What is in the slides.

Slide 1 A picture of a spiral galaxy similar to the one we live in. If this were our galaxy we would be living about ¼ of the way out from the center on one of spiral arms. The center of our galaxy contains a million solar mass black hole. Most galaxies are found to have a massive black hole in their center.

Slide 2 This is a movie made up of many telescope pictures put together in to a movie. It shows stars near the center of our galaxy being pulled by the gravitational attraction of the black hole. The black hole has a mass of millions of suns. It is indicated in the picture by the red cross. All the stars in the movie escape from being captured by the black hole but you will see one of them gets pretty close to being eaten. There is no light coming from the black hole itself. The date when the picture was taken is shown on the top right . You will see the individual pictures that make up the movie were taken months to years apart.

Slide 3 This is an actual picture of a black hole which has a mass of billions of suns. It is in a galaxy a few million light years away from us (a light year is the distance light travels in one year – very big). The picture was made with 9 radio telescopes distributed around the earth working together. It was a big event last year. The picture shows the shadow of the black hole in the center and a ring of radio wave sources that look like a halo around the black hole. The ring comes about because there is an orbit around the black hole for radio waves (as well as all other colors of electromagnetic waves) which is stable. This means the waves can be captured in the ring by the gravitational distortion of space around the black hole. You can think of this that gravity is so strong at the black hole that it bends the light into such an orbit. We see the ring because some of the waves don't quite stay in the orbit, a few head to our telescope and others fall into the black hole. The ring is continuously fed by more waves coming in.

Slide 4 Again a movie but also a place to hear the associated sound by clicking on the loudspeaker on the right. This slide is more complicated than the others. It shows a computer simulation of the collision of two black holes (each about 5 solar masses), the type of source now being measured regularly by the gravitational wave detectors since 2015. The time for each image in the movie is shown on the top right. The movie is much slower that the event itself (you will realize this listening to the gravitational wave signal). The wave form in time is

shown at the bottom of the picture. The picture itself shows the distortion of space due to the strong gravity of the black holes. The little arrows indicate the direction and by their length the strength of the stretching and squeezing of the space. The colors show the distortion of time, red indicates clocks going slower and black where the clocks have actually stopped. The position of the black holes is shown above the distortions for reference. The gravitational waves emitted by the collision are the moving circles that are going away from the colliding black holes. They are what was detected on the Earth.