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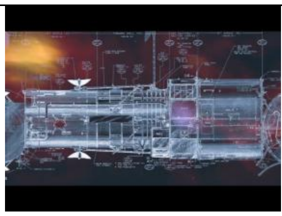
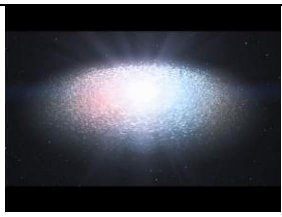
Hubblecast Episode 43: Hubble and Black Holes FOR IMMEDIATE RELEASE 28 February 2011		
00:00 [Narrator] For centuries, scientists imagined objects so heavy and dense that their gravity might be strong enough to pull anything in — including light. They would be, quite literally, a black hole in space. But it's only in the past few decades that astronomers have conclusively proved their existence. Today, Hubble lets scientists measure the effects of black holes, make images of their surroundings and glean fascinating insights into the evolution of our cosmos.		
		
00:57 [Dr J] Hi everyone, and welcome to the Hubblecast. In science fiction, black holes are often portrayed as some kind of menacing threat to the safety of the whole Universe, like giant vacuum cleaners that suck up all of existence. Now, in this episode, we're going to separate the fiction from the facts and we're going to look at the real science behind black holes and how Hubble has contributed to it.		
01:27 [Narrator] Black holes come in different sizes. We've had solid evidence for the smaller ones since the 1970s. These form when a huge star explodes at the end of its life. As the outer layers are blown away, the star's core collapses in on itself forming an incredibly dense ball. For instance, a black hole with the same mass as the Sun would have a radius of only a few kilometres.		

These black holes won't suck you in unless you get very close to them though. In fact, contrary to popular belief, a black hole the size of the Sun doesn't actually exert any more gravitational pull than the Sun does. But these stellar black holes are just part of the story.		
02:13 [Dr J] Before Hubble was launched, astronomers had noticed that the centres of many galaxies were somehow much denser and brighter than they were expected to be. And so they speculated that there must be some kind of huge, massive objects lurking in the centres of these galaxies in order to provide the additional gravitational attraction. Now, could these objects be supermassive black holes, that is, black holes which are millions or even billions of times more massive than the stellar ones? Or was there perhaps a simpler, less exotic explanation, like giant star clusters? Frustratingly, at that time, telescopes just weren't quite powerful enough to see enough detail to solve the mystery.		
02:56 [Narrator] Fortunately, Hubble was on its way, along with a range of other high-tech telescopes. When the space telescope was being planned, the search for supermassive black holes was in fact one of its main objectives.		
03:11 [Dr J] Some of Hubble's early observations in the 1990s were dedicated to these dense, bright galactic centres. Where ground-based telescopes were just seeing a sea of stars, Hubble was able to resolve the details. In fact, around the very centres of these galaxies, Hubble discovered rotating discs of gas and dust.		
03:33 [Narrator] When Hubble observed the disc at the centre of a nearby galaxy, Messier 87, the astronomers saw that its colour was not quite the same on both sides. One side was shifted towards blue and the other towards red, and this told the scientists that it must have been rotating very quickly. This is because the wavelength of light is changed by the motion of an object emitting it. Think about how the pitch of an ambulance siren drops as it drives past you, because the sound waves are more spaced out as the vehicle moves away. Similarly, if an object is moving towards you, the light's wavelength is squashed, making it bluer; if it's moving away, it's stretched, making it redder. This is also known as the Doppler effect.		

04:20 [Dr J] So, by measuring how much the colours had shifted on either side of the disk, astronomers were able to determine its speed of rotation. And it turned out that this disk was spinning at a rate of hundreds of kilometres per second. This in turn allowed astronomers to deduce that, hidden at the very centre, there must be some kind of object which was two to three billion times the mass of our Sun – and this was very likely a supermassive black hole. Now, along with a lot of other observations, this was a key piece of evidence that led to the notion that there is a supermassive black hole lurking at the centre of most, if not all, giant galaxies, including our own Milky Way.		
05:05 [Narrator] So far, so good. But this work was almost 20 years ago — what does it tell us about cutting-edge science today? Well, the science of black holes has moved along a lot since then. The mystery now isn't whether they exist, but why they behave in the strange ways they do.		
05:28 [Dr J] For example, Hubble observations have helped to show that the mass of a black hole is closely related to the mass of its surrounding host galaxy. The bigger the black hole, the bigger the galaxy. Now the reason for this is totally unclear. A supermassive black hole is pretty big, and it packs a lot of punch, but you've got to remember that compared to its host galaxy it's actually tiny. The region of space that is most obviously and most immediately influenced by a supermassive black hole is in fact about a million times smaller than its surrounding galaxy. That's about the same size difference as between this coin and a whole city. So it's pretty hard to think of any processes that would link the two in a long-lasting way.		
06:18 [Narrator] So a big area in science just now is trying to find out what's going on here, and why the two are linked. Do black holes regulate the size of galaxies, or do galaxies regulate the size of black holes? Or is something altogether different happening? Just now, astronomers don't know, but they're working hard to find out.		
06:46 [Dr J] But there's another interesting, and probably connected black hole mystery, that has astronomers scratching their heads. When matter falls into supermassive black holes, it forms this big swirling disc that heats up and gives off a lot of powerful radiation. The more matter falls into the black hole, the more powerful the radiation.		

Now these active, accreting black holes are called quasars, and they are among the most luminous and most powerful objects in the Universe. The thing is, a quasar can get so greedy that its radiation is powerful enough to actually blow away all the gas and dust that's feeding it. And so it seems there's a natural upper limit to the rate at which a black hole can grow. Now, this implies that one wouldn't expect to see any really big and powerful quasars in the very early Universe, because there simply wouldn't have been enough time to build up the supermassive black hole that is needed to power a quasar. But recent discoveries have in fact shown quasars in existence just a billion years after the Big Bang, which is much earlier than we had expected. And so there you have it: another mystery for astronomers to pore over.		
08:02 [Dr J] 13. So, by helping to clear up one mystery about black holes, Hubble has opened up whole new research areas, and these will eventually give us a better understanding of the history of our Universe. This is Dr J signing off for the Hubblecast. Once again, the Universe has surprised us beyond our wildest imagination.		

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