-1:

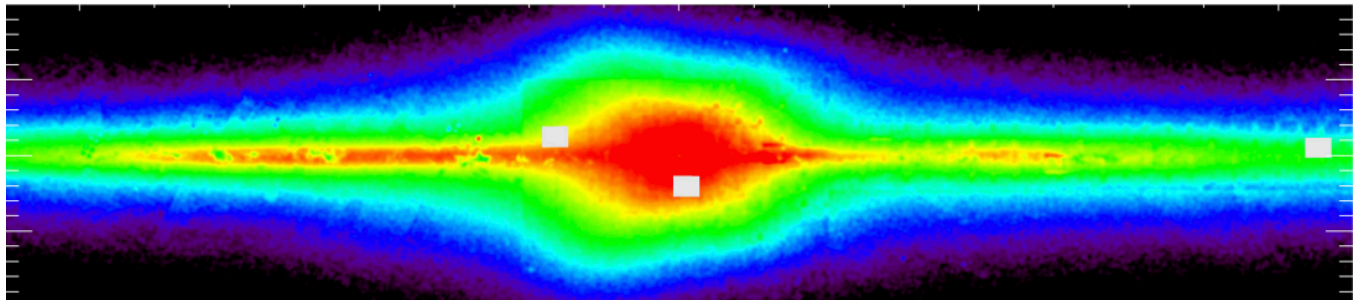
- Getting familiar with basic terminology
- Galactic bars in disk galaxies
- The long and thick galactic bars in the Milky-Way

PART-2:

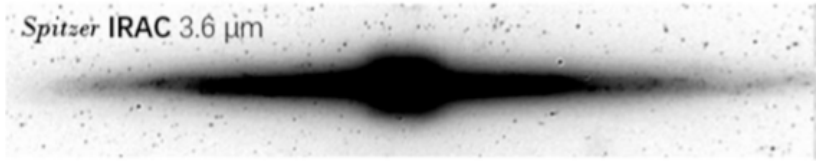
- Dynamics of sources within 4kpc of the Galactic centre
- My work and analysis on long bar of the Milky Way

PART- 1:

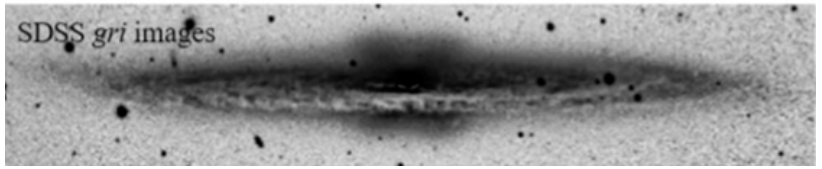
Reid & Zheng 2020



C. Wegg, O. Gerhard and M. Portail, 2015



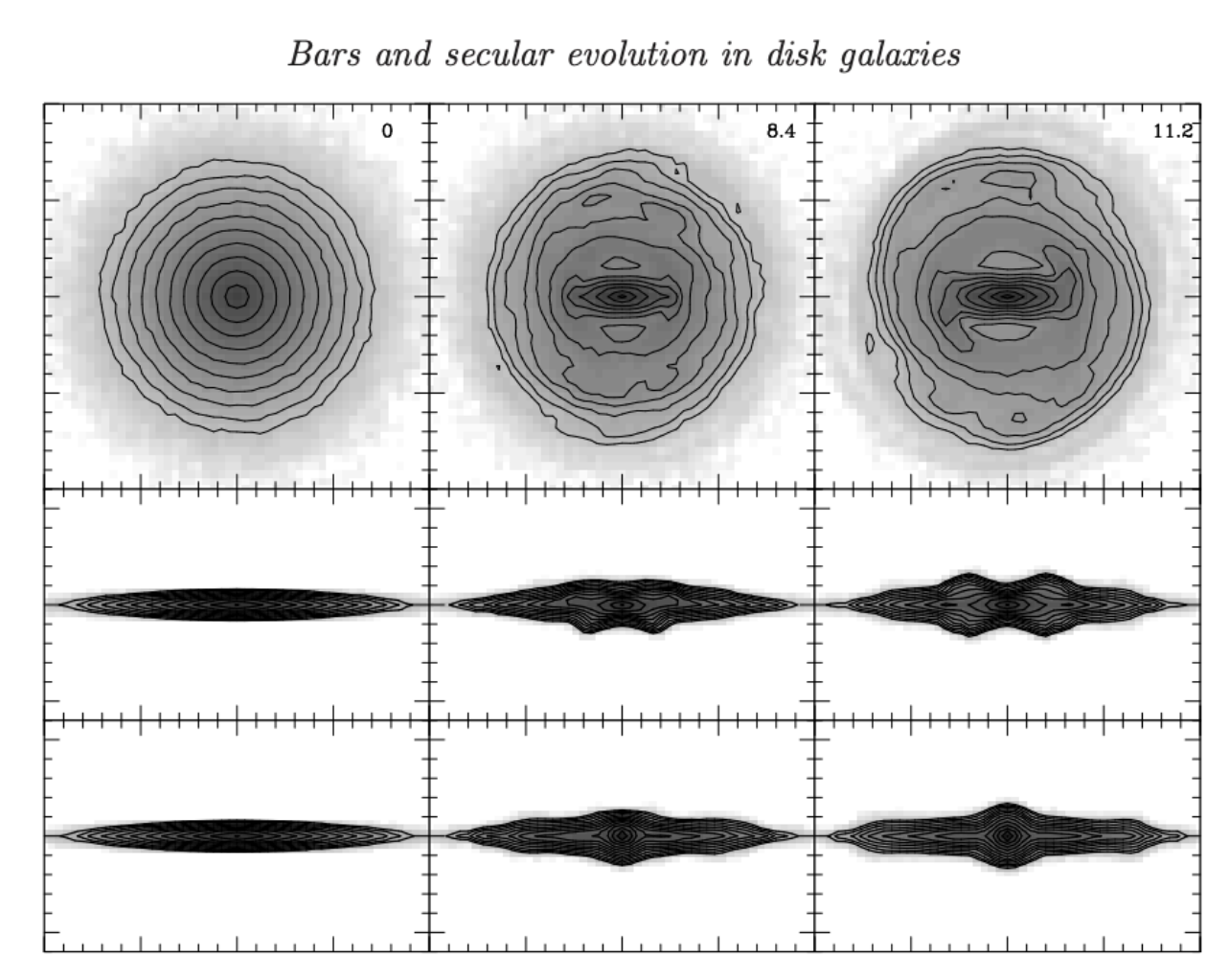
Zhi Li, 2022



Zhi Li, 2022

Galactic bars in disk galaxies

- Redistribution of Angular momentum
- MH and MD Bars
- Lindblad and Corotation Resonance
- Resonant orbits (periodic, X1 orbits)
- Chaotic orbits
- Double barred (long and thick bars in) Milky Way ?

