VLBI位置天文観測に準拠した、密度波理論の検証

Test of the Density-wave theory Using VLBI astrometry results

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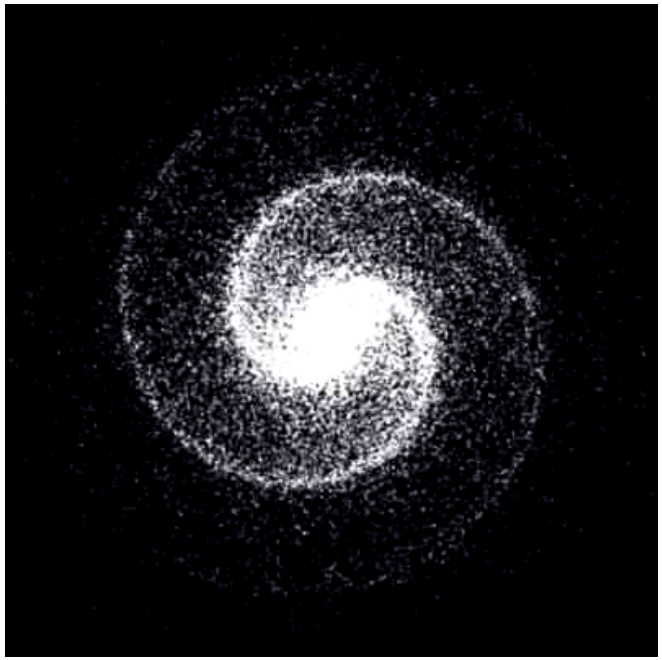
Theories for the Spiral arm

Density wave theory
(Lin & Shu 1964)



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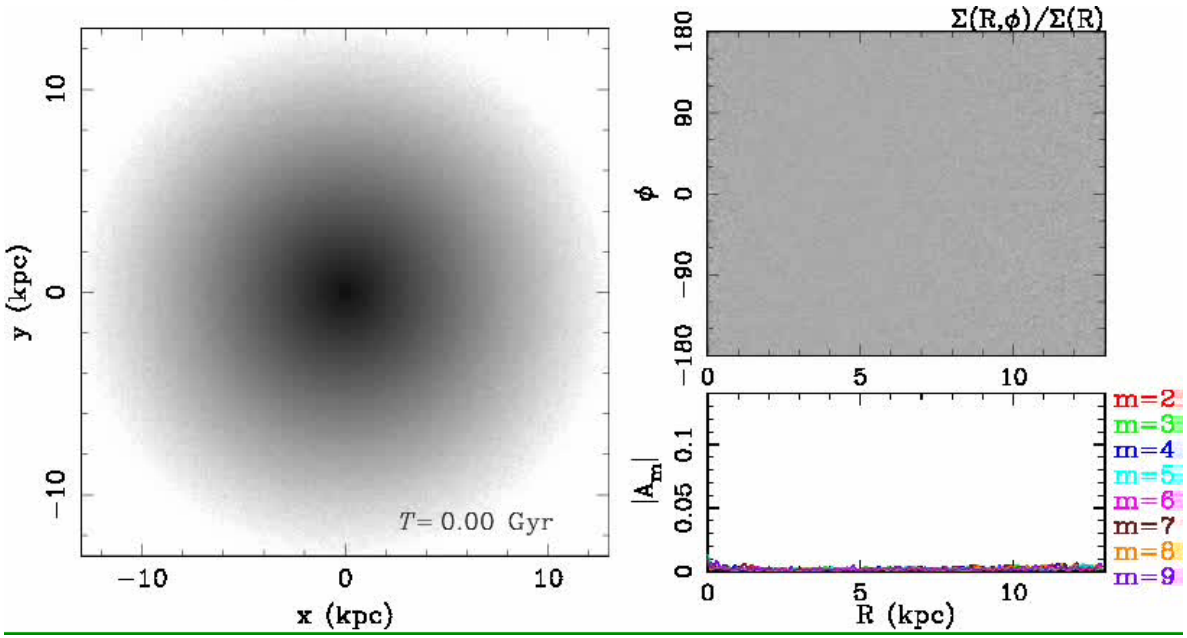
Recurrent transient spiral
(e.g. Goldreich & Lynden-Bell 1965)

