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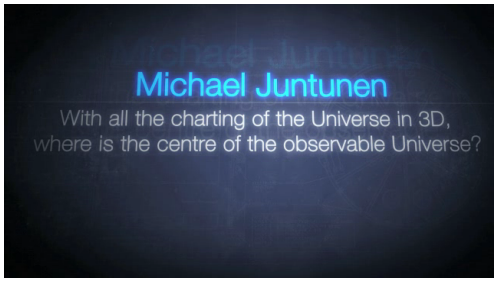
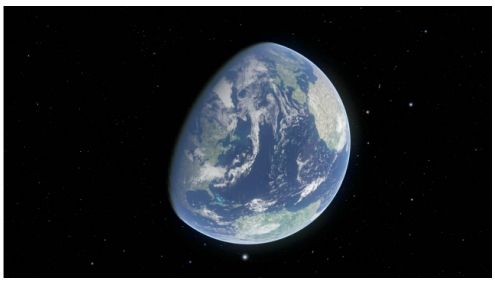
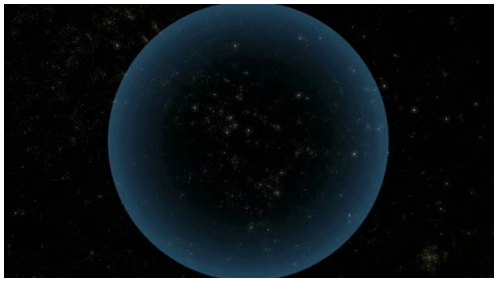
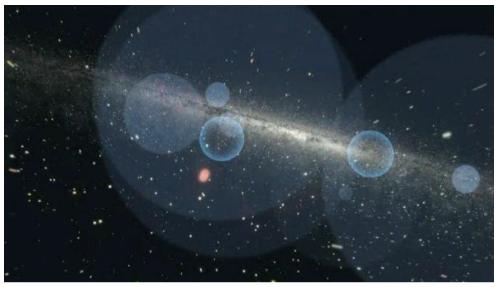
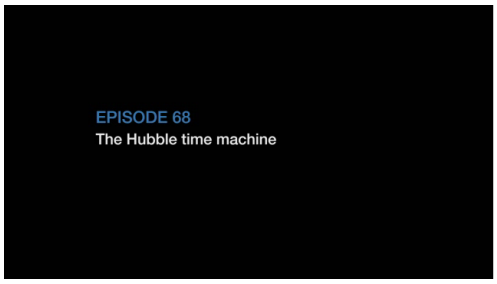
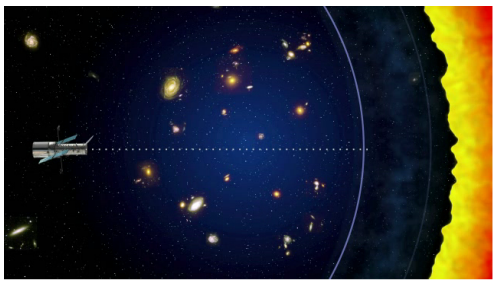
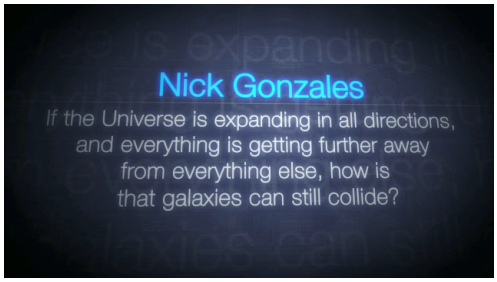
Hubblecast 79: Q&A with Dr J part 2	
00:00 **[Dr. J]** 1. Hello and welcome to part two of our special Q&A Hubblecasts. In the last episode we looked at some of the more technical questions that you sent us, and in this episode we'll get to the science questions.	
00:14 **2. Intro**	
00:42 **[Dr. J]** 3. Lots of the questions we received had something to do with the Big Bang….really a lot! So let's start there. Many people picture the Big Bang as some sort of explosion, and then ask "where did this explosion take place?" or "where is the Universe expanding from?"	

01:07 **[Public Question: Eric Fischer]** 4. If the Universe is expanding, what is the centre point of the expansion?	
01:15 **[Dr. J]** 5. The answer is: everywhere! Now the key is to realise that the term “Big Bang” does not describe an event in space, but rather one in time. The Big Bang was not an explosion. It was an event that happened everywhere at the same time and the Universe was infinitely large right from the start. And so there is no single point from which the Universe is expanding, and also there is no centre. It is simply impossible to define a centre in an infinitely large space.	
01:46 **[Dr. J]** 6. But, you may have heard people talking about the centre of the *observable* Universe. Now that does make sense.	
01:57 **[Public Question: Michael Juntunen]** 7. With all the charting of the Universe in 3D, where is the centre of the observable Universe?	

