

## Rotation Curves

Ideal tracer of the potential: a test particle on a circular orbit

stars: good test particles,  
but not always on circular orbits

$$\frac{v^2}{R} = -\frac{\partial \Phi}{\partial R}$$

gas: more likely to be on circular orbits (due to dissipation)  
but also subject to non-gravitational forces

## 3 Laws of Galactic Rotation

### 1. Flat rotation curves

$v \rightarrow v_f \approx \text{constant}$  at large radii which persists indefinitely

### 2. Mass-Velocity relation (Baryonic Tully-Fisher Relation)

$$M_b = M_{\star} + M_g \sim v_f^{\alpha} \quad \text{with } \alpha \approx 4$$

### 3. The distribution of mass is coupled to that of light

Persic-Sallucci URC —  $v(R/R_d) = f(L, R/R_d)$

Sancisi's Law — correspondence of features

MDAR —  $a \sim \frac{v^4}{g_{\text{vir}}} \quad \left(\frac{v}{v_b}\right)^2 \sim \frac{a_b}{a}$