Exercises for the course on Physics of Galaxies.II

Disk galaxies

In a galaxy where the gravitational potential follows the Plummer model

$$\Phi(r) = \frac{-GM_t}{\sqrt{r^2 + a^2}} \tag{1}$$

where M_t is the total mass of the system, and a is a characteristic scale.

1. Find the rotation curve $V(r)$. Show that $V_{max}^2 = 2GM/(3\sqrt{3}a)$. Find at what distance r this maximum velocity is reached. Sketch $V(r)$ for $r \leq 4a$.

2. Derive the mass density that is responsible for this potential. *Hint:* Find how the mass is distributed with radius M(r) using Newton's second law.

3. Derive the surface brightness profile, assuming a constant mass-to-light ratio.