02:04 **[Narrator]** 8. The Universe as a whole does not have a centre, but the part of it that we can observe does. The observable Universe is the part of space that it is physically possible for us to see. All the light emitted in this region has had enough time since the Big Bang to reach Earth. This region is a sphere with us at its centre but our position has no particular significance. If there are astronomers in some distant galaxy then they will also be at the centre of their own observable part of the Universe. Like a sailor at sea, we are always at the centre of our own horizon.	  
02:49 **[Dr. J]** 9. Now this is of course somewhat related to your questions about how far Hubble can see.	
03:00 **[Clip from [Hubblecast 68](#) - Dr. J]** 10. These images show some of the most distant galaxies that have ever been observed, going back an incredible 13.2 billion years to a time when the Universe was only about half a billion years old.	

03:21 **[Dr. J]** 11. So this is pretty much at the limit of what you can do with Hubble. We know, however, that the most distant objects identified with Hubble are not the Universe's first. To spot these we will need Hubble's successor, the James Webb Space Telescope, which will be able to peer even further back into the history of the Universe.	
03:42 **[Public Question: Gladstone Faria]** 12. Would it be possible to build a new Hubble with more advanced instruments and larger than the current technology? A Hubble that could see beyond the boundaries of the Universe?	
03:54 **[Dr. J]** 13. No matter how big or how powerful your telescope, because the age of the Universe is finite there is a fundamental limit to how far you can see.	
04:08 **[Dr. J]** 14. Now another topic that you really wanted to know about is the expansion of space. Specifically, if the Universe is expanding, how can two galaxies nevertheless collide?	
04:24 **[Public Question: Nick Gonzales]** 15. If the Universe is expanding in all directions, and everything is getting further away from everything else, how is that galaxies can still collide?	

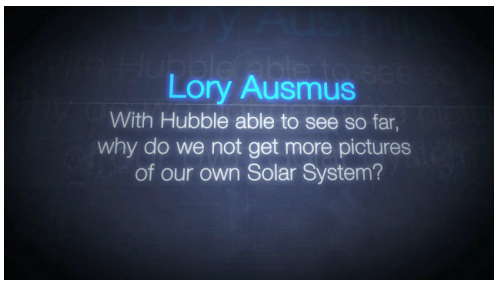
04:36
[Dr. J]
16. Well, although the Universe is expanding as a whole, that does not mean that every part of it is expanding.

For example, this room is not expanding, neither is the Solar System, nor the Milky Way.

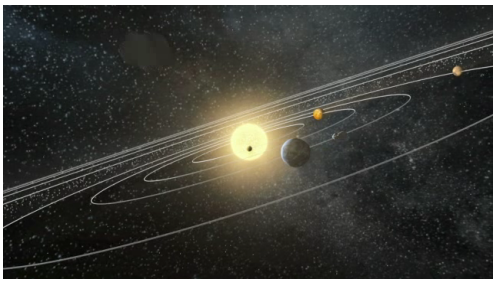
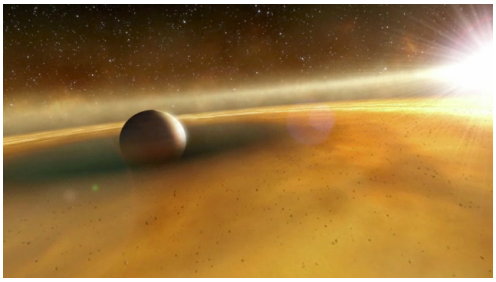
These structures are held together either by the electromagnetic force or by gravity. So, while on average the distances between galaxies become larger as the Universe expands, two nearby galaxies can nevertheless attract each other until they collide. This is not a contradiction.

But now, let's move a little closer to home.

05:15
[Public Question: Lory Ausmus]
17. With Hubble able to see so far, why do we not get more pictures of our own Solar System?

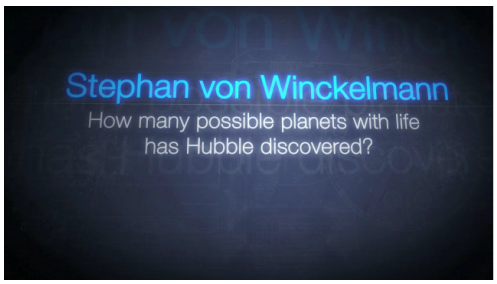


[Public Question: Karilee Schmeckpeper]
18. Are there any Hubble pictures of Pluto?

05:31 **[Dr. J]** 19. Some of you wanted to know why Hubble has not looked closely at the planets and moons in our own Solar System. Well, for the most part, it has!	
05:47 **[Clip from [Hubblecast 27] - Bob Fosbury]** 20. Hubble cannot observe our Sun, or the closest planet, Mercury, because its instruments are light-sensitive and would be damaged. However, the telescope has examined every other planet in the Solar System including dwarf planets Pluto, Ceres, and Eris. But of course Hubble does not just produce pretty pictures. It provides planetary scientists with vital information about our neighbours that may help us better understand our own home planet: Earth.	 
06:24 **[Dr. J]** 21. But what about beyond the Solar System? Before the launch of Hubble we didn't know about the existence of extrasolar planets, but of course now, astronomers are finding them everywhere!	