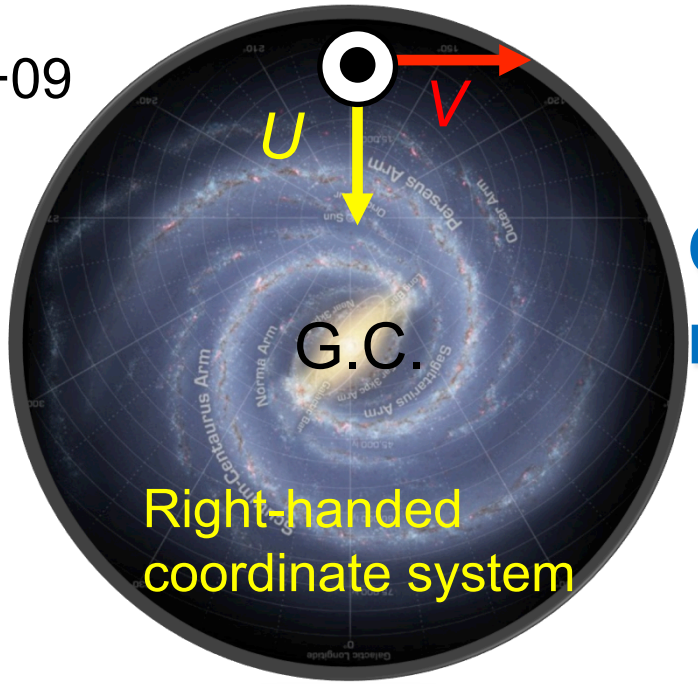


Fujii et al. 2011:N-body simulation

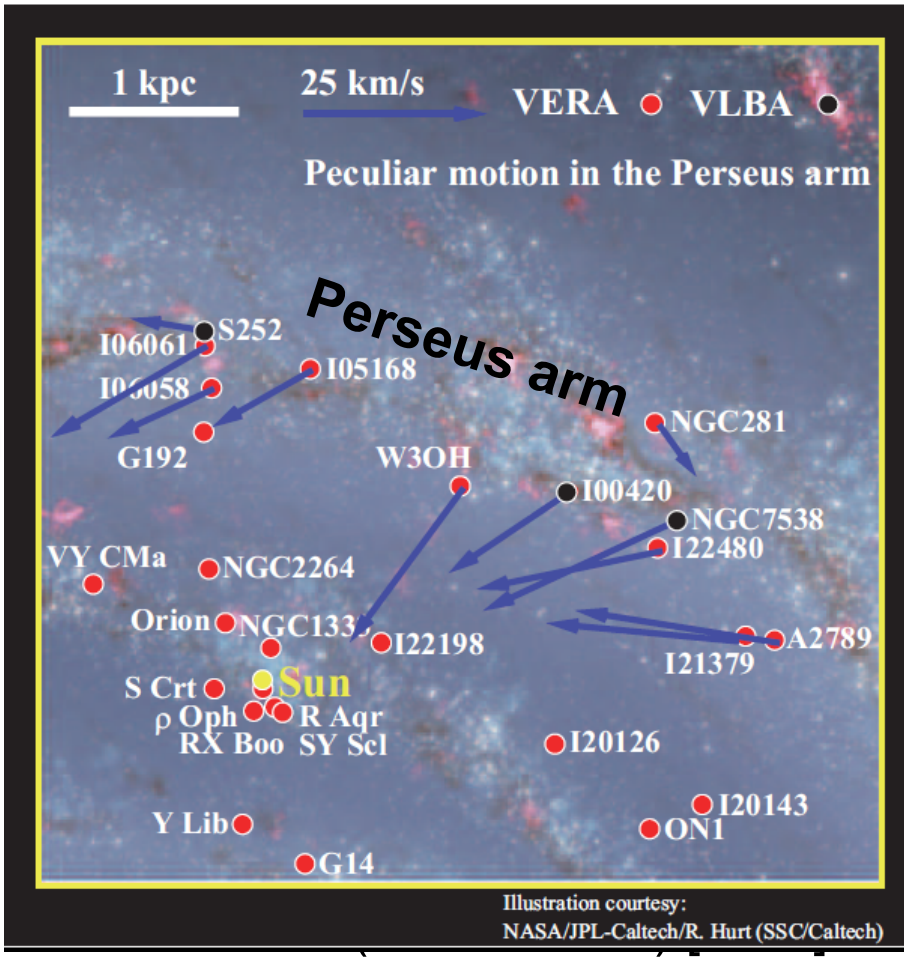
- Spiral arm is the most prominent structure in a disk galaxy.
- However, the nature, origin and evolution are still unknown.

3-D astrometry results

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



Gal. rotation



Choi et al. (2014) found the same tendency **with 25 sources** !

