Trigonometric distance and maser kinematics of the fastest (and farthest) water fountain source

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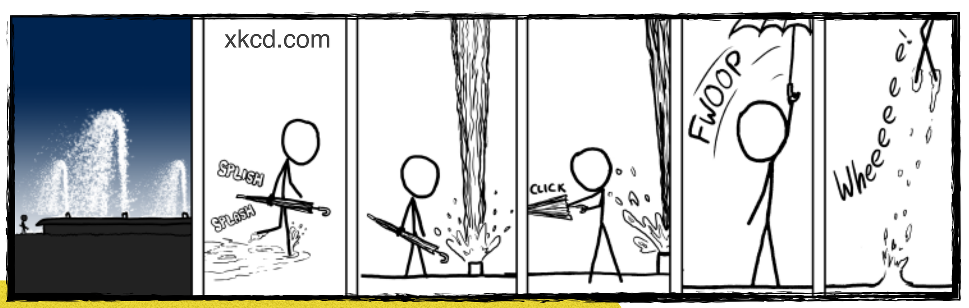
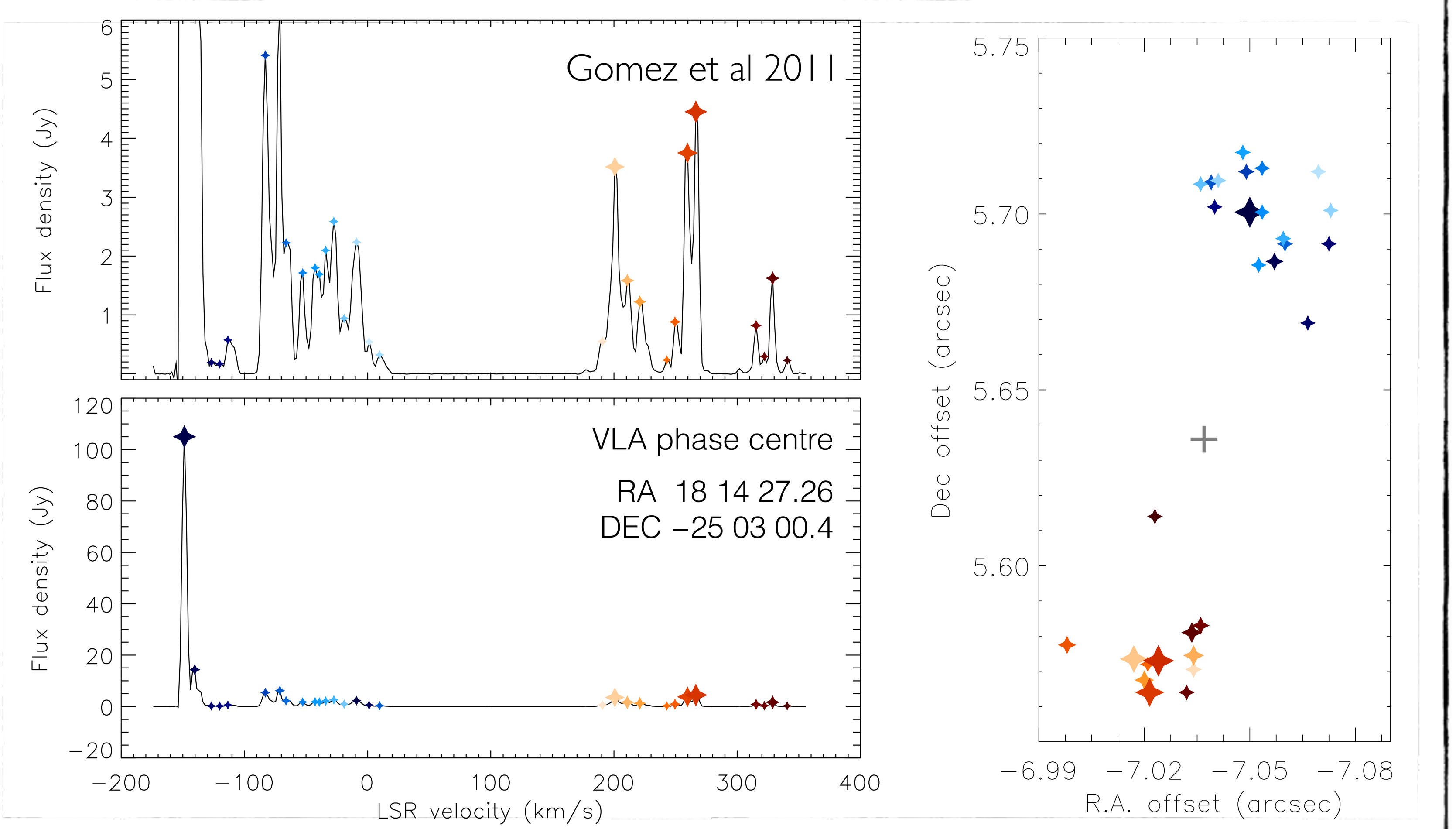
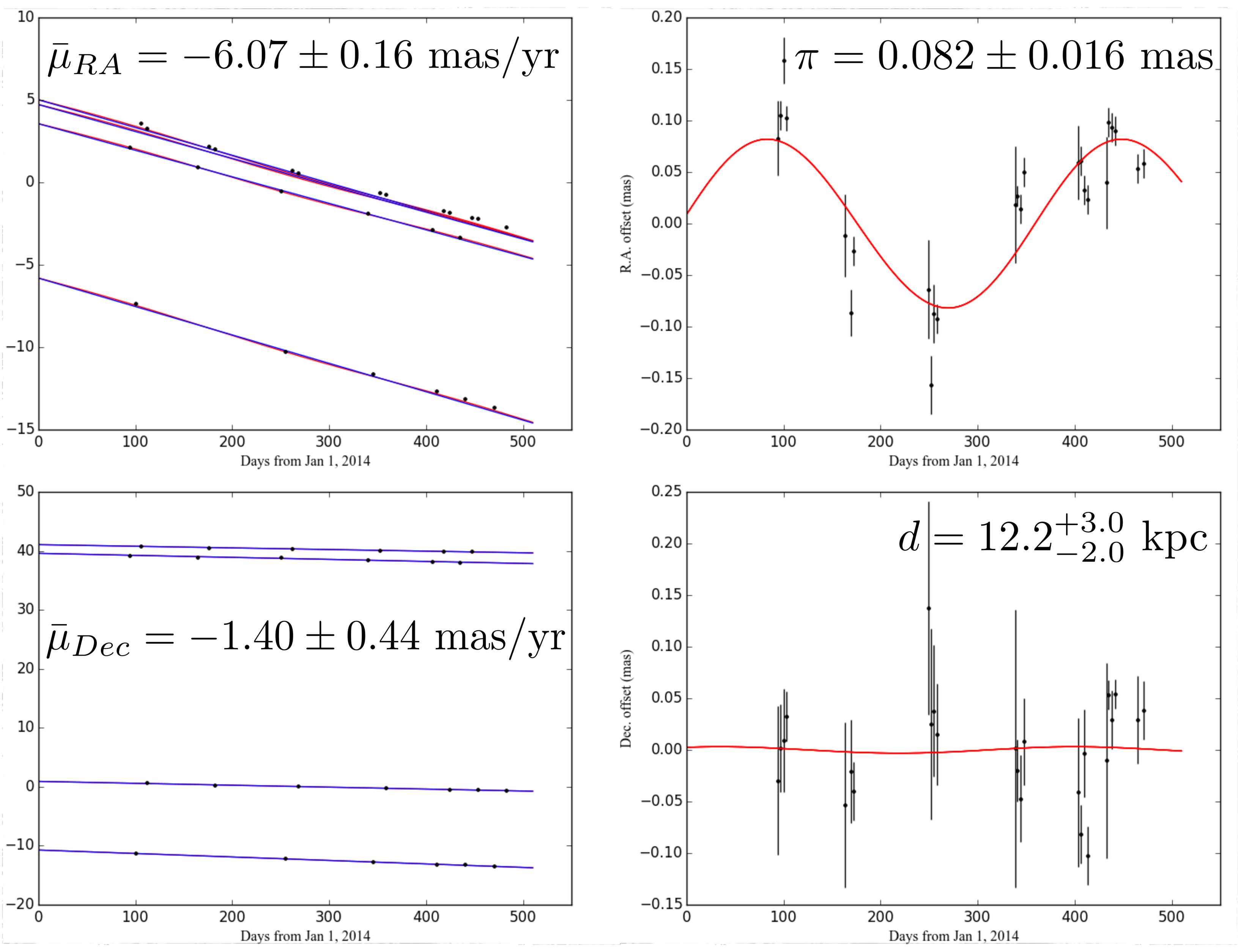