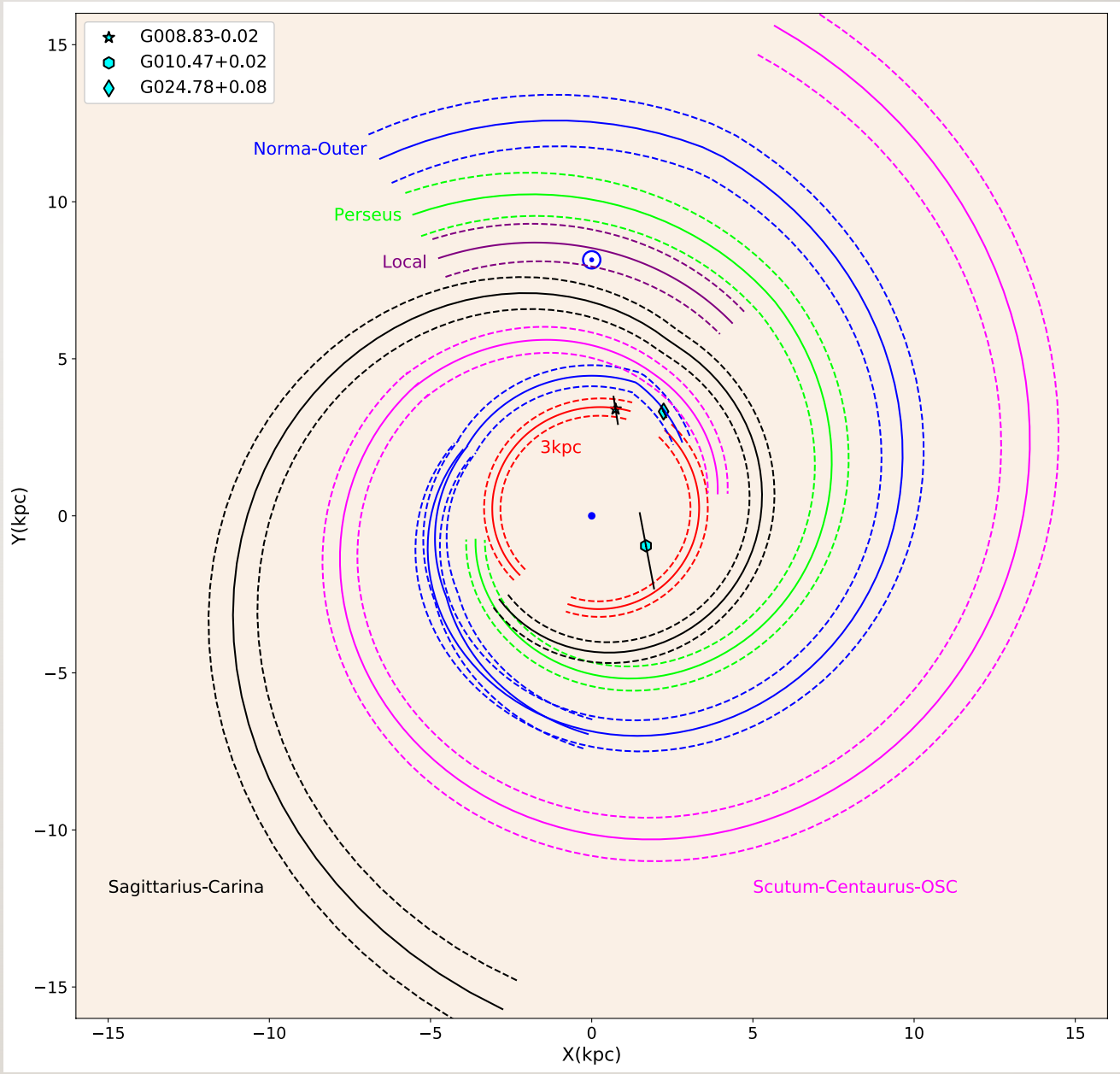


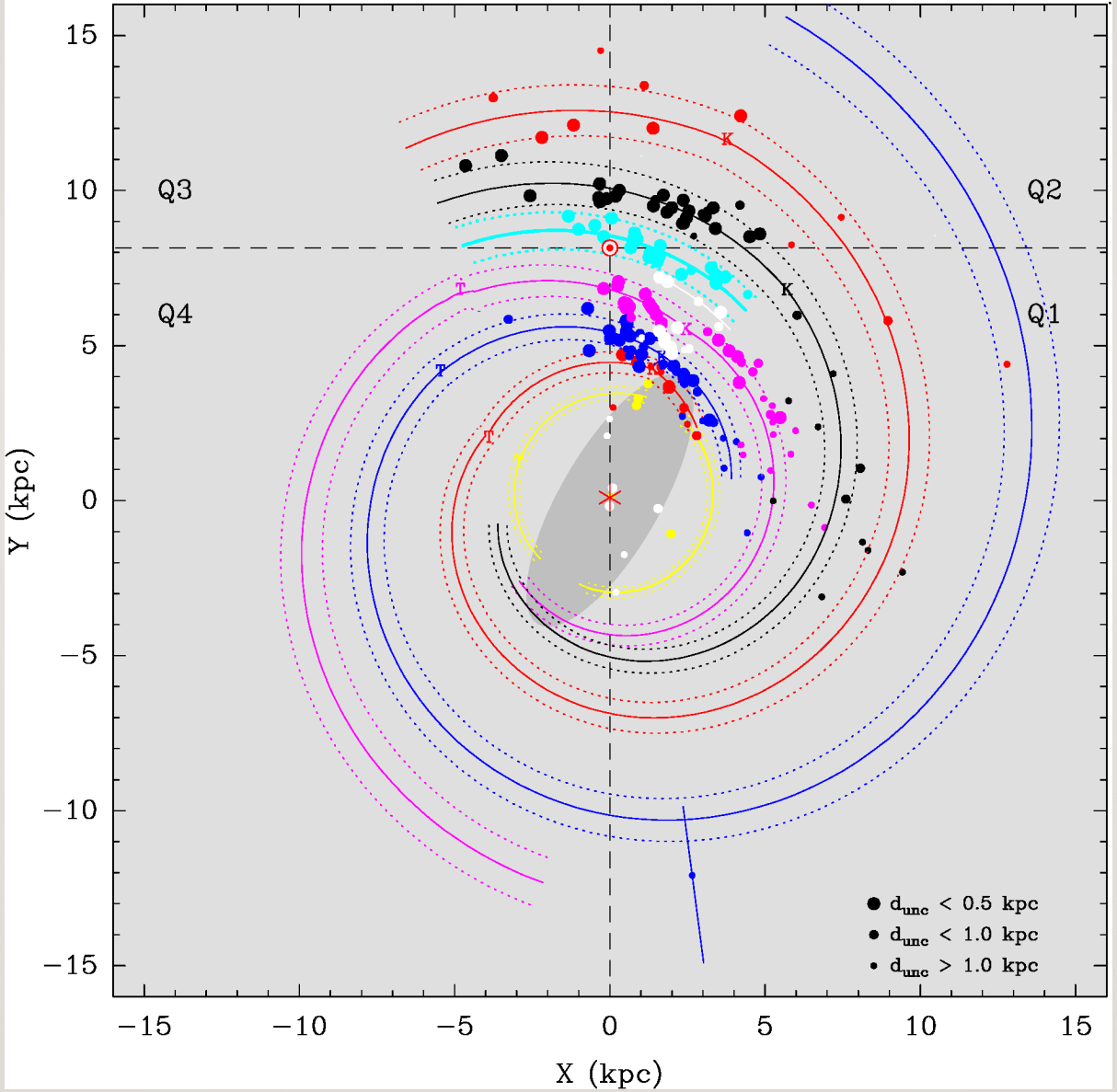
E. Athanassoula, 2012

UNIVERSITY of TASMANIA

PART- 2

Trigonometric parallaxes to 3 water masers within 4 kpc of the Galactic centre, Kumar et. al 2022 (in preparation)

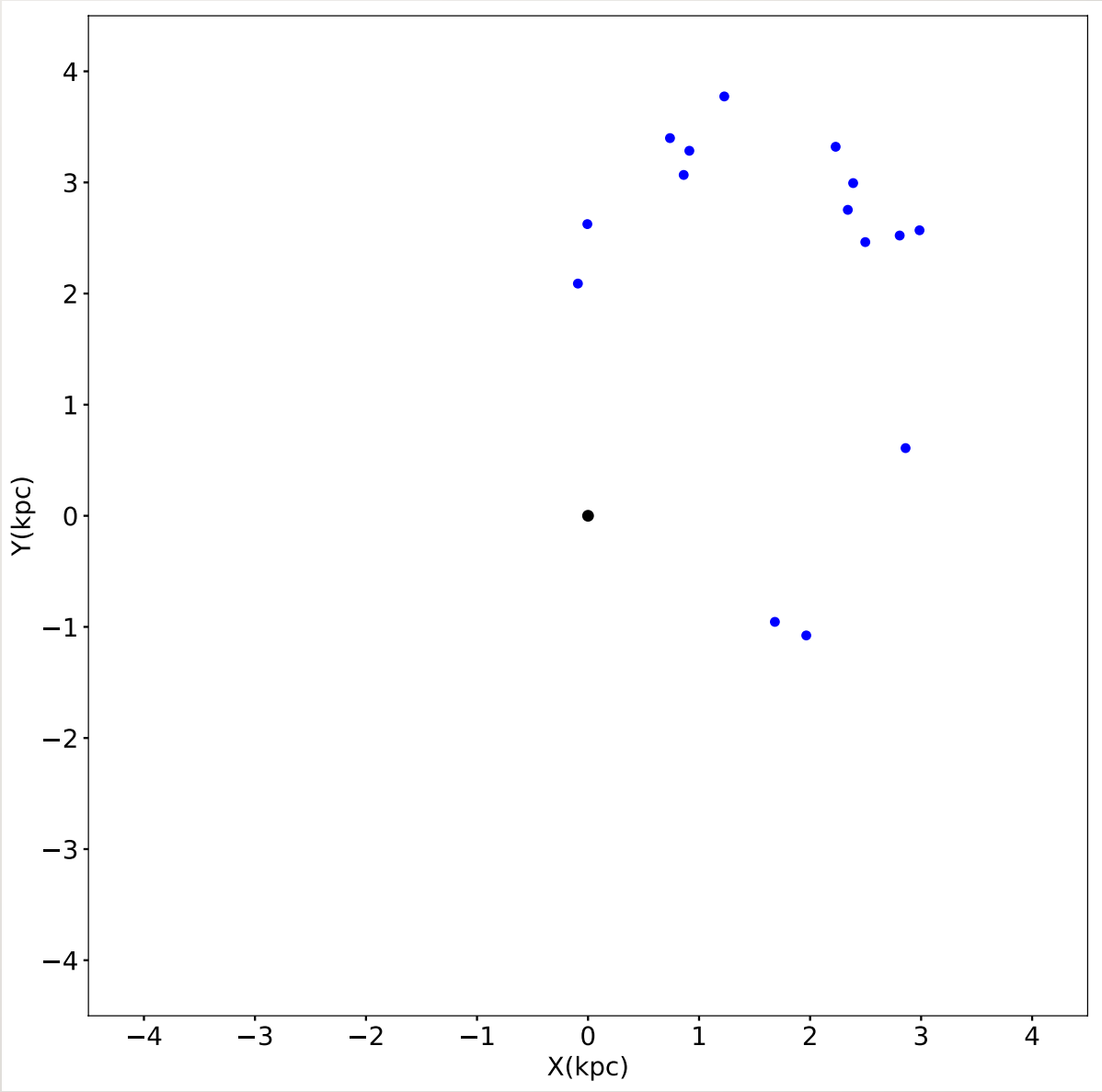




Milky Way with measured parallaxes (Reid et al. 2019)