Averaged non-circular motions with 8 sources in the Perseus arm

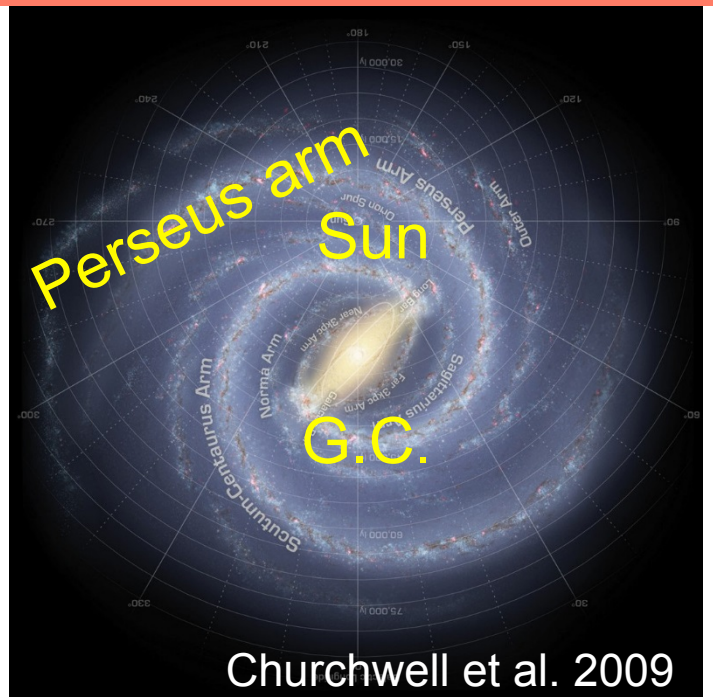
(U_{mean}, V_{mean}) = (9.8+/-2.6, —17.8+/-2.5) km/s in Sakai et al. (2012)

→Systematic inward motion and slower Gal. rotation

Goals of this research

①We compare astrometry (3D) results for **the Perseus arm** with an analytic gas dynamics model based on the density-wave theory.

②Using the results, we make a suggestion toward an **incoming astrometry** (e.g. Gaia).



Churchwell et al. 2009

Ultimate Goal

・We aim to understand the origin and evolution of the spiral arm in the Milky Way.

