回転曲線および近太陽円銀河定数観測の最適化

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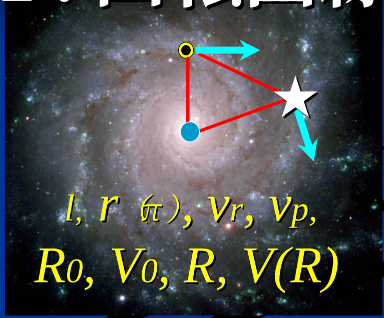
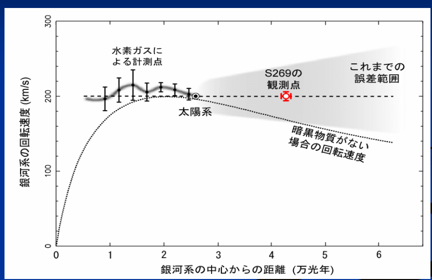
2008.10.9-10, VERA UM, Mitaka

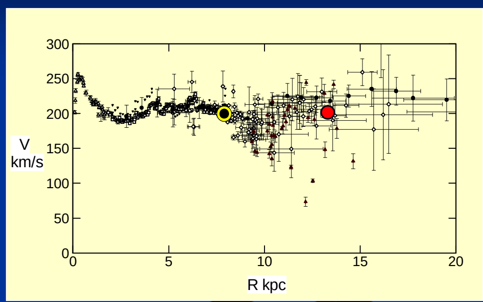
I . 回転曲線



銀河系回転曲線 (Honma et al. 2007)

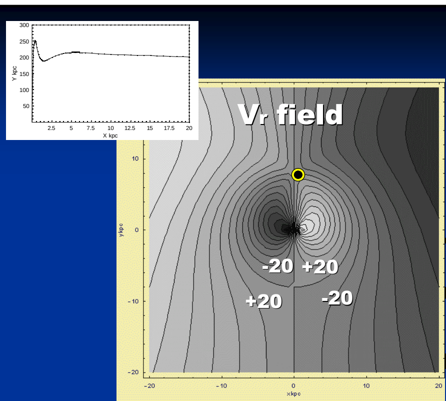


V_0=200 km/s, R_0=8kpc
(Sofue, Honma, Omodaka, et al. 2008)



回転曲線 - 1

円軌道を仮定して
[Vr,]測定から
従来の方法)



$$V_{rot}^{rad} = \frac{R}{R_0}\left(\frac{v_r}{\sin l} + V_0\right)$$

$$\delta V_{rot}^{rad} = \sqrt{\delta V_{vr}^2 + \delta V_r^2}.$$

$$\delta V_{vr} = \frac{\partial V}{\partial v_r}\delta v_r, \quad \delta V_r = \frac{\partial V}{\partial r}\delta r.$$

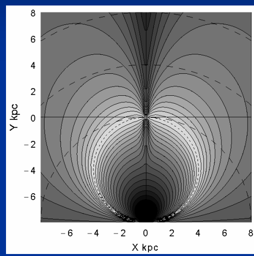
$$\delta V_{rot}^{rad} = \sqrt{\left(\frac{R}{R_0 \sin l}\right)^2 \delta v^2 + \left(\frac{s\,V}{R^2}\right)^2 \delta r^2}$$

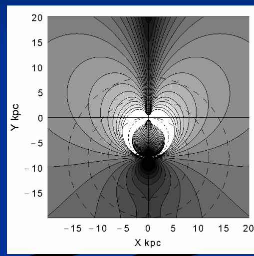
$V = V_0 = 200$ km s^{-1}

$\delta v = 2$ km s^{-1}

$\delta r / r = 0.1$

vr → Vrot ：Error plot





回転曲線 -2

円軌道を仮定して
[vp, r]測定から
(vrが不定の場合)

$$V_{rot}^{prop} = -\frac{R}{s}(v_p + V_0 \cos l\ ).$$

$$\delta V_{rot}^{prop} = \sqrt{\left(\frac{R}{s}\right)^2 \left[\delta v_p^2 + \left(\frac{r R_0^2 v_p \sin^2 l}{s R^2}\right)^2 \left(\frac{\delta r}{r}\right)^2\right]}$$