Water fountains

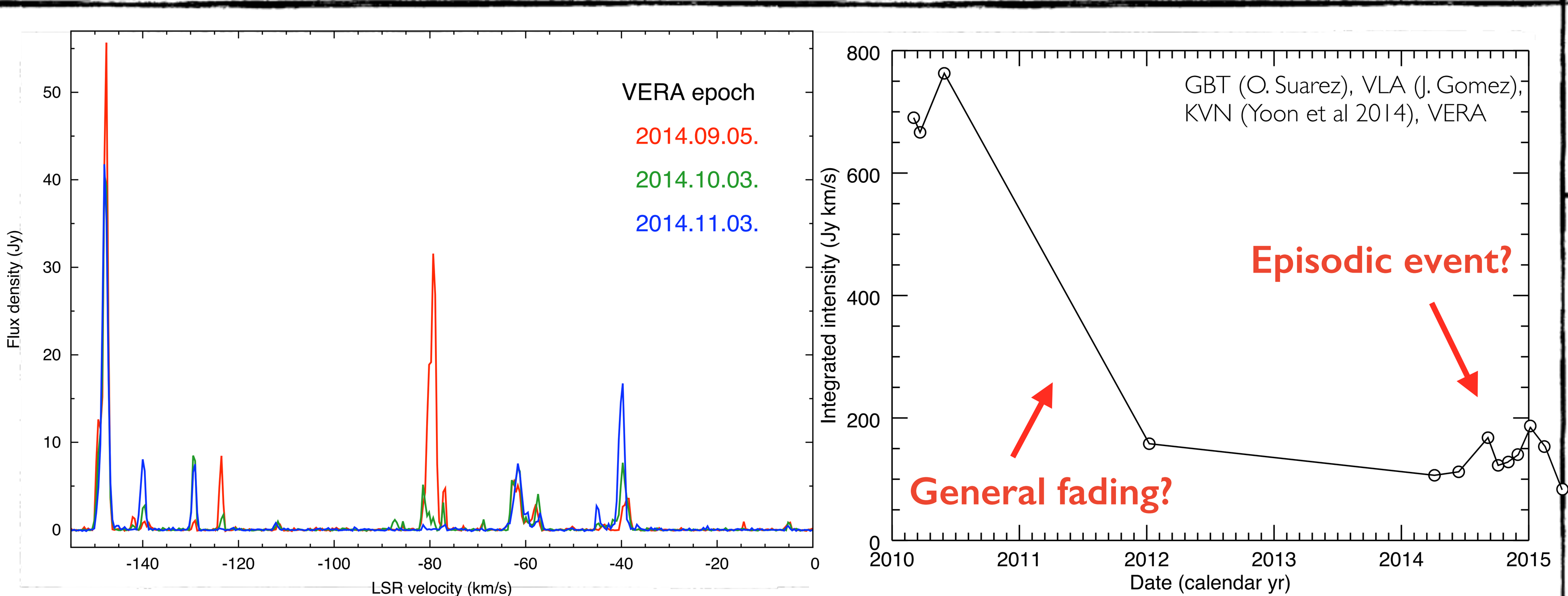
Water fountain sources are evolved stars with morphologically and kinematically highly collimated fast jets traced by water maser emission. Interferometric observations show that the maser emission is shock-excited in bipolar outflows. Water fountains are believed to be associated with a very short transitory phase in late stellar evolution (~1000 years) after the AGB period, which should play an important role in the sculpting of the intricately shaped planetary nebulae (Sahai and Trauger 1998). Due to the short lifespans of water fountains, only about a dozen are known so far.



The VLA observation shows the fastest bipolar outflow in a water fountain. Due to the large spread in velocity, we could only observe one lobe with VERA. Maser features show extended internal structures along the axis of the outflow (likely caused by their high velocity), making identification between epochs challenging. The parallax is consistent with the far kinematic distance to 1.5-σ.