The least squares fit

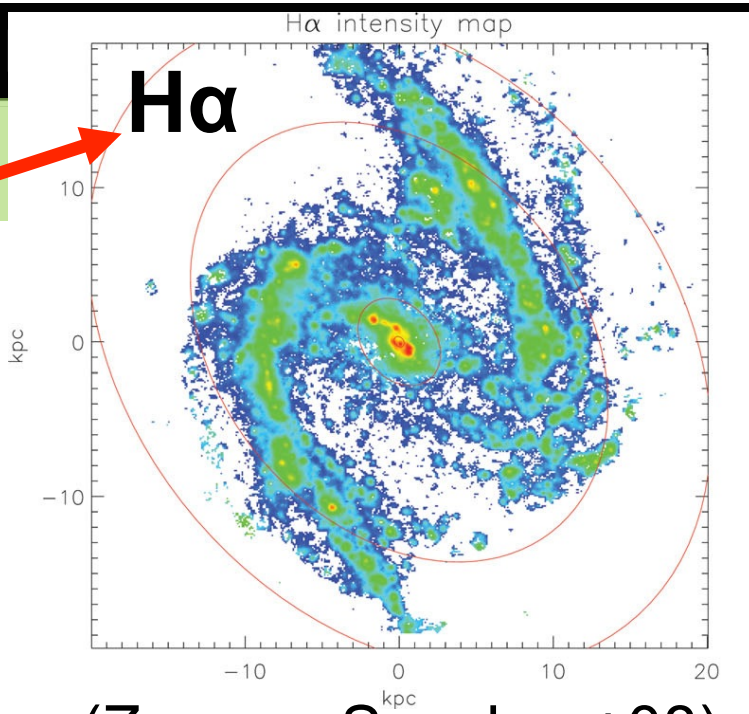
Observables

(U, V) for 27 sources in the Perseus arm

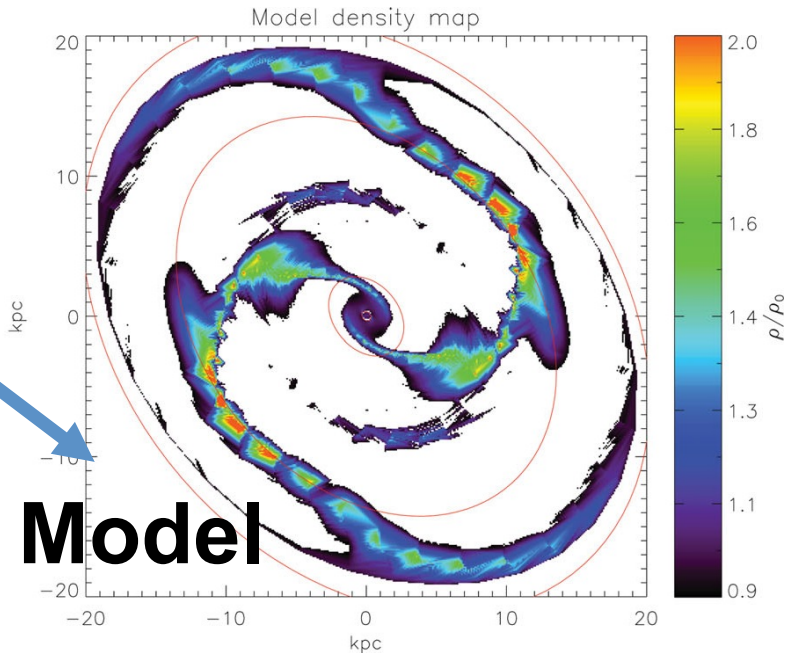
χ^2_ν **was minimized**

Spiral model (density wave)

- Pinol-Ferrer+12 & 14 (analytic)
- Equations of motion with a gas friction term were solved using the linear approximation.
- 7 model parameters



(Zanmer Sanchez+08)



Results

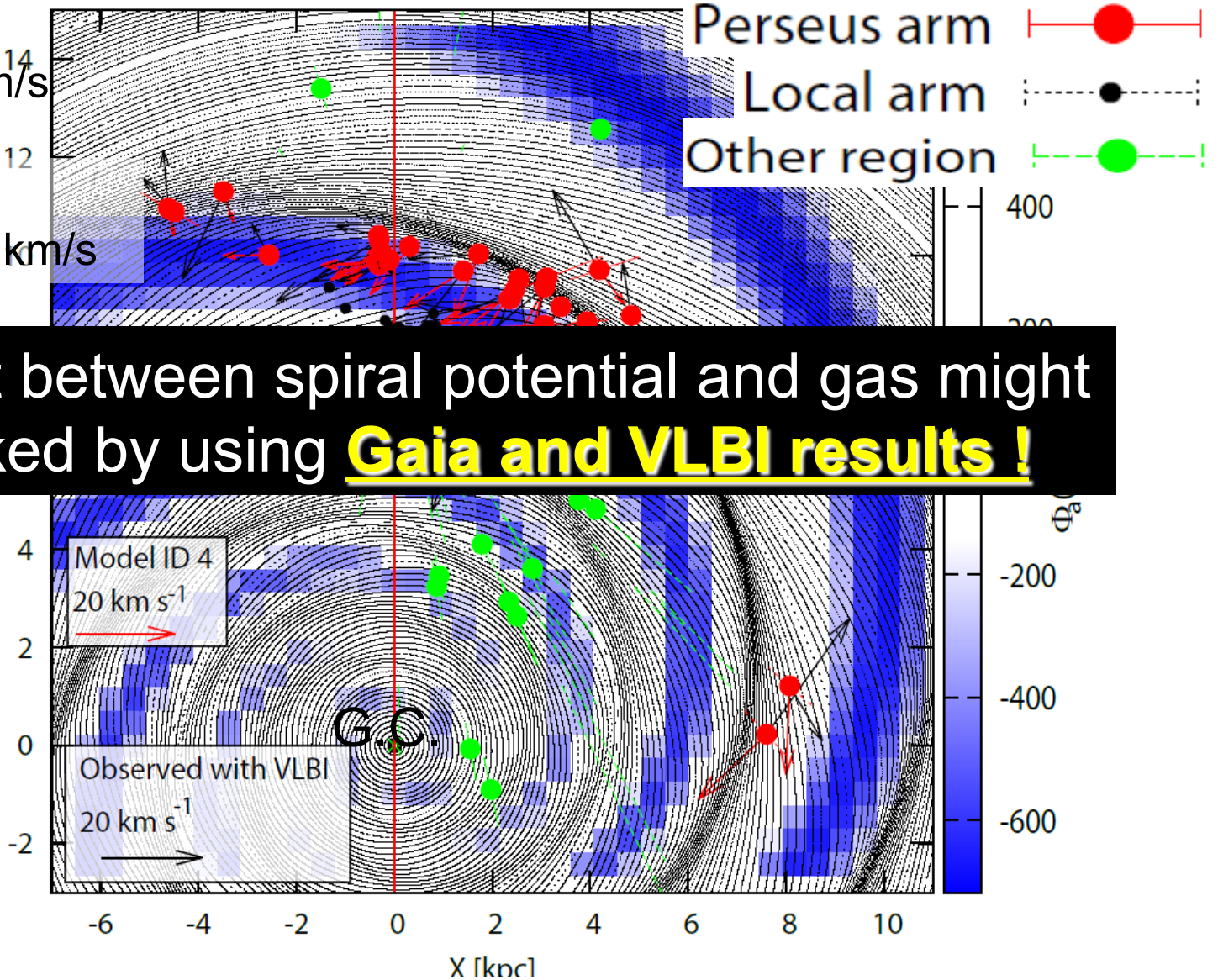
(U_{mean}, V_{mean})
= (8+/-3, −9+/-2) km/s

