

## Galaxies final exam, course 2007

Please write down your name and your student ID on every page. You can answer the questions in English or in Dutch. For the first exercise, please explain clearly all the steps you have used. For the items 2 to 5, please elaborate using approximately half a page per item.

1. In a galaxy where the gravitational potential follows the Plummer model

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

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

- (a) 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  $r \leq 4a$ .
  - (b) 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.
  - (c) Derive the surface brightness profile, assuming a constant mass-to-light ratio.
2. Describe the motions of stars in the Galactic disk. Explain how these results have been derived observationally. Do not forget to mention (and explain) the Oort constants.
  3. Describe the properties of elliptical galaxies. Mention results from photometric as well as from spectroscopic studies.
  4. Describe the luminosity and colour evolution of a single stellar population. On the basis of this, do you think that globular clusters were brighter or dimmer in the past?
  5. Describe the physical paradigm of AGNs. Explain what is meant by the Eddington luminosity.