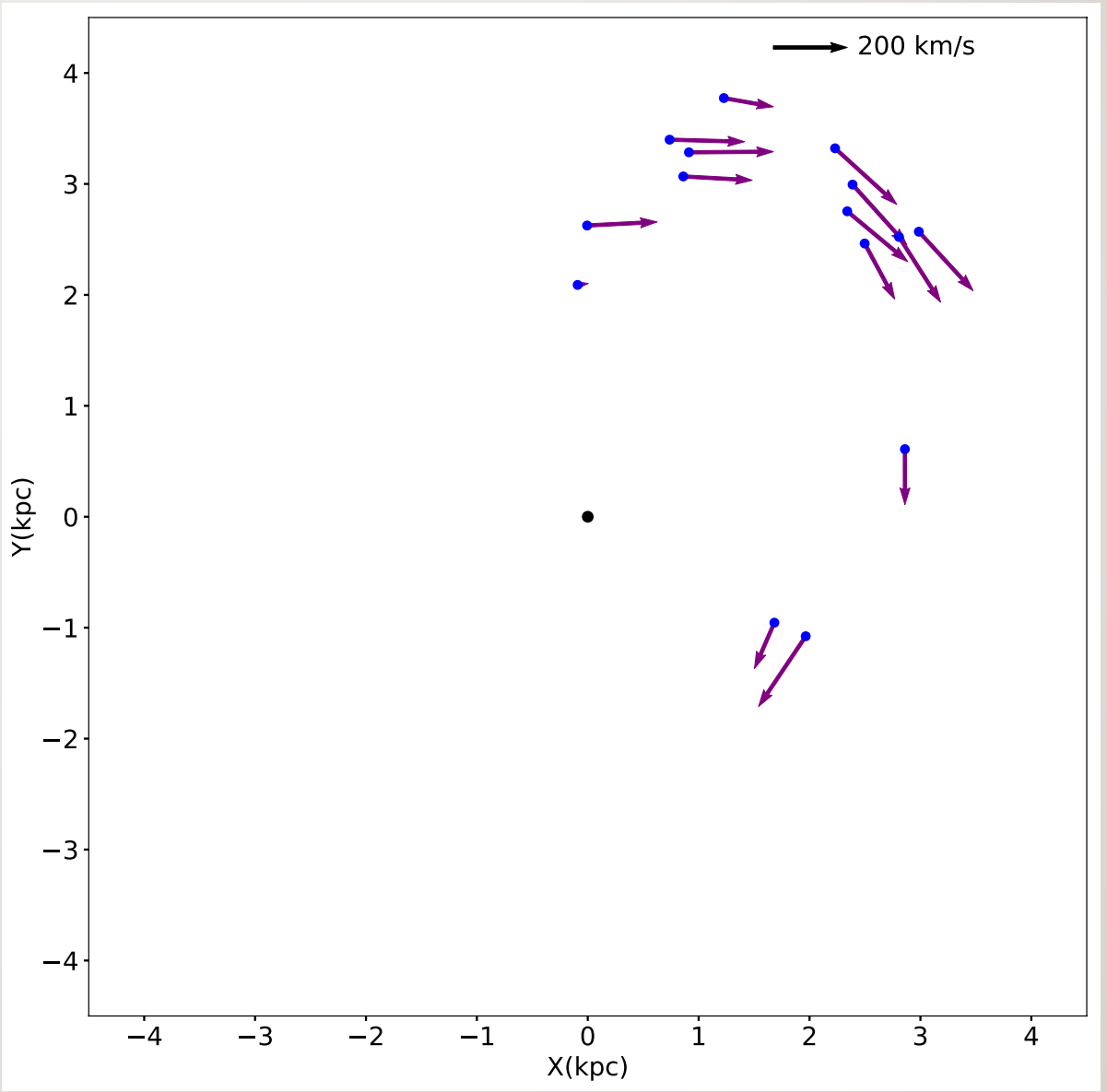
Dynamics of sources inside 4kpc region of the Galactic centre

Location of sources (within 4kpc of the Galactic centre & have better than 20% parallax accuracy) in the Galactic plane