$(\Delta U_{mean}, \Delta V_{mean})$
= (−2+/-2, −2+/-2) km/s

Gas d
mode

Spiral potential model

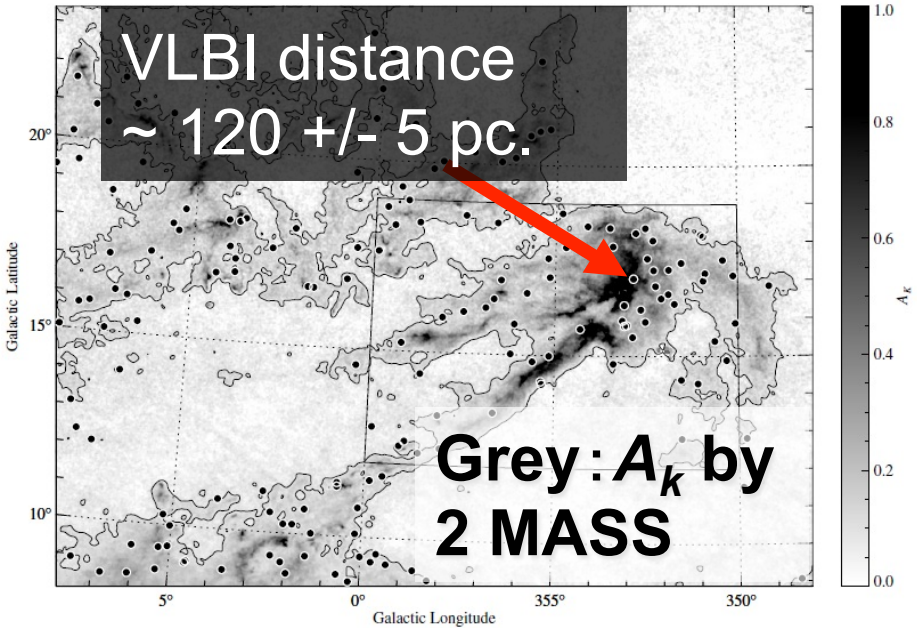
An offset between spiral potential and gas might be checked by using **Gaia and VLBI results !**



Collaboration between Gaia and VLBI

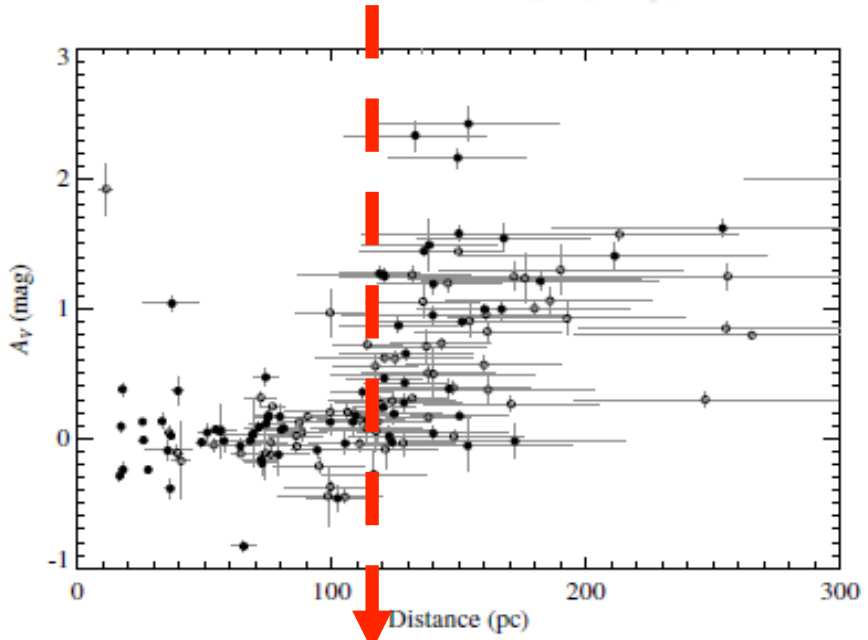
①Reference (ICRF & GCRF) frame ties
②Cross check (e.g. "**Pleiades distance controversy**", **Melis+14**)
③Model selection (e.g. **Spiral arm**)

