Eight New Astrometry Results of 6.7 GHz CH_3OH and 22 GHz H_2O masers in the Perseus arm



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Spiral Arm Theories since 1960s

Density wave theory
(Lin & Shu 1964)



©Ingo Berg **Quasi stationary**

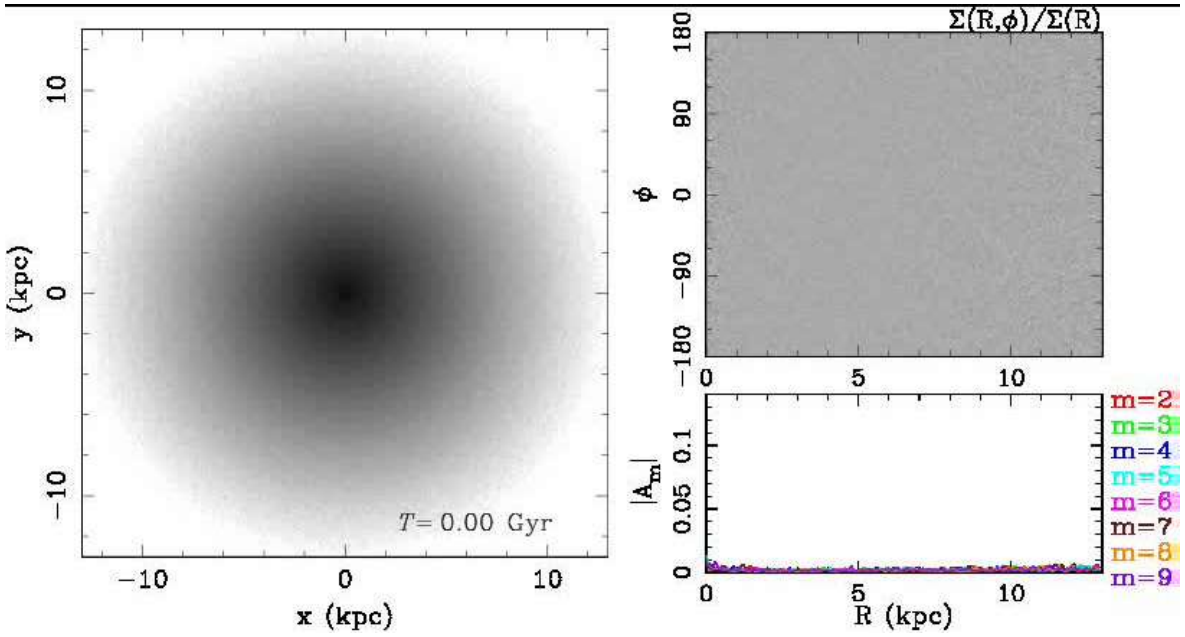
$$\frac{\partial \Omega_{\mathrm{star}}(R)}{\partial R} \neq 0$$

Differential rotation

$$\frac{\partial \Omega_{\mathrm{spiral}}(R)}{\partial R} = 0$$

Rigid body rotation

Dynamic spiral (i.e. transient & recurrent)
(e.g. Goldreich & Lynden-Bell 1965)



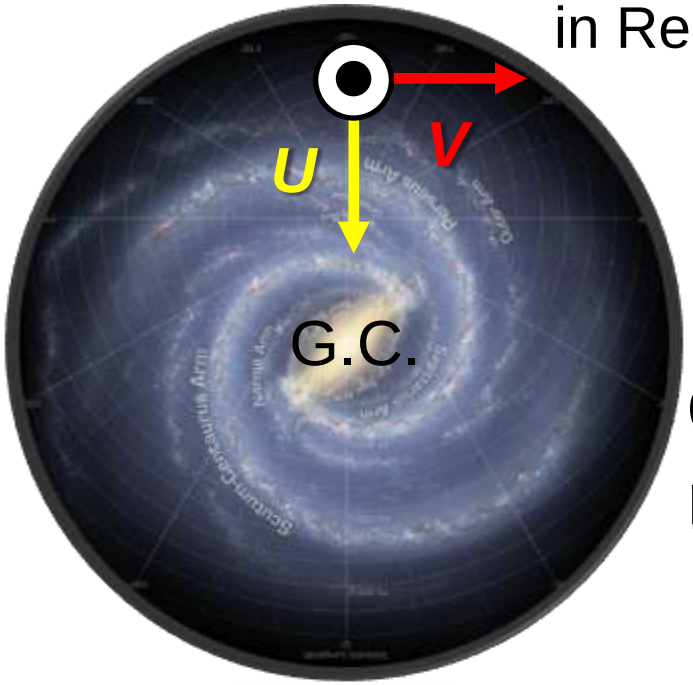
Fujii et al. 2011:N-body simulation

$$\frac{\partial \Omega_{\mathrm{star}}(R)}{\partial R} = \frac{\partial \Omega_{\mathrm{spiral}}(R)}{\partial R} \neq 0$$

