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31186 Relativity and Black Holes

In the past few years, the enigmatic black hole has been an object of great interest in the study of stellar evolution. Einstein's general theory of relativity provides the framework for the concept of the black hole — an object, believed to result from the collapse of an extremely massive star, which generates a gravitational field so strong that not even light can escape from it.

This 23-slide set, "Relativity and Black Holes" (31186), provides the instructor with informative diagrams, illustrations, and photographs for use with lectures on these topics. The subjects of the slides include the Michelson-Morley experiment; the principle of equivalence; the effect of a massive object on spacetime; a static and a rotating black hole; X-ray binary star Cygnus X-1; the Lorentz contraction factor; and how a black hole might be a connection either to a parallel universe or to another region of our universe.

Each of the slides is numbered. The following list contains the number of each slide, followed by a general description.

1. This diagram shows the apparatus used and the experimental setup of the Michelson-Morley experiment, with reference to the theory behind it.

2. This slide illustrates the principle of equivalence. The Einstein caricature is shown in three different frames of reference: in a one-g gravitational field

on earth; in space; and under a one-g gravitational acceleration in space. The slide shows the equivalence of a gravitational field and an accelerated frame of reference.

3. This diagram shows the path of a light ray bending as the light passes through a rapidly accelerating frame of reference, demonstrating the effects of the principle of equivalence on light passing through a strong gravitational field.

4. This is an embedding diagram showing how spacetime is increasingly curved around a massive object.

5. This is an embedding diagram showing spacetime warping around an image of the eclipsed sun. A ray of light from a distant star is shown being deflected by the curved spacetime around the sun, undergoing a shift of 1.75 seconds of arc.

6. This diagram shows the advance of the perihelion pos Mercury's orbit, explained by the general theory of relativity.

7. This illustration shows the "redshift" of photons leaving the surface of a massive star, an effect predicted by the general theory of relativity. As distance from the star increases, the star's gravitational effect decreases; as a result, the wavelength of a photon increases as the photon moves farther away from the star, shifting it toward the red end of the spectrum.

8. This illustration shows four stages in the collapse of a massive star, and the effect of the star's increasing gravity on light rays emitted from a point on its surface. The slide also shows the development of a closing exit cone.

9. This slide illustrates the structure of a static (non-rotating) black hole, showing the photon sphere, event horizon, Schwarzschild radius, and singularity.

10. This graph shows how the diameter of the event hori Schwarzchild radius) increases linearly with increasing mass.

11. This representation of the structure of a rotating black hole shows the event horizon, the ergosphere, the stationary limit (inside which nothing is at rest), and the ring-shaped singularity.

12. This embedding diagram illustrates the speculative concept that a black hole could connect to a parallel universe through a structure called an Einstein-Rosen bridge. In this scenario, the black hole would be connected to a corresponding “white hole” in the parallel universe.

13. This embedding diagram illustrates an alternative view of the structure described in Slide 12, showing how both black and white holes connected by the Einstein-Rosen bridge could be part of the same universe.

14. This embedding diagram illustrates an alternative interpretation of the information in Slide 13. In this diagram, both black and white holes exist in a flat spacetime network, connected by a structure called a wormhole.

15. This is an artist's conception of Cygnus X-1, an X-ray binary star system. The illustration shows a B-type supergiant star with its orbiting black hole companion; matter is being pulled from the star, forming an accretion disk around the black hole.

16. This is a schematic diagram of the process illustrated in Slide 15. The diagram shows the blue supergiant star, the accretion d escaping matter, the generation of X-ray radiation, and the orbit of the black