Qualifying Examination—Galactic and Extragalactic Astronomy
May 19, 2022

1. The Oort constants A and B can be used to describe the rotational properties near R_0 (the radius of solar orbit to Galactic center). Using the definition of Oort constants, please calculate A and B under two different cases (here assuming $R_0 = 8\ kpc$ and solar velocity $V_0 = 220\ km/s$): (a) the solid body rotation **(12 points)** and (b) the flat rotation curve **(12 points)**. (c) Please also compare your calculation to the current measurement of Oort constants and argue which scenario can better describe the rotational properties near R_0 **(6 points)**.

2. Please list 5 differences between the physical properties of elliptical and spiral galaxies. **(20 points)**

3. Please explain why astronomers know that there are dark energy and dark matter in the Universe. (**20 points**)

4. What are the angular diameter distance and the luminosity distance? (**10 points**)

5. The Supermassive Black Hole in our Milky Way
   A. The 2020 Nobel Prize of Physics was given to the precise mass measurements of the supermassive black hole (SMBH) in our Milky Way. If your friends heard about this news and ask you how you astronomers measure the mass of this SMBH. How would you answer their questions as a professional? (**10 points**)
   B. The Event Horizon Telescope just released the shadow image of the SMBH in our Milky way. Your friends heard about this news and ask you why the image of the black hole looks like a donut. How would you answer their questions? (**10 points**)