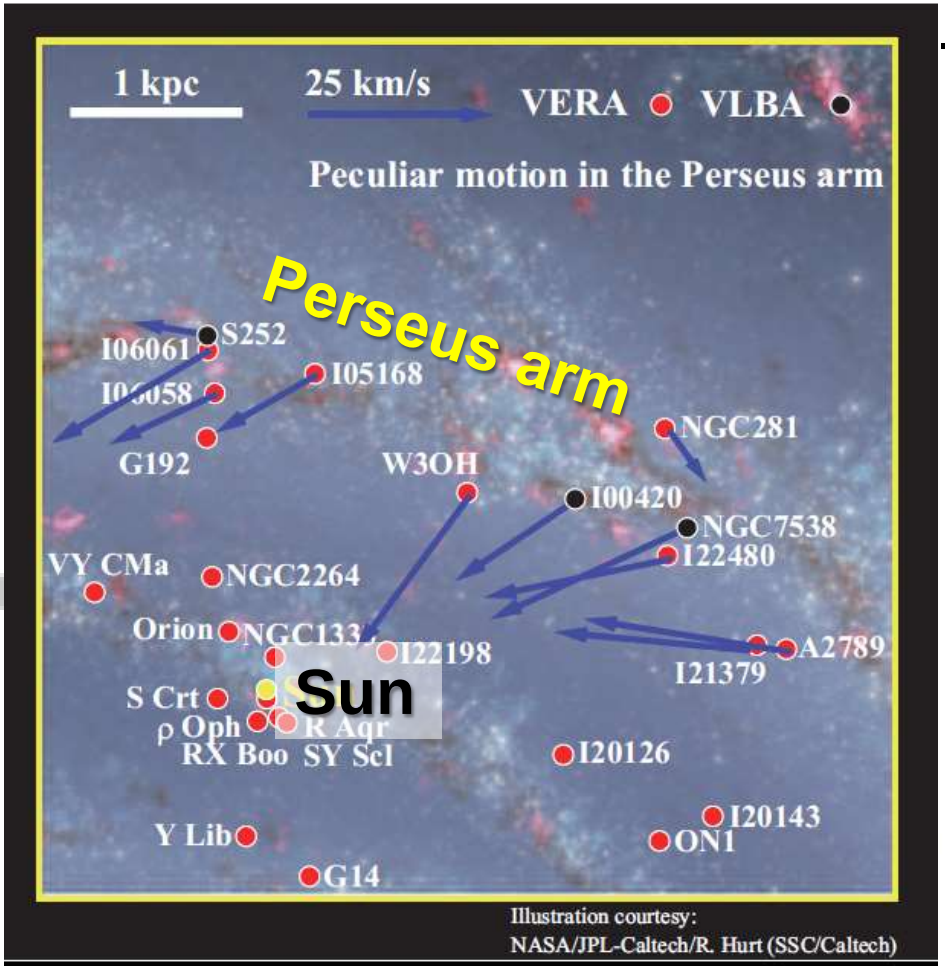
Called as material arm

Perseus arm in the Milky Way

3D non-circular motion (***U, V, W***) in Reid+09



Gal. rotation



Choi et al. (2014) found the same tendency based on **25 astrometry results in the Perseus arm** !

