ZAH - Astronomisches Rechen-Institut
Galactic and Extragalactic Astronomy (MVAstro3) - Winter semester 2021
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Exercise Sheet #6

Submit by Friday 26-03-2021

Exercise 1. - Globular clusters vs dwarf galaxies Consider the dwarf spheroidal galaxies (Carina and Boo II) and the ω Centauri globular cluster. Relevant information about these two objects is given in Table 1.

(a) Calculate our distance from the three objects in kpc and the physical size of their half-light radii in pc. (10 points)

(b) Under the assumption of isotropy, what is the total velocity dispersion σ_{tot} of the two objects? (10 points)

(c) Assume the half-light radius to be an estimate for the radius of the objects. Calculate their enclosed mass using the virial theorem. (10 points)

(d) Calculate the dynamical mass-to-light ratio of all three objects. Briefly comment on your results, also comparing them to the dynamical mass-to-light ratio in the solar vicinity ($M/L \approx 0.7$) and within the Solar radius ($M(< R_\odot)/L(< R_\odot) \approx 5$). (10 points)

Name	r_h [arcmin]	L_V [$10^7 L_\odot$]	$m - M$	σ_r [km/s]
Carina	8.2	0.04	20.11	6.6
ω Cen	4.2	0.1	13.92	16.8
Boo II	4.2	0.0001	18.10	10.5

Table 1: Angular half-light radius r_h, V-band luminosity L_V, distance modulus $m - M$ and stellar radial velocity dispersion σ_r for Carina and ω Centauri. The data are taken from Harris (1997), McConnachie (2012), and Sparke & Gallager (2007).

Exercise 2. - Tidal stripping The center of the Sagittarius dwarf spheroidal galaxy is at the moment situated at ~ 20 kpc from the center of the Milky Way.

(a) Calculate the mass of the Milky Way within this radius, assuming a constant rotation velocity of $v_r = 220$ km/s. (10 points)

(b) How massive does Sagittarius need to be, in order for stars situated at 5 kpc from its center to remain bound to it? (10 points)

(c) What would the corresponding mass-to-light ratio be? (Sagittarius has an estimated total luminosity of $L = 8 \cdot 10^7\, L_\odot$). Compare this value to those you got in Exercise 1. Is the result realistic? If not, what do you expect to happen to Sagittarius? (10 points)