

# Laws of Galactic Rotation

1. Flat rotation curves :  $V(R) \rightarrow \text{constant}$  for large  $R$   
 ( $V_f$ )  
 Flatness persists indefinitely far out.

2. Sancisi's Law: For any feature in the light,  
 there is a corresponding feature in the rotation curve, and vice-versa.

3. The Baryonic Tully-Fisher Relation

$$M_b = AV_f^4$$

$$M_b = M_* + M_g$$

$$M_* = \eta_* L$$

$$M_g = \eta (M_{\text{HI}} + M_{\text{H}_2})$$

$$A = 48.5 \pm 3.5 M_\odot (\text{km s}^{-1})^{-4} \quad [2020]$$

(RNATS, 4, 45)

4. The Central Density Relation

$$\Sigma_{\text{dym}}(R=0) = \Sigma_* f(\Sigma_*(R=0))$$

Lelli et al (2016)

Milgrom (2016)

5. The Radial Acceleration Relation

$$g_{\text{obs}} = F(g_{\text{bar}}) = \frac{g_{\text{bar}}}{1 - e^{-\sqrt{\frac{g_{\text{bar}}}{g_*}}}}$$

$$g_* = 1.20 \pm 0.02 \times 10^{-11} \text{ m s}^{-2}$$

modulo  $\eta_*$  systematics

The first four laws are implied by the fifth.

They are all related by the acceleration scale  $g_*$

$$g_* = G \Sigma_*$$

$$g_* = \frac{\xi V_f^4}{GM_b}$$

$\xi \approx 0.8$  for a finite thickness disk