Averaged non-circular motion of the **Perseus arm** with 8 sources
(*U*_mean, *V*_mean) = (10+/-3, −18+/-3) km/s in Sakai et al. (2012)
→Systematic inward motion & Slower Gal. rotation

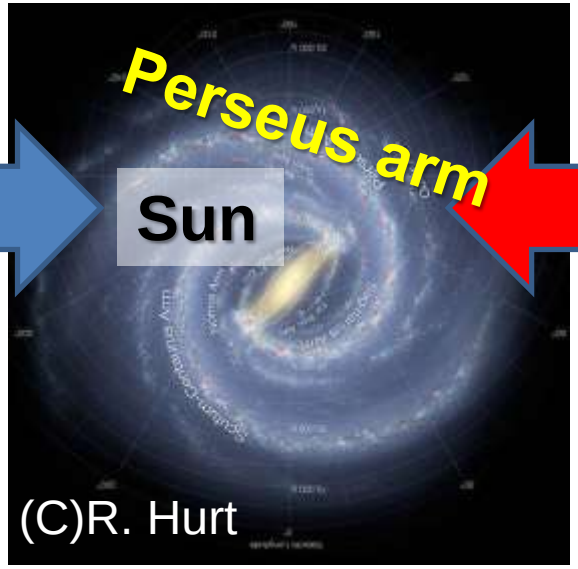
What is the best spiral arm model ?

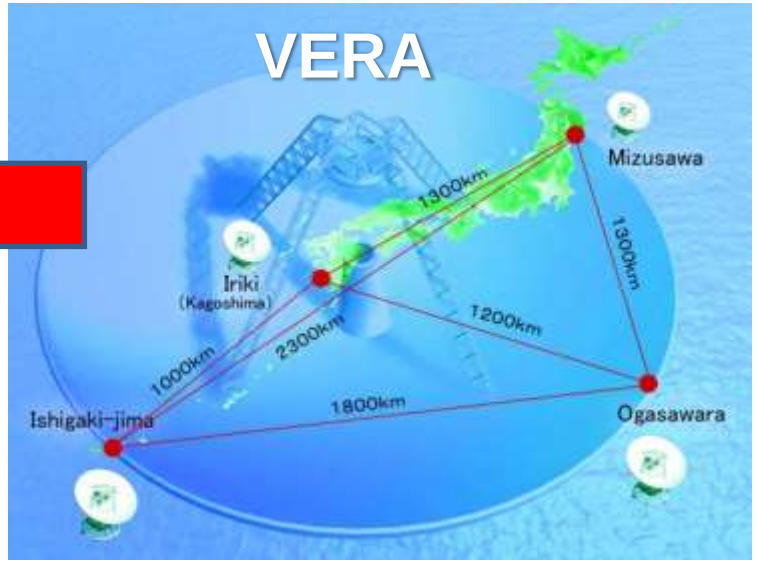
Comparisons between models and observations have been suffered from insufficient **spatial resolution** and a lack of **kinematic** (3D) info.

After 2000s, VLBI (Radio) astrometry has provided us 6D kinematic info. (3D position & 3D motion) for the Milky Way with high accuracy (**Δπ~10 μas, Reid & Honma 2014**).

I would like to evaluate the spiral arm theories with the astrometry results and to reveal impact of the arm on Galactic dynamics !!