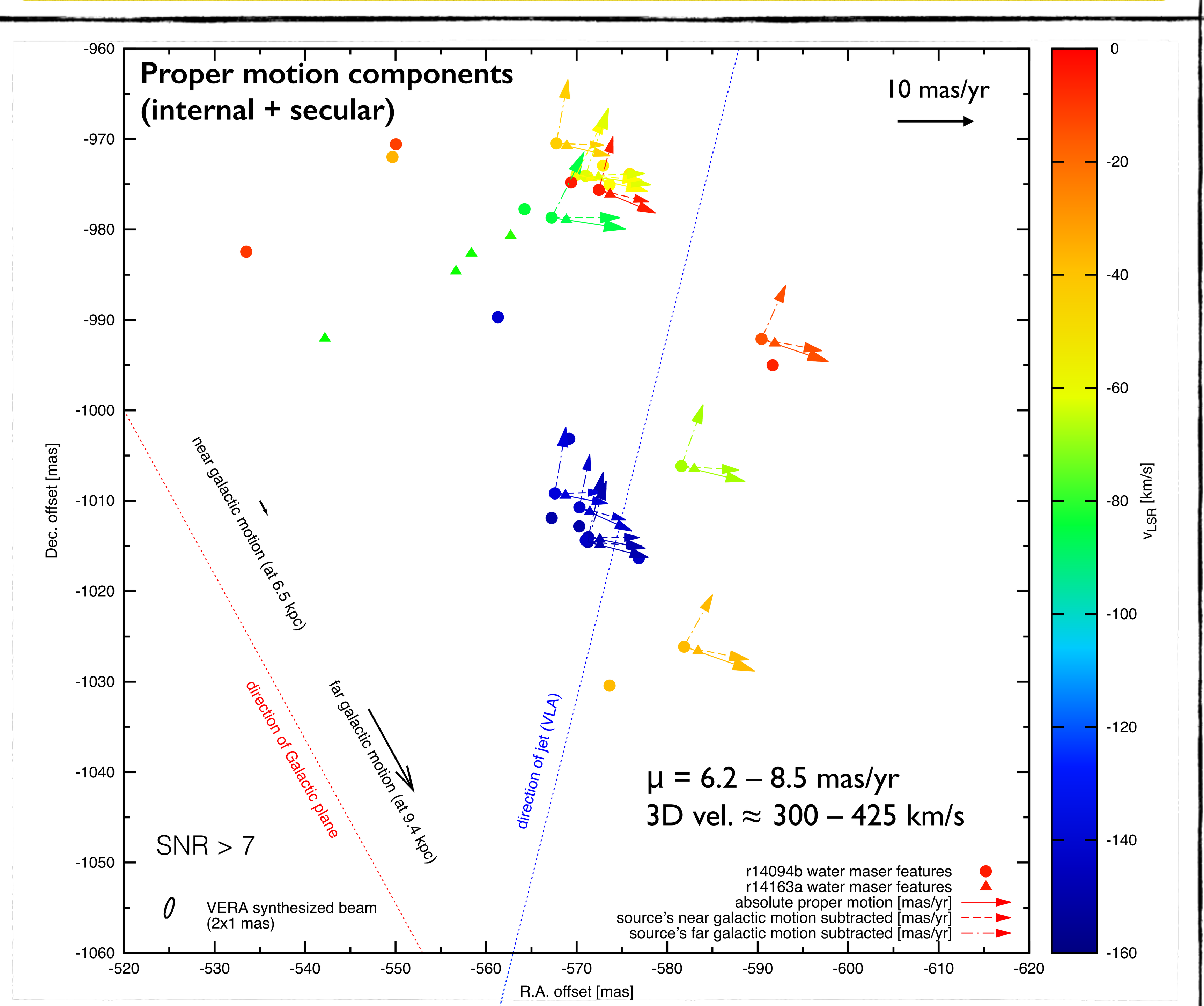


Spectrum components show rapid variability on monthly scales (left), making it difficult to trace the masers over a year. The integrated maser intensity also varies on a longer scale (right), however it is not clear whether this is the fading of the source or a recurring event from e.g. discontinuous mass loss. (Perhaps both?)

