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Hubblecast Episode 50: Q&A with Dr J		
00:00 [Dr J] Have you ever wondered why Hubble can make detailed images of of galaxies, but stars appear as featureless blobs? What the most distant object ever observed is? Who gets to use Hubble? Or what Hubble's oddest discovery is? Then stay tuned.		
[Intro]		
00:46 [Dr J] Hello and welcome to the Hubblecast. Believe it or not this is in fact our 50th episode. To mark the occasion we've decided to do something a little different today. Last time we asked you to send your astronomy-related questions, and over the last month or so, you've sent us hundreds of really good questions. Now unfortunately, there's no way we can discuss them all. And so what we've done is, we've picked the ones we like best , and we'll try to answer them in today's episode.		
01:16 [Narrator] What is the most empty spot of space you have ever seen? What's the longest single-shot exposure ever recorded of any object or area of space by Hubble? What are the farthest objects discovered by Hubble?		

01:32 [Dr J] Three questions, just one answer. In 2003, Hubble was pointed at a part of sky which is, by normal standards at least, pretty empty. In particular, there are no bright stars in this area. Now Hubble observed this field, which is only about a tenth the size of the full moon, for almost a million seconds. That's around 11.3 days' worth of total exposure time. The result is an image we call the Hubble Ultra Deep Field, and it is in fact the deepest optical image of the Universe that humanity has ever produced. Almost every object you see in this image is in fact a very distant galaxy. In fact, let's have a look at this guy over here. This is galaxy UDFj-39546284. Boring name, I know, but the point is that this is probably the most distant object ever discovered. Now its distance isn't 100% confirmed yet, but it's believed to be so far away that the light took 13.2 billion years to reach us. That's about 96% of the age of the Unvierse.		
02:44 [Narrator] How do you prioritise what Hubble photographs?		
02:51 [Dr J] Now once a year, all the astronomers who want to use Hubble apply for observing time with Hubble by submitting proposals that contain detailed information on the scientific questions they want to address and the data they need. Now the total amount of observing time requested by all of the proposals is always much greater than the total amount of time that is actually available. And so there's a committee of astronomers that looks at all the proposals and ranks them according to their scientific merit. And it's only the best 10-15% that actually get executed		
03:24 [Narrator] If Hubble can zoom into distant galaxies with striking detail, why can't it point the same cameras to a nearby star and map its surface in recognisable detail?		
03:35 [Dr J] This is the star Betelgeuse. It's a very big star, and quite close to us, only a few hundred light years away. This is the galaxy Arp 273, which is about 500 000 times farther away than Betelgeuse. But at the same time, it's also a billion times bigger. Which means that its apparent size on the sky is still about 2000 times larger than that of Betelgeuse.		

Although stars are very close to us, they're just too small, so that being able to see details on the surface of a star is beyond the capabilities even of Hubble.		
04:14 [Narrator] When galaxies collide and incorporate each other, what happens to the black holes? Do they eventually merge into one giant black hole?		
04:25 [Dr J] Yup, that's pretty much what happens. As Hubble helped us discover in the 1990s, we think that almost all massive galaxies contain a central, supermassive black hole. In addition, galaxy collisions are very common: they happen all the time and again, Hubble has showed us lots of great images of these collisions. Now, eventually the two galaxies merge and settle into a single bigger new galaxy, and during this process, the same thing happens with their supermassive black holes. They merge into a single, even bigger, supermassive black hole at the centre of the new galaxy. Now astronomers have made computer simulations of how this process works, but we also have some pretty good observational evidence that this process really does take place.		
05:10 [Narrator] After watching the 49th episode, I was wondering whether there's more dynamics that Hubble could help identify, like gravity lens effects, rotating objects or clusters, collisions and so on.		
05:26 [Dr J] In episode 49, we looked at so-called Herbig-Haro objects, which are jets of matter that are shot out by newborn stars. Now Hubble was able to 'film' the motion of these jets over a time period of about14 years. And it is indeed true that over the past 20 years, Hubble has been able to capture the change or the motion of a number of other phenomena and objects. Now some of these videos have been morphed together using computer software to smooth out the motion, but everything you are about to see is based on real Hubble images. Nearby objects within the solar system show the most impressive movement in Hubble pictures. Planets rotate, and their satellites move around their orbits. Like the Northern Lights here on Earth, Saturn has aurorae, and Hubble has watched them dance. Comets and asteroids sweep around the Sun, and sometimes even break up. But there are also objects further away that we can see move. Fomalhaut b was the first planet outside the solar system to be directly imaged in visible light, and images taken 21 months apart show it inching along its		• 

orbit. Hubble has also imaged a flash of light propagating through the dust surrounding the star V838 Monocerotis. The distances are so huge that this sequence took 4 years to film even though it's moving at the speed of light. Cassiopeia A, a cloud of debris left over from a supernova that exploded three centuries ago, is still expanding, and Hubble observations 9 months apart show the material moving. One of the most distant objects that Hubble has been able to watch change over time is Supernova 1987a — the explosion of a star in the Large Magellanic Cloud that happened in 1987. Over the past 20 years, Hubble has watched the shockwave spread out and light up the gas surrounding the star. Now Hubble is really good at this type of observation because, a) its images are very detailed – so it can spot even very subtle motion – and b) it's been in operation for so long, almost 22 years now.		
07:47 [Narrator] Can Hubble detect potential supernovae, and if so are we likely to see one from the surface of the Earth, and can we know when it's likely to occur?		
07:58 [Dr J] Predicting supernovae is a bit like predicting earthquakes – we can spot which stars are likely to explode, but we can't tell when exactly the explosion is going to happen. One of the supernova candidates which is closest to Earth is the star Eta Carinae, which is about 7 to 8000 light years away. Now this star nearly exploded already in the 19th century, and when Hubble came to image the star in the 1990s, the huge gas cloud that was ejected during that failed supernova was clearly visible. Now again, we can't predict exactly when Eta Carinae is going to explode – it could be tomorrow, it could be a million years from now. But of course in astronomical terms, that's just any minute now!		
08:43 [Narrator] What is the most odd thing you guys have discovered with Hubble?		
08:48 [Dr J] Well, one thing's for sure, although this came up a lot in the questions, it's not little green men, and it's not planet X. More seriously though, you might have heard that the 2011 Nobel prize for physics was awarded for the discovery that the expansion of the Universe is accelerating. Hubble played a part in that discovery, and it came as a complete surprise to everyone. Now, such revolutionary and completely unforeseen discoveries are of course very rare. But from time to time, Hubble does send us images that at least *look* surprising.		

And I'll leave you with a collection of these. This is Dr J signing off for the Hubblecast. Once again, and for the fiftieth time, nature has surprised us beyond our wildest imagination.		

ENDS 10:59