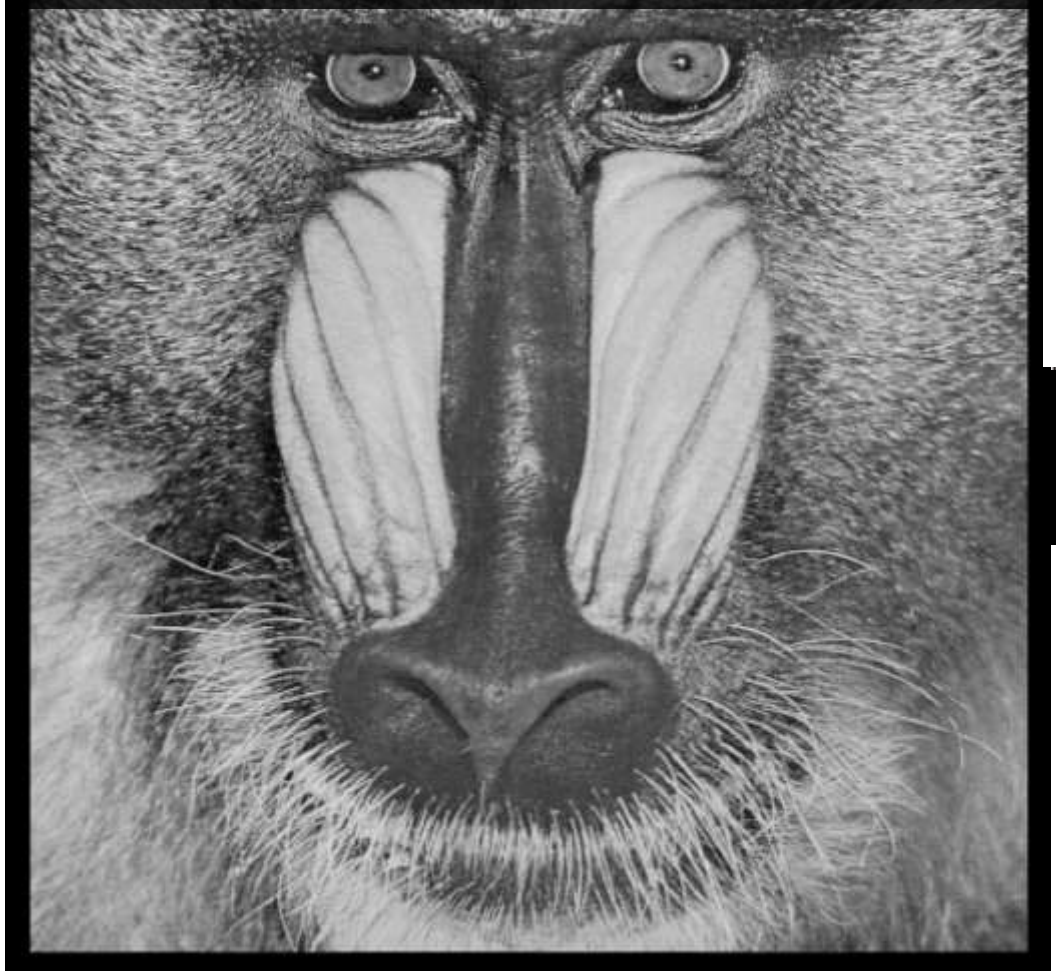




Perseus arm observations & Data reduction

Astronomical **I**mage **P**rocessing **S**ystem (C)NRAO

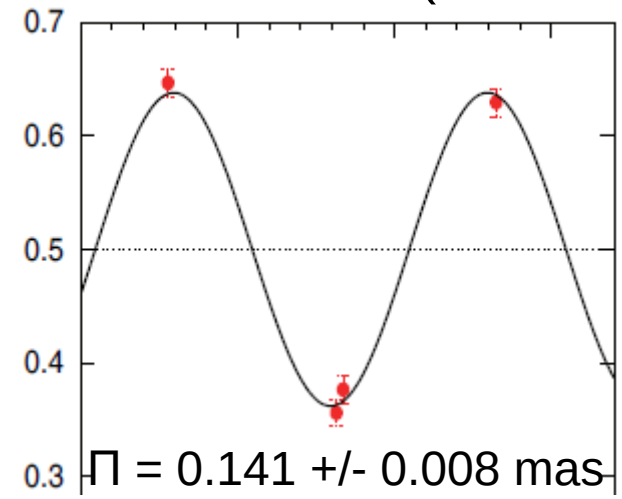
*see **Reid+17** for 6.7 GHz data reduction



Python script for BeSSeL developed by Andreas

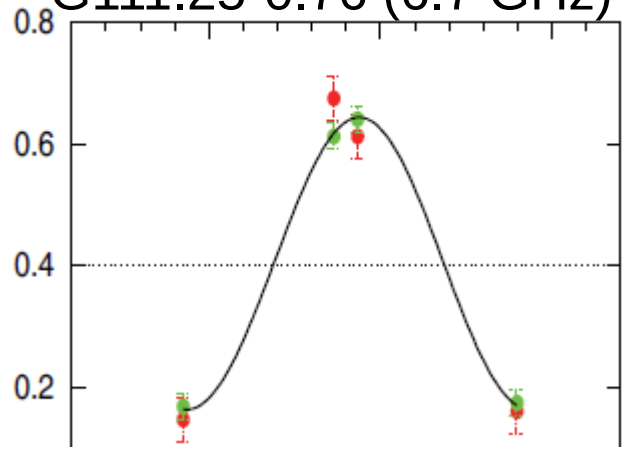
Parallax results for ~~8~~ 7 sources

G070.18+1.74 (6.7 GHz)