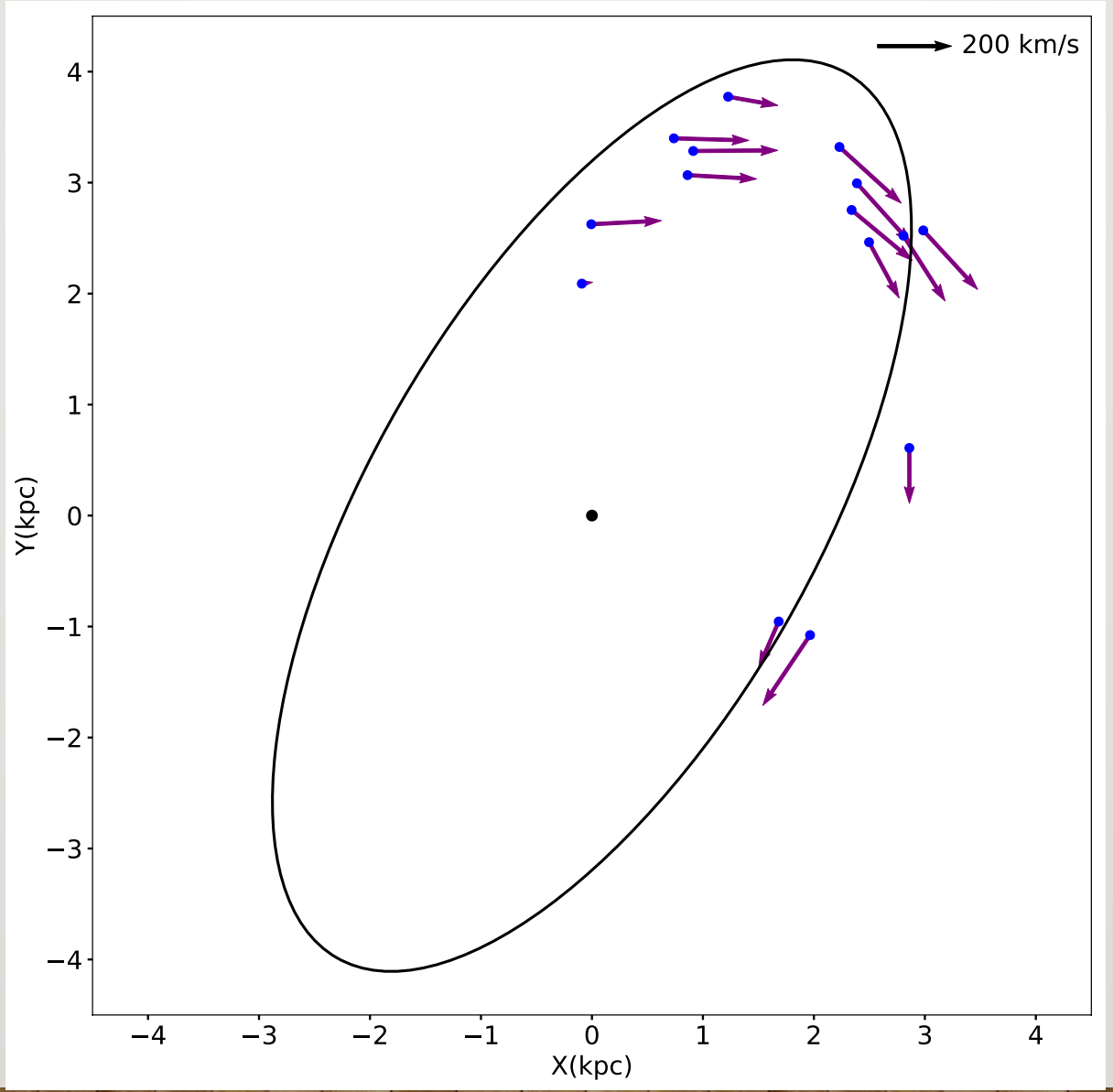


Dynamics of sources inside 4kpc region of the Galactic centre

Location as well as velocity of sources (within 4kpc of the Galactic centre & have better than 20% parallax accuracy) in the Galactic plane

