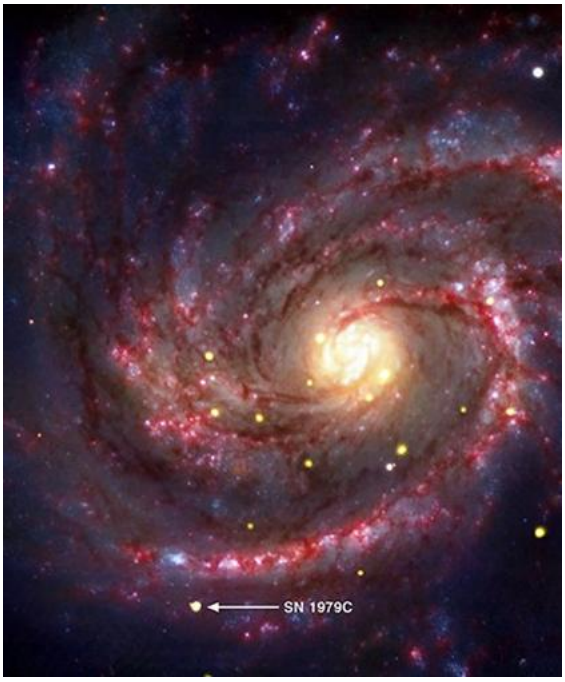

The Chandra X-Ray Observatory recently found evidence for an infant black hole in the nearby galaxy Messiar-100. The black hole is thought to have been produced when a star with a mass of about 20 times that of the sun exploded and left behind a black hole with a mass about 8 times the sun's mass.

The satellite observatory has detected x-rays from the gasses in the orbiting accretion disk that are falling into this young black hole. Infalling gas can be heated to over 100,000,000 K as atoms collide at higher and higher speed during the infall process. The temperature of this x-ray emitting gas is related to its distance from the black hole.

At a distance of R kilometers from a black hole with a mass of M times the sun, suppose that the two equations below relate the temperature of the gas, T, and the wavelength, L, at which the in-flowing gas emits most of its light:

Equation 1 - $T = 100,000,000\left(\frac{M}{R^3}\right)^{1/4}$ Kelvin

Equation 2 - $L = \frac{3,600,000}{T}$ nanometers

where M is in solar mass units, and R is in kilometers.

Problem 1 - Combining these equations using the method of substitution, what is the new formula L(R,M), for the wavelength, L, emitted by the gas as a function of its distance from the black hole center, R, and the mass of the black hole, M?

Problem 2 – X-rays are detected from the vicinity of the SN 1979C black hole at a wavelength of 0.53 nanometers (2,300 electronVolts). If the mass of the black hole is 8 times the sun, at what distance from the center of the black hole is the gas being detected?

Problem 3 – The Event Horizon of a black hole that is not rotating (called a Schwarschild black hole) is located at a distance of Rs = 3.0 M from the center of the black hole, where M is the mass of the black hole in units of our sun, and Rs is in units of kilometers. What is Rs for the SN 1979C black hole, and where is the x-ray emitting gas in relation to the Event Horizon?