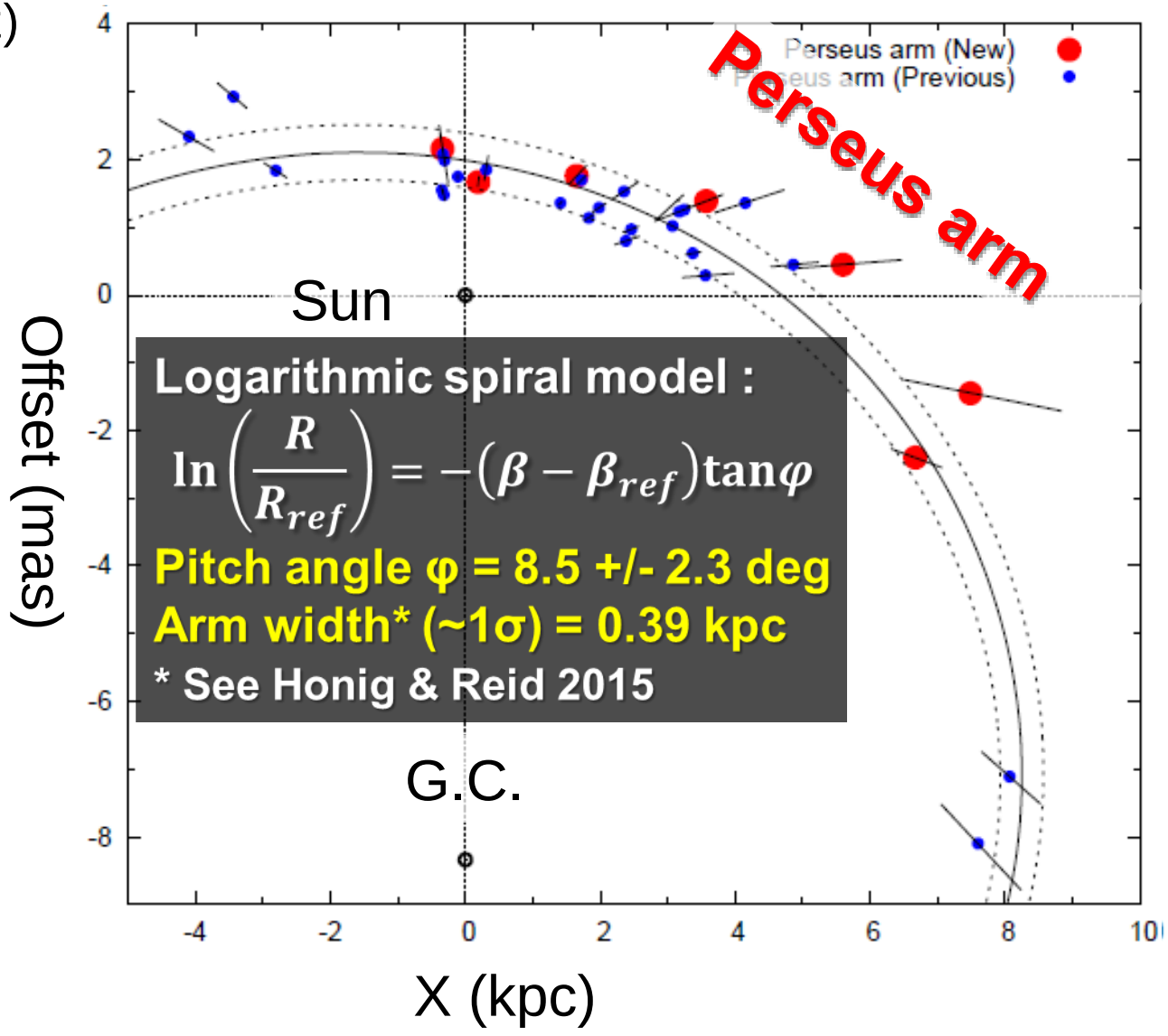


Π = 0.141 +/- 0.008 mas