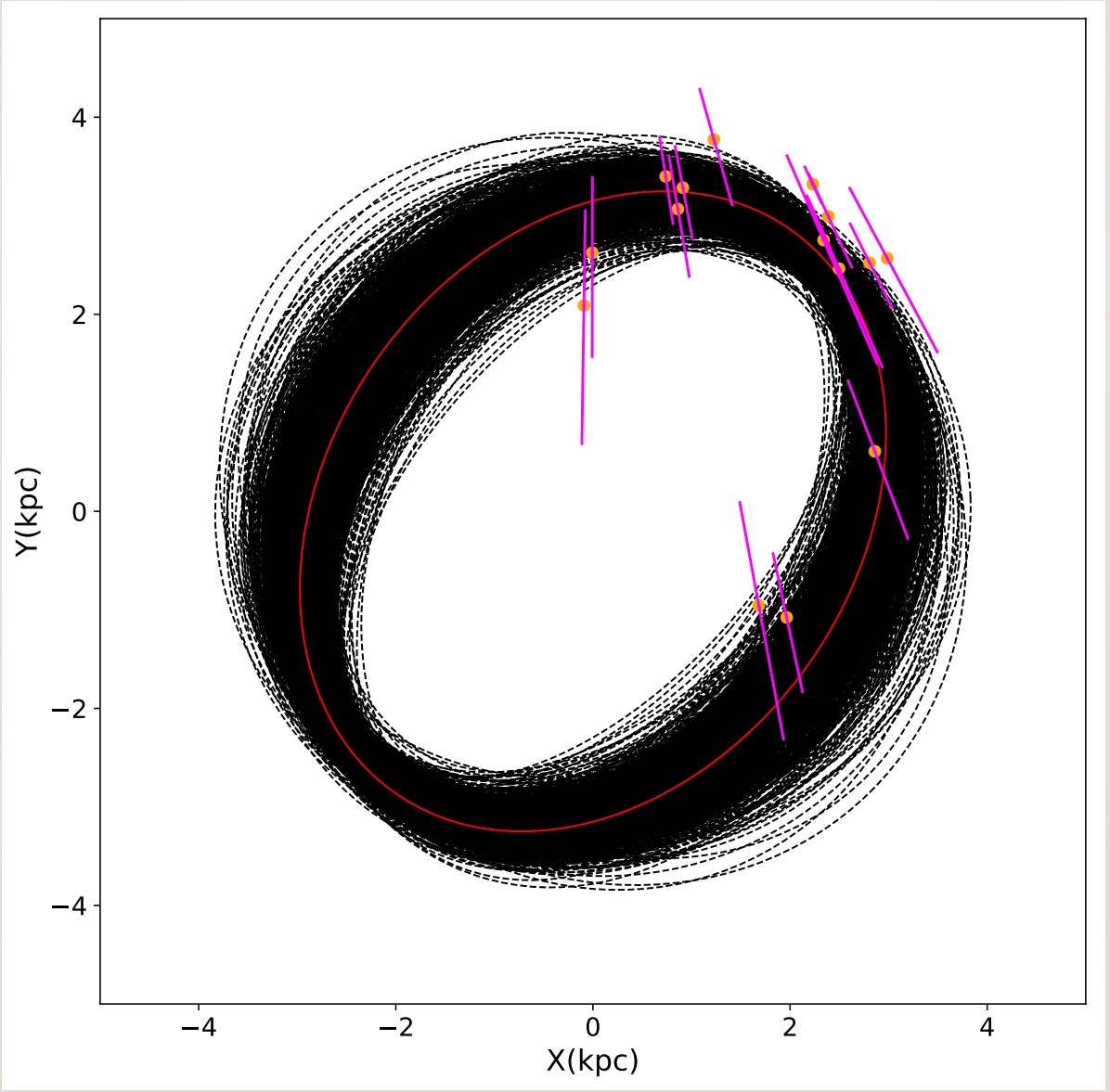


Dynamics of sources inside 4kpc region of the Galactic centre

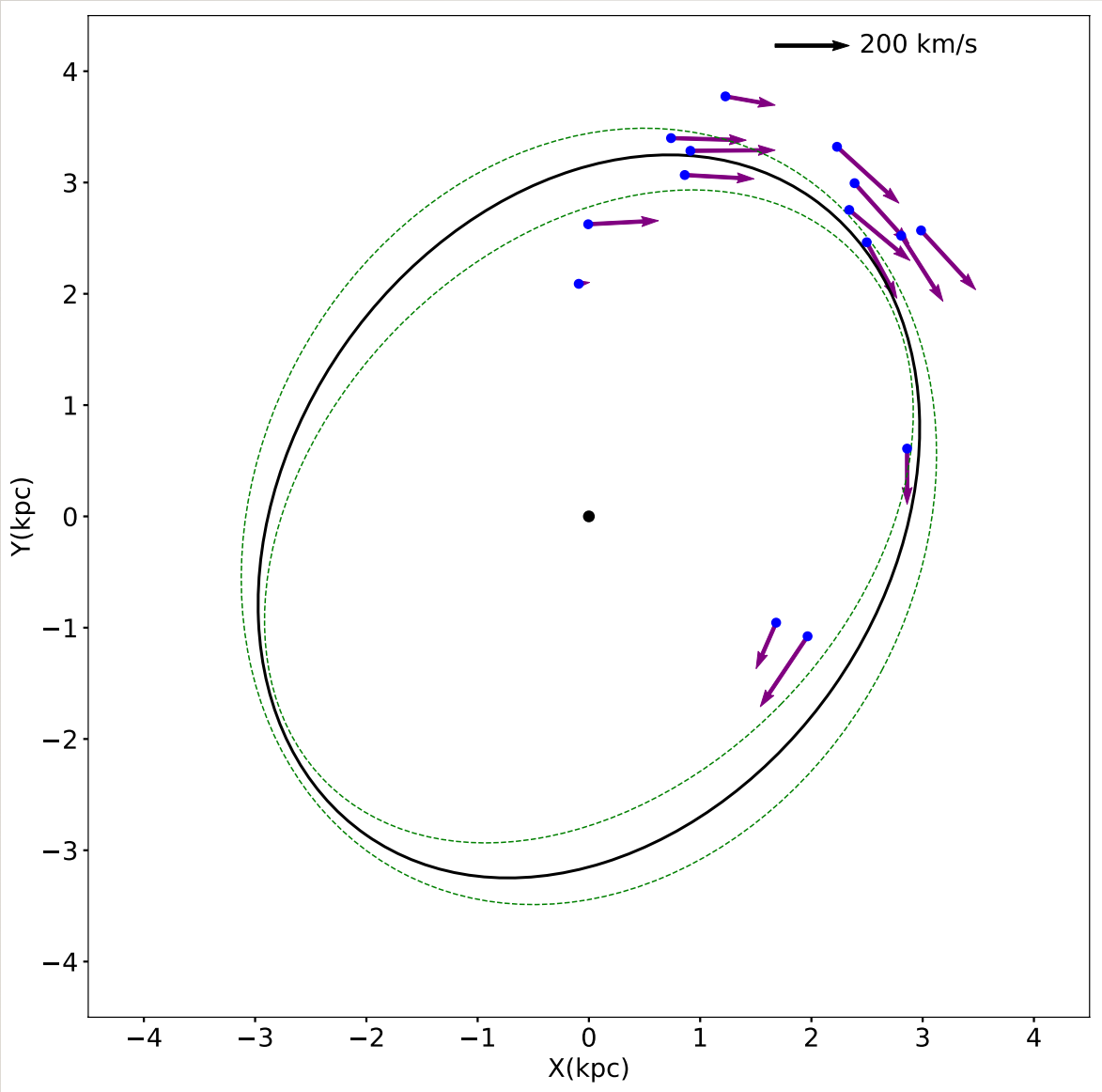


C. Wegg et al 2015:
Bar half-length = 4.6 kpc