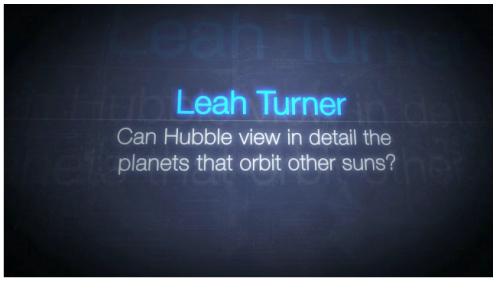
06:40
[Public Question: Stephan von Winckelmann]

22. How many possible planets with life has Hubble discovered?



[Public Question: Leah Turner]

23. Can Hubble view in detail the planets that orbit other suns?



06:55
[Dr. J]

24. Now Hubble has played some part in discovering some of these planets, but other space telescopes such as Kepler and CoRoT are much better at this because they were specifically designed for this purpose.

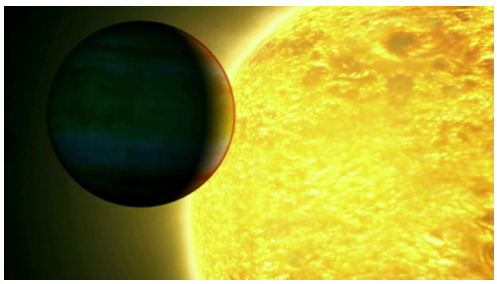
Hubble's forte lies more in the measuring of the atmospheres of these planets.

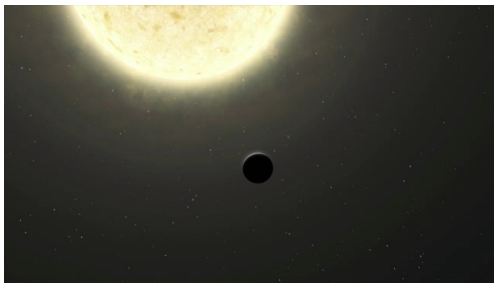
07:14
[Narrator]
25. Astronomers study planetary atmospheres using a technique called transmission spectroscopy.

They watch as a planet crosses in front of its parent star and some of the dazzling light from the star passes through the rim of the planet's atmosphere.

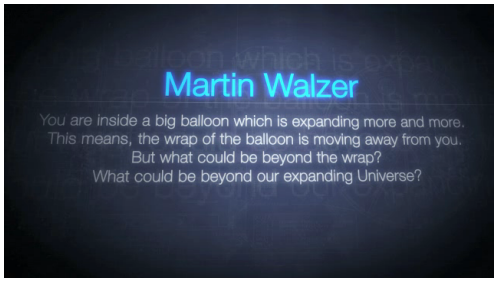
Any molecules in the atmosphere will absorb some of the starlight, leaving distinct signatures in the light that reaches Hubble.

So far, Hubble can't quite do this for planets as small as Earth. But astronomers are getting there fast and on larger planets they have already found water vapour, oxygen, and methane, all of which play key roles in life on Earth.





08:13
[Public Question: Martin Walzer]
26. You are inside a big balloon which is expanding more and more. This means, the wrap of the balloon is moving away from you. But what could be beyond the wrap? What could be beyond our expanding Universe?



08:28
[Dr. J]
27. There were of course a lot of questions that we've not had time to get into. But among the questions there were also a couple of misconceptions that I would like to talk about.

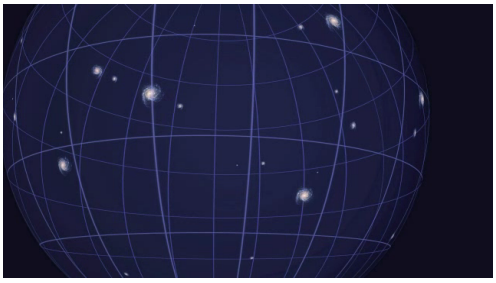
One example is the inflating balloon analogy of the expansion of space. The idea here is of course that the surface of the balloon represents a two dimensional version of the expanding Universe. Now for the analogy to work, you should imagine yourself being a two dimensional creature living on the surface of the balloon.

Now the key is to realise that the third dimension, i.e. up or down, is not needed to describe any of the physics that goes on in your Universe, i.e. on the surface of the balloon. And so, for the purpose of the analogy the third dimension does not exist and to ask what the balloon expands into is therefore entirely meaningless.

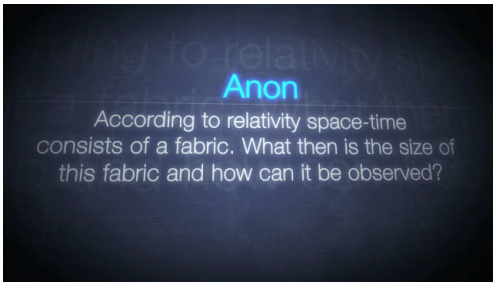
Similarly, to ask what our 3D Universe expands into, or what lies beyond our Universe, is just as meaningless.