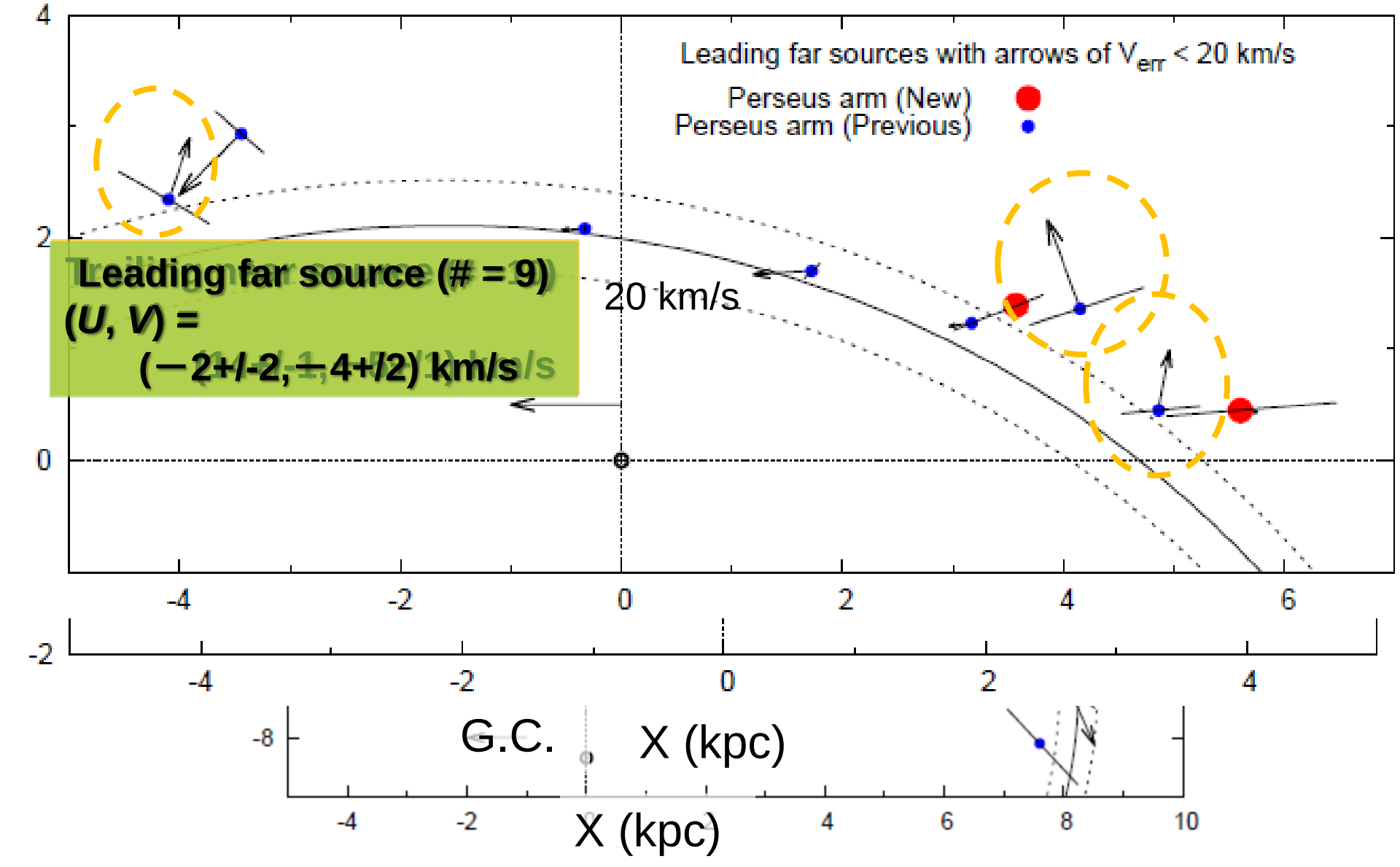
G111.25-0.76 (6.7 GHz)