Line-of-sight angle = 30˚

Least-squares fitting maps of elliptical orbits

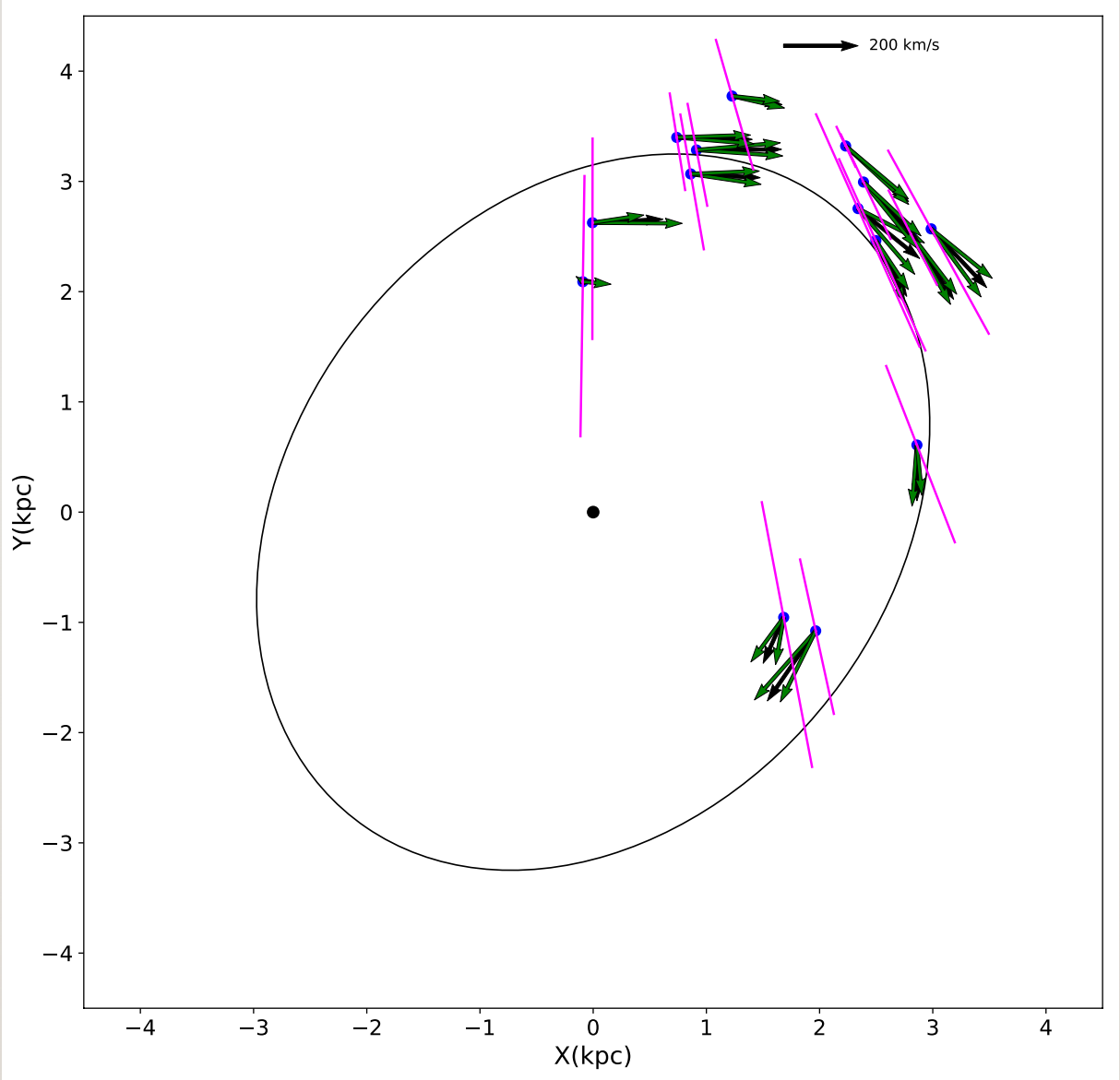


Least-squares fitting results

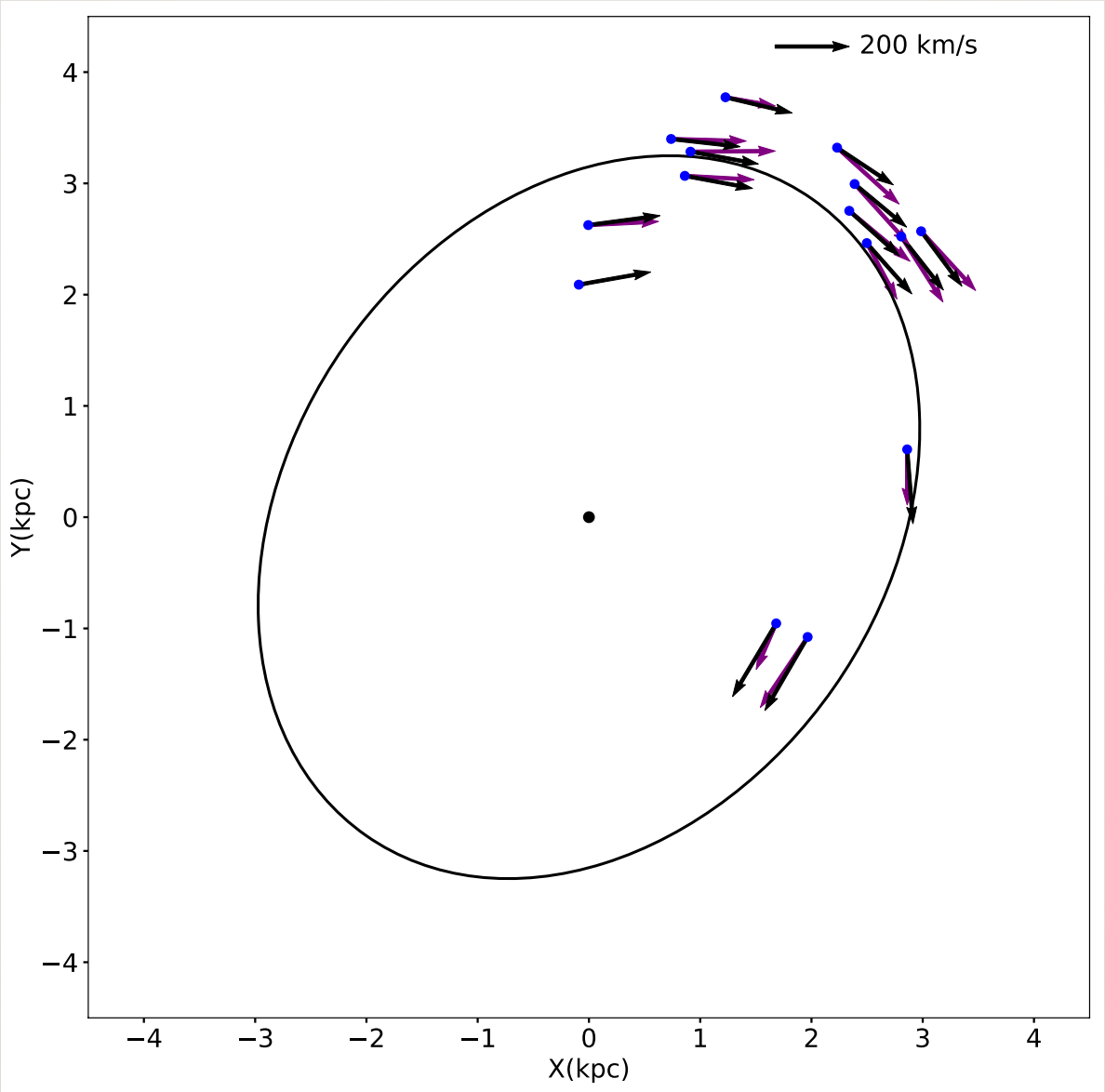


