ZAH - Astronomisches Rechen-Institut
Galactic and Extragalactic Astronomy (MVAstro3) - Winter semester 2021
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Exercise Sheet #4

Submit by Tuesday 23-03-2021

Exercise 1. - The dynamical mass of the Galaxy

(a) Calculate the dynamical mass of the Galaxy within the orbit of the Sun (which is located at 8.27 kpc (Pietrukowicz et al. (2015)) from the Galactic center). What enclosed mass results if instead you consider a gas cloud at twice that distance from the Galactic center? You can assume in both cases a rotation velocity of 220 km/s. (10 points)

(b) Calculate the enclosed mass for a Galactocentric distance of 200 kpc assuming the same rotation velocity as in part (a). Is this a realistic result? Why? (10 points)

(c) If the rotation curve of the disc showed the profile expected from a mass distribution inferred only from the luminous disc components, the resulting rotation velocity of the Sun would be ~ 160 km/s. What enclosed mass would result then, and what does that tell us about the dark matter content out to the Galactocentric distance of the Sun? (10 points)

Exercise 2. - Cosmic dust

(a) What is the approximate temperature of a dust grain that radiates mainly at 100 μm? (10 points)

(b) At what distance to a B-type star with $L = 10^4\, L_\odot$ ($T_{\rm eff} = 23\,000$ K and $R = 6.3\, \mathrm{R}_\odot$) would you need to place such a dust grain (assume spherical shape) so that it is heated to roughly the temperature from part (a)? (Hint: remember that a grain absorbs starlight only over its irradiated circular disc, but emits from its whole surface). In addition, we assume that the dust grain is in thermal equilibrium. (10 points)

(c) How far away from the star would the dust have to be so that its radiation peaks at 50 μm? (10 points)