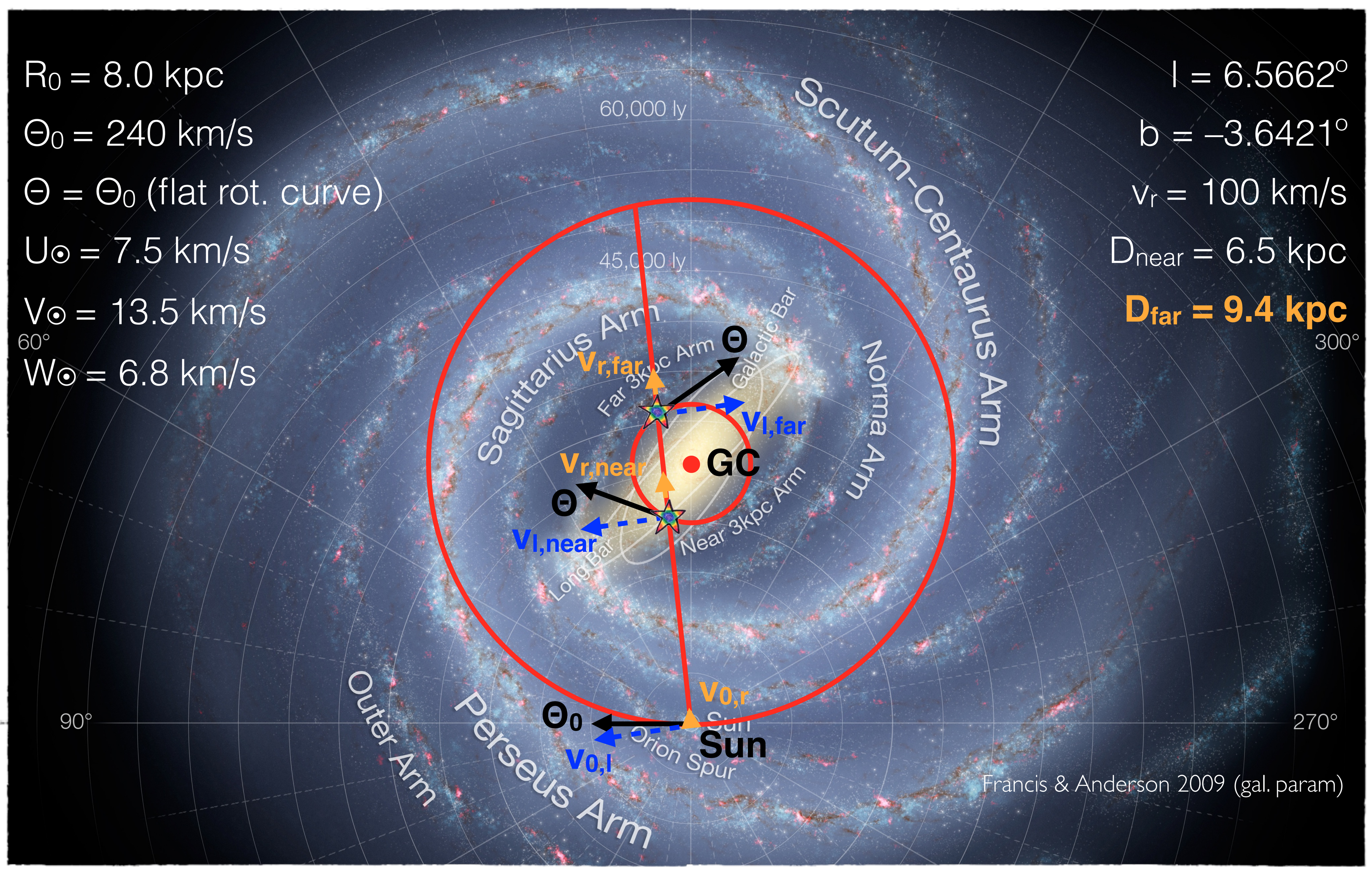


IRAS 18113–2503

This water fountain is located towards and beyond the Galactic Centre in the thick disk, with jets spanning a very large line-of-sight velocity range of ~500 km/s. Both lobes show a high velocity dispersion as well, ~170 km/s. This can be interpreted as the jets having a large opening angle, or as internal shocks along the jet, generated by episodic mass-loss events with increasing velocities. To measure the motion and distance of the water fountain, we conducted monitoring observations of the brighter blueshifted lobe with VERA over a year in 9 epochs. We derived a parallax of 0.082 mas with a relative accuracy of 19%, making this source the farthest known water fountain to date and only the third with a measured trigonometric distance.



Subtracting the independently modeled Galactic rotation from the measured maser proper motions, we can estimate the internal motions in the outflow. At the far kinematic distance, the residual maser motions follow the jet axis derived from VLA observations. The large spread in the calculated 3D velocities favors the episodic mass-loss scenario. We are currently analyzing new VLBA data to measure the internal motions directly and characterize the kinematic structure.



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Francis, C., & Anderson, E. 2009, NewA, 14, 615
Gómez, J.F., Rizzo, J.R., Suárez, O., et al. 2011, ApJ, 739, L14
Sahai, R., & Trauger, J.T. 1998, AJ, 116, 1357
Yoon, D.H. et al. 2014, ApJS, 211, 15

2015.09.24-25.