Major axis (a)= 3.49 ± 0.13 kpc
Minor axis (b)= 2.68 ± 0.28 kpc
Line-of-sight angle= 35 ± 8 degrees

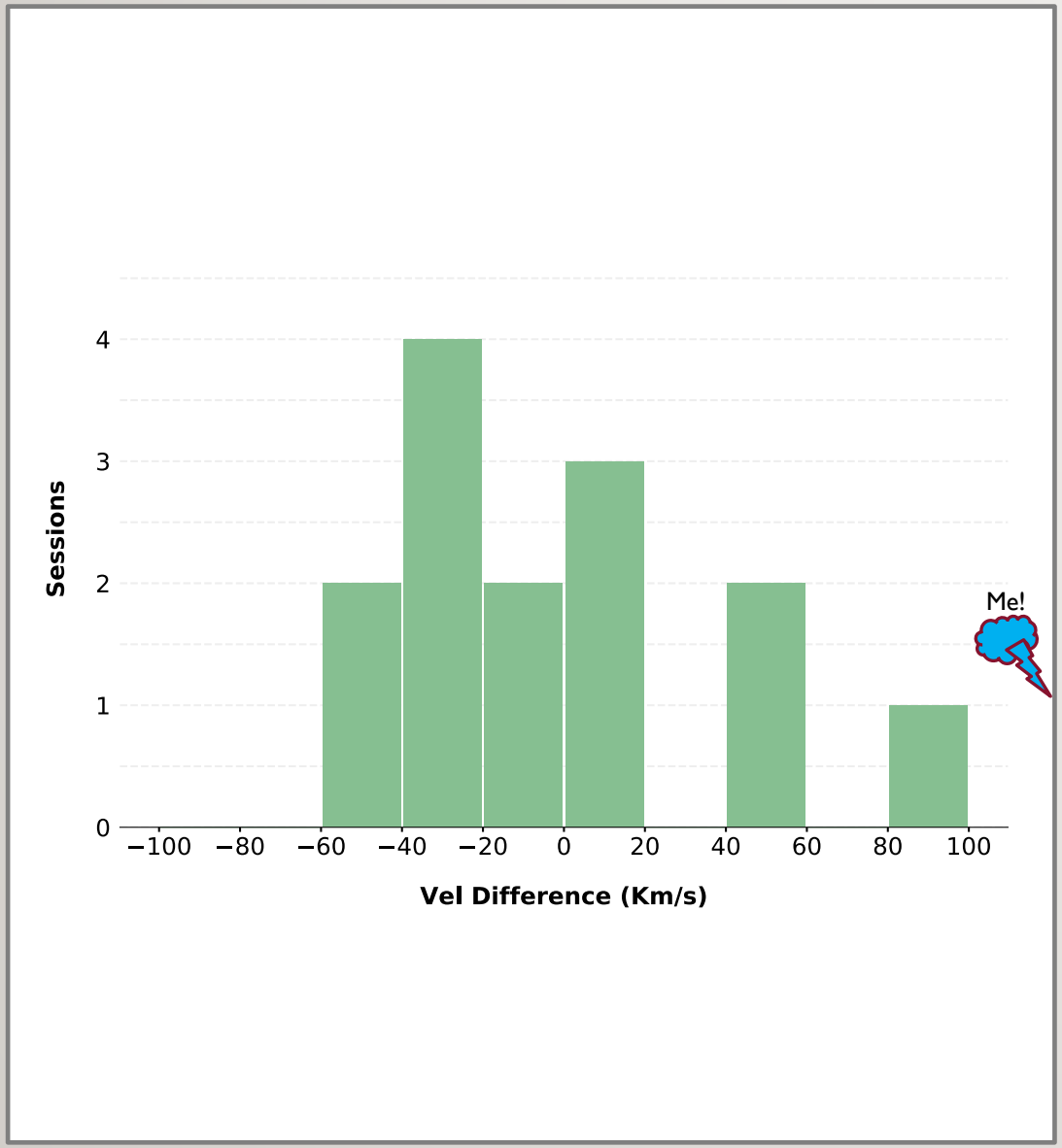
Dynamics of sources inside 4kpc region of the Galactic centre

