Wednesday, April 15, 2026

Example: Estimate the mass of the Milky Way galaxy

$R = 130$ kly $= 130 \times 10^3$ light years $= 1.22 \times 10^{18}$ km

(9.4×10^{12} km)

$= 1.22 \times 10^{21}$ m

velocity $= v = 300$ km/s $= 300 \times 10^3$ m/s

→ Assume a circular orbit

Method 2: Gravitational Force

Force of gravity: $F_G = G \dfrac{M_{galaxy} M_{gas}}{R^2}$

Centripetal Force for circular motion: $F_c = \dfrac{M_{gas} v^2}{R}$

$F_G = F_c \iff \dfrac{G M_{galaxy} M_{gas}}{R^2} = \dfrac{M_{gas} v^2}{R}$

$\iff M_{galaxy} = \dfrac{R v^2}{G} = \dfrac{(1.22 \times 10^{21})(300 \times 10^3)^2}{6.6743 \times 10^{-11}}$

$= 1.645 \times 10^{42}$ kg $\div M_{sun} = 1.99 \times 10^{30}$ kg

$= 8.27 \times 10^{11} M_{sun}$

≈ 10 times larger than the previous calculation

$\Rightarrow$ **$M_{galaxy} = 827$ billion M_{sun}**