2023/05/25 Report Problems (Ebisawa)

1. Combining the three most fundamental physical constants, derive the values which have the unit of mass, length and time. These values are called Planck mass, Planck lengh and Planck time.

2. What is the meaning of the Planck mass.

3. Estimate the apparent angular size of the black hole in Sgr A* (in arcsec), by dividing the Schwarzschild radius by its distance.

4. According to General Relativity, the "photon-capture radius" of a black hole is $\sqrt{27}R_g$, where R_g is the gravitational radius ($= GM/c^2$). In 2019, the Event Horizon Telescope observed a bright photon "ring" around the central black hole in M87 (distance = 16.8 Mpc), where the ring diameter is 42 μarcsec. By identifying the ring radius as the photon-capture radius, estimate the black hole mass.

5. Let's assume that we detected gravitational waves due to a blackhole merger, where the relative amplitude of the gravitational wave was 10^{-21}. How much did the distance between Sun and Earth (1 astronomical unit) vary due to this gravitational-wave event? Answer with the unit of Bohr radius.