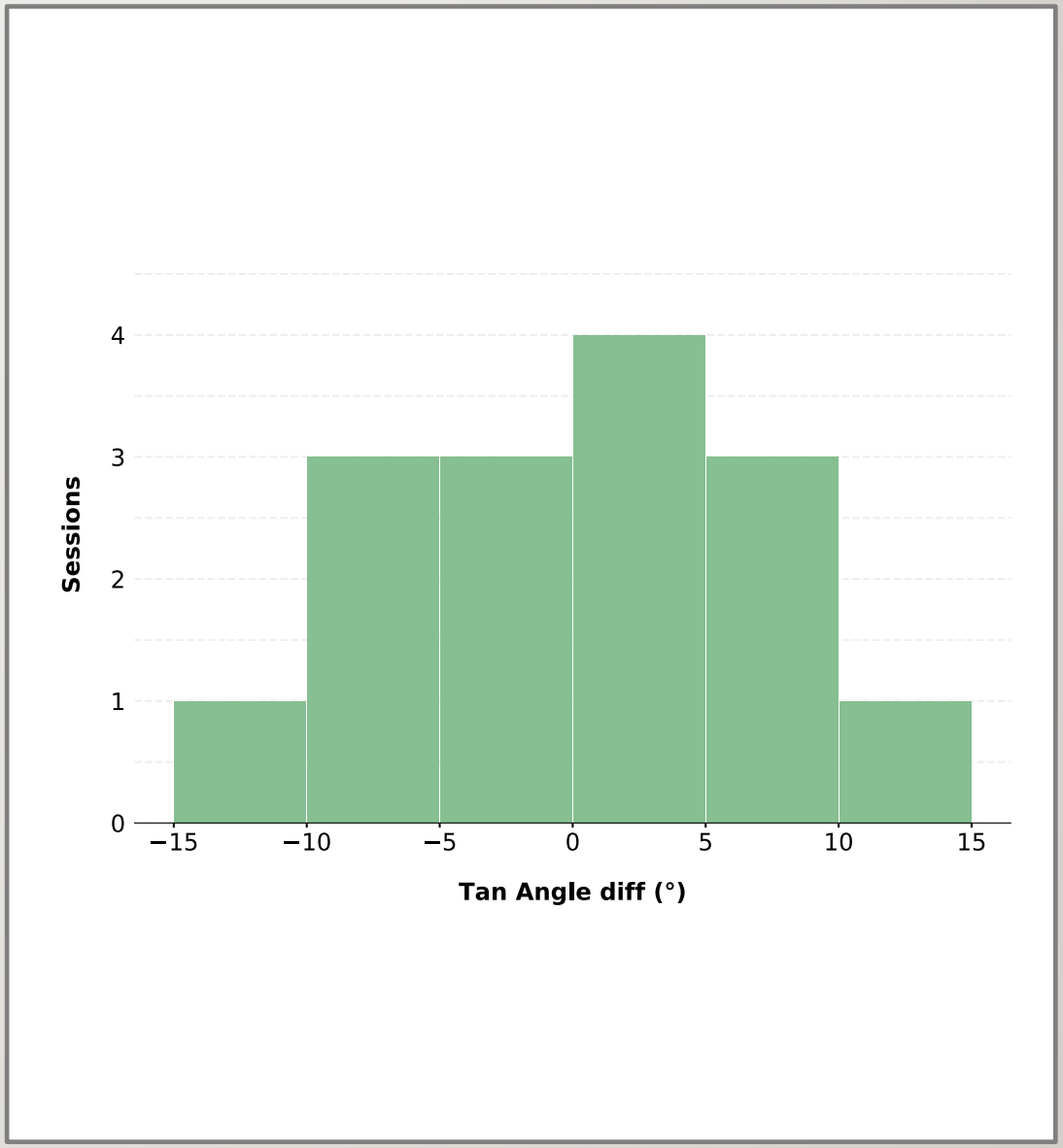


Comparison of measured and model velocities of sources



Comparison of measured and model velocities of sources





CONCLUSION

- First investigation of the dynamics of the Milky Way bar using absolute 3D position and velocity information without any prior assumptions
- Sources inside 4 kpc of the Galactic centre consistent with elliptical orbits with similar properties to the suggested long elliptical Galactic bar
- Least-squares fitting gives an ellipse with semi-major axis equal to 3.49 ± 0.13 kpc
- Line-of-sight angle for the bar is 35 ± 8 degrees
- More parallax and proper motion measurements required (especially in the 4^{th} quadrant of the Galaxy) to further refine our understanding of bar dynamics