Π = 0.261 +/- 0.017 mas

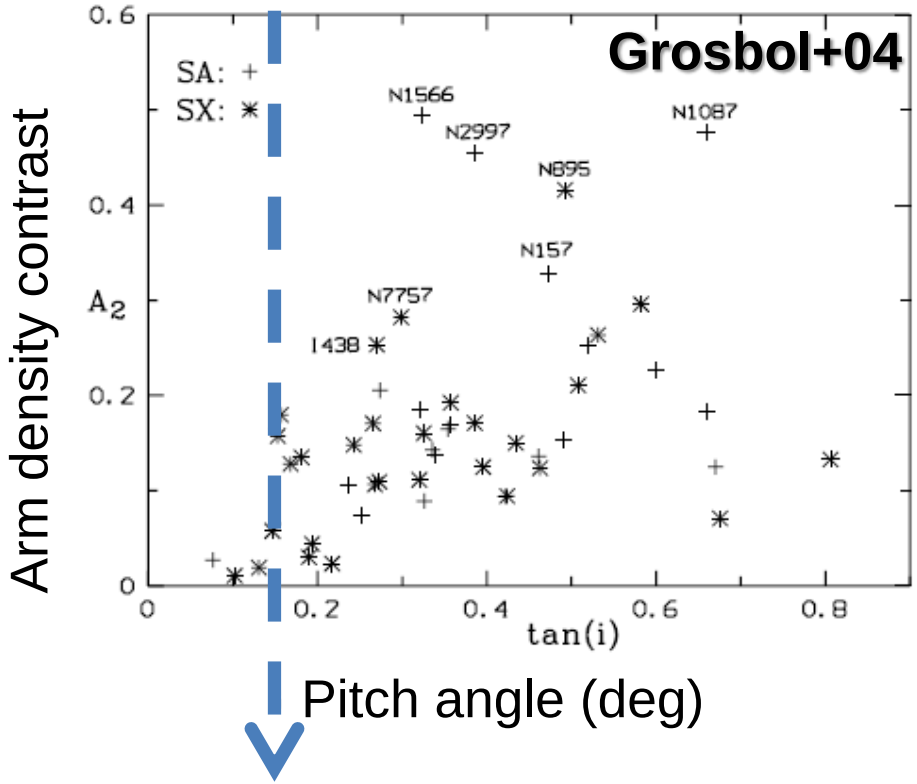


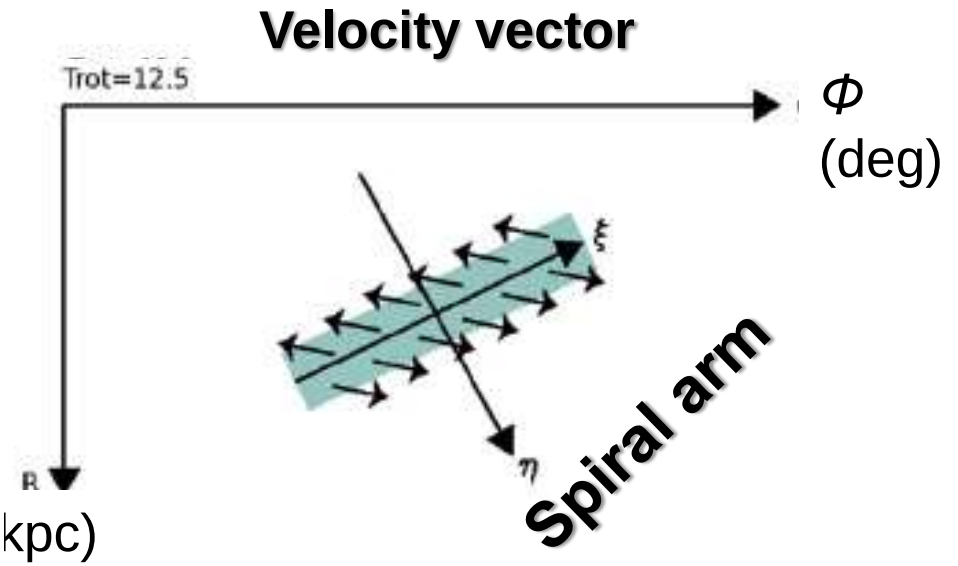
Non-circular motion in the Perseus arm



Perseus arm vs. Spiral model (Baba+13)

Dynamic (i.e. recurrent & transient) spiral with *N*-body simulation





Damping phase
(due to the Coriolis force)

Perseus arm is now damping phase ?

What is the next ?

Physical parameters of the Perseus arm (# = 28):

Pitch angle = 8.5+/-2.3 deg

Width = 0.38 kpc

(*U*, *V*) = (7.4, 9.8) km/s@all

(14+/-1, -5+/-1) @Near

(-2+/-2, -4+/-2) @Far

Damping phase ??

Astrometry (spiral arm) research is entering in the exciting era !

Next step

①Perseus arm with different radii for choosing the model

②Stellar information

BeSSeL South (?)