Ophiuchus Region



●: ***Hipparcos* results**
(Lombardi+08)

Reddening (A_v)



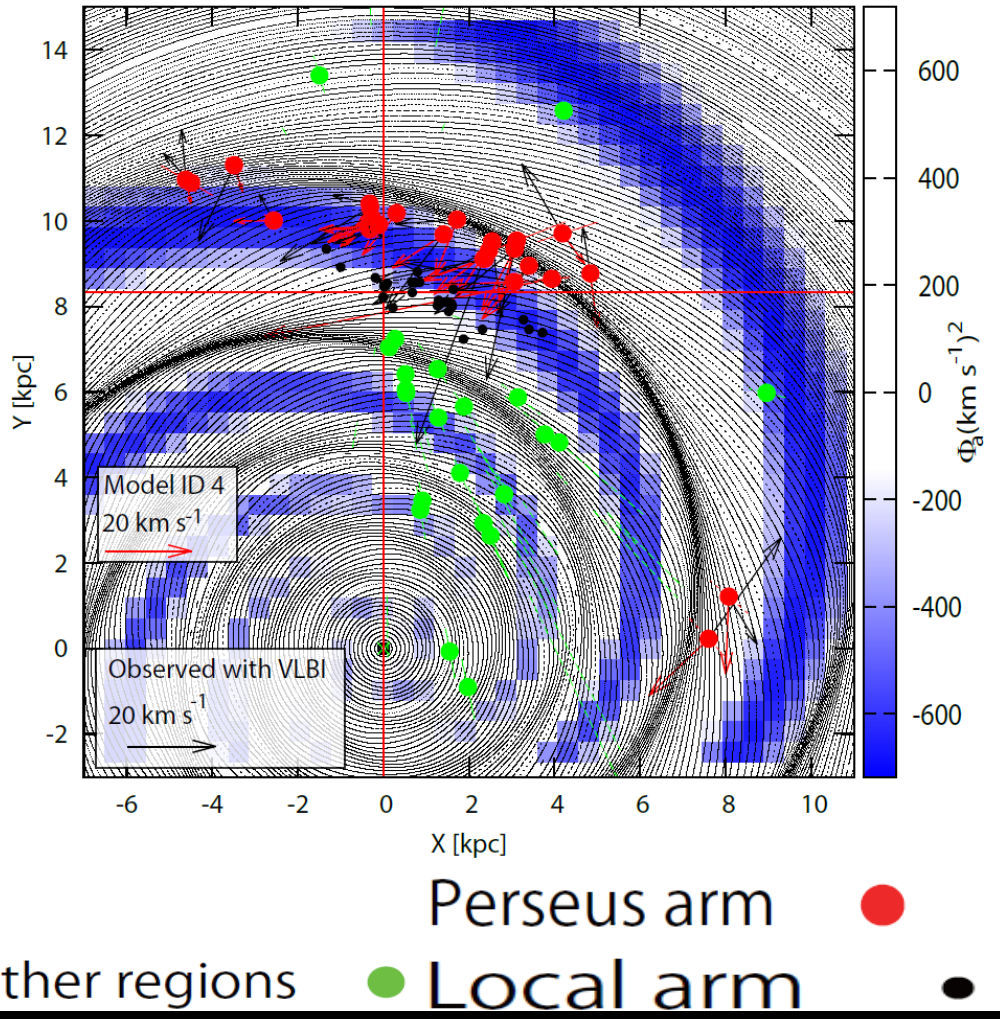
D ~ 120 pc

Conclusion

・We tested the density-wave theory using VLBI astrometry results. Then, we found

①A dense gas region at the downstream of the spiral potential (model)

②Collaboration between Gaia and VLBI astrometry is crucial for model selection.



VLBI astrometry vs. The model of the Milky Way