1. **Galactic Orbital Periods** (Ex. 26.2)

2. **Galactic rotation from 21 cm radio observations** (Ex. 26.3)

   **NOTE: CORRECTION FROM FoA TEXTBOOK:**

   Suppose radio observations along the mid-plane of the Milky Way over a range in galactic longitude $\ell_{\text{min}} < \ell < 90^\circ$, show that line emission from the atomic H (for which the rest wavelength $\lambda_o = 21.106$ cm) is shifted to a maximum wavelength that varies with longitude as

   \[ \lambda_{\text{max}}(\ell) \approx \lambda_o \left[ 1 + \frac{V_o}{c} (1 - \sin \ell) \right], \tag{1} \]

   where $V_o = 220$ km/s is the Sun’s orbital speed at a distance $R_o = 8$ kpc from the galactic center.

   (a) Use this to derive the galactic rotation speed $V(R)$ (in km/s) for radii $R$ (in kpc) within the Sun’s orbital radius $R_o$ down to some minimum radius $R_{\text{min}}$.

   (b) Derive an expression for $R_{\text{min}}$ in terms of $R_o$ and $\ell_{\text{min}}$.

   (c) From the results in part (a), derive the mass $M(R)$ (in $M_\odot$) within any radius $R$ (in kpc) over this same range from $R_{\text{min}}$ to $R_o$.

3. **Quasar properties from redshift** (Ex. 28.5)

4. **Luminosity from Accretion onto a Black Hole** (Ex. 28.6)

5. **Object at center of Active Galaxy M84** (Ex. 28.7)