PHYS 371 practice question
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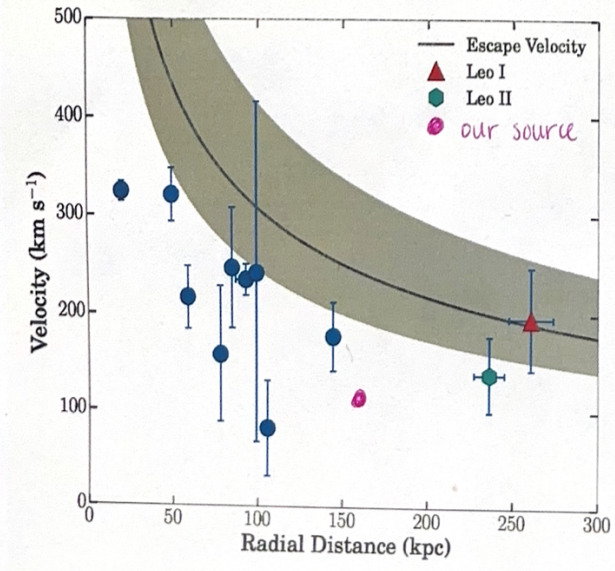
You are an astrophysicist that is from a far away planet on Andromeda, and you are interested in studying the environment of your neighbor galaxy, the Milkyway. While taking targeted observations of the MW, you come across a strange and bright source that is nearby it. This serendipitously detected source is nowhere to be found in the literature so you decide to do some more investigation to publish this finding.... HOORAY!!

A) Using a spectrograph, you get a spectra of this source and find that it has a strong h-alpha emission line at λ = 656.543 nm. What is the redshift of this source?
B) What is the velocity?

With the power of SED fitting you combine the photometric and spectroscopic data to fit the SED of this source and estimate its mass to be M~ $5 \times 10^{11} M_{\odot}$.

C) In order for us to determine if this galaxy is bound to the MW and therefore a satellite, we would need to see where the source lies in velocity-radius phase space. The Navarro-Frenk-White (NFW) profile describes a dark matter halo around a galaxy and is a helpful tool when deciding if a satellite is bound to another galaxy. The plot below shows satellite galaxies of the MW with the escape velocity profile. Being over this line would indicate that a neighboring galaxy is likely not a satellite to the MW. What is the radial distance of this source from the center of the MW and is this a bound satellite to the MW?



(Lipnicky+ 2017)

A) $\lambda_{obs} = 656.543\,nm$

$\lambda_{rest\ H\alpha} = 656.281\,nm$

$z = \frac{\lambda_{obs}}{\lambda_{rest}} - 1 = \boxed{0.0039}$

B) $v = z \cdot c = 117\,080\ m/s = \boxed{117\ km/s}$

C) $M \sim 5 \times 10^{41} M_{\odot} = 9.94 \times 10^{41}\ kg$

$v^2(R) = \frac{GM}{R}$

$R = \frac{GM}{v^2} = 4.84 \times 10^{21}\ m$

$= \boxed{157\ kpc}$

yes it is bound! and likely a galaxy w/ how massive it is