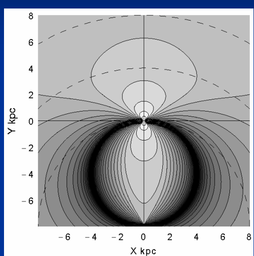
$V = V_0 = 200$ km s^{-1}

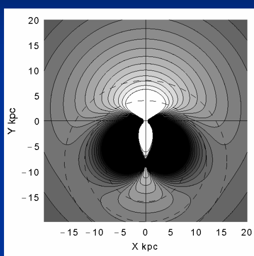
$\delta\mu = 0.21$mas y^{-1}

$\delta v_p / r = 1$ km s^{-1} kpc^{-1}

$\delta r / r = 0.1$

vp → Vrot ：Error plot

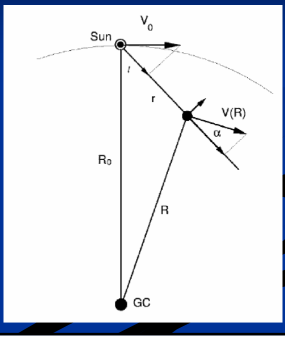




回転曲線 -3

究極のVERA法
円軌道を仮定せず
vp, vr, r測定から
直接V-vector

[vp, vr, r] → V vector



Velocity Vector from vp, vr, and r

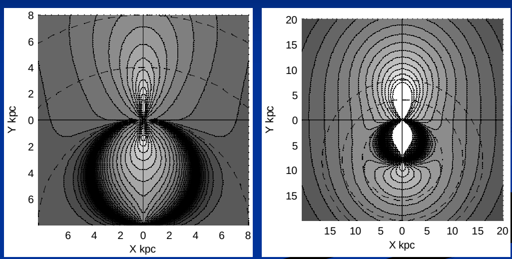
$$V = [(v_p + V_0 \cos l\ )^2 + (v_r - V_0 \sin l\ )^2]^{1/2}$$

$$\delta V = [\delta V_p^2 + \delta V_r^2]^{1/2} = \left[\left(\frac{\partial V}{\partial v_p} \delta v_p \right)^2 + \left(\frac{\partial V}{\partial v_r} \delta v_r \right)^2 \right]^{1/2}$$

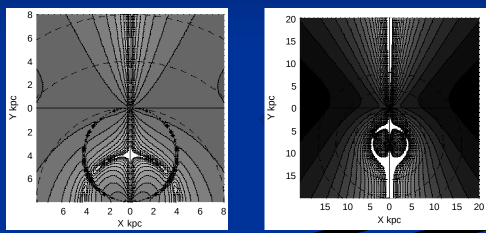
$$v_r = \left(V \frac{R_0}{R} - V_0 \right) \sin l.$$

$$v_p = \frac{r}{R}(R_0 \cos l - r) - V_0 \cos l,$$

vr, vp, r → V –vector: Error plot



V –vector Error plot, dvr>>dvp

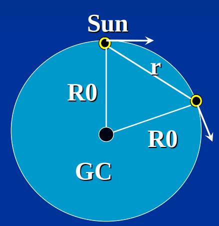


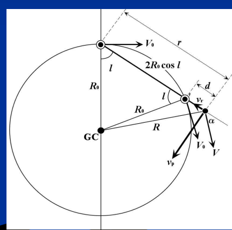
II.銀河定数
近太陽円法

cf VERA KP Honma et al;
cf 安藤、中川、et al

R0, V0決定

真太陽円　　近太陽円





真太陽円

$$r = 2R_0\cos l,$$

$$v_p = -2V_0\cos l.$$

$$R_0 = \frac{r}{2\cos l}$$

$$V_0 = -\frac{v_p}{2\cos l}$$

近太陽円

$$R_0 = \frac{r}{2\cos l}\left(1+\frac{v_r}{A r\sin 2l}\right) = \frac{r}{2\cos l}\left(1-\frac{d}{r}\right)$$

$$V_0 = -\frac{v_p}{2\cos l}\left(1-\frac{d}{r}-2\frac{v_r}{v_p}\frac{\cos^2 l}{\sin l}\right) = -\frac{v_p}{2\cos l}\left(1-\frac{d}{r}\right)+v_r\cot l$$

$$\delta R_0 = \frac{1}{2\cos l}\left[\delta r^2+\left(\frac{\delta v_r}{A\sin 2l}\right)^2\right]^{1/2}$$

$$\delta V_0 = \frac{1}{2\cos l}\left[\left(\frac{1}{A r\sin 2l}-\frac{2\cos^2 l}{v_p\sin l}\right)^2 v_p^2\delta v_r^2+\delta v_p^2\right]^{1/2}.$$

VERA, ON2, l=76 deg (Ando, Nakagawa, et al. 2008)

Preliminary: 参考！

Table 1. VERA Determination of the Galactic Constants R_0 and V_0 by Solar Circle Method - Observations

	r kpc	δr	v_r km s^{-1}	δv_r km s^{-1}	v_p km s^{-1}	δv_p km s^{-1}
VERA (wtd mean v_r)	[illegible]	[illegible]	[illegible]	±5.15	-133.2	±6.66
VERA (mean v_r)	[illegible]	[illegible]	[illegible]	±10.58	-133.2	±6.66
† G75.8+0.40 H92α	[illegible]	[illegible]	[illegible]	±0.3		
† G75.8+0.35 H	[illegible]	[illegible]	-8.0	±0.5		

VERA [illegible] Constants R_0 and V_0 by Solar Circle Method-

		R_0 kpc	δR_0 kpc	V_0 km s^{-1}	δV_0 km s^{-1}
真太陽円仮定	On-circle Values	9.34	–	271.27	–
	VERA (wtd mean v_r)	8.66	±4.66	250.76	±46.0
近太陽円法	VERA (mean v_r)	7.42	±5.36	213.71	±91.3
	G75.8+0.40 H92α	8.29	±4.43	239.69	±13.80
	G75.8+0.35 H92α	7.06	±4.43	202.98	±14.22

R0, V0決定近太陽円法 :最適化