Astronomy 1 fall 2009
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Solutions to Assignment 9

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1

a) Black holes, especially distant ones in the centers of galaxies (super massive) and those in binary star systems (stellar mass), can have matter falling into them. The matter tends to form a disk (an accretion disk to be precise) due its rotation (similar to the orbital plane of our solar system) that moves around the black hole with very high velocities. It heats up from friction between rings of the disk moving at different speeds. This hot accretion disk radiates like a black body with the very hottest inner parts radiating in the x-ray part of the spectrum.
b) A curved space affects the paths of objects traveling through it. Massive objects are said to curve the space around them in the sense that they affect the paths of other objects in the space around them. An example is the orbit of a planet around the Sun, and the bending of light rays around massive objects.
c) If you threw a rock into a black hole it would appear to take forever to reach the event horizon.

2

a) Heavy elements are produced in stars and released into space when they age and die, so for a star to contain heavy elements it needs to be created in a region where other (relatively massive) stars have lived and died. The spiral arms of our galaxy are regions where matter is concentrated so fresh star forming gas, as well as some heavy elements from older stars are mixed together to form new stars.

b) Population II stars have no heavy elements and therefore were formed in a time before any stars had lived and died. These are old stars. Population I stars do contain heavy elements and were formed in part out of debris from old stars. These new stars exist in places where star recent formation could occur.

3

One prediction of Einstein's Theory of General Relativity to be confirmed was the loss of energy (slowing down the period of the orbit) due to gravitational radiation. The gravitational radiation was not measured directly, but inferred by the precise amount of orbital energy lost. The second prediction is the precession

of the orientation of the orbit due to the warping of spacetime close to the neutron stars.

4

A spacetime diagram is a tool used by physicists to investigate the properties of spacetime. On a spacetime diagram, time is plotted along one axis, on equal footing with a dimension of space on the other. These diagrams are helpful when resolving many of the apparent paradoxes about the laws of physics and causality when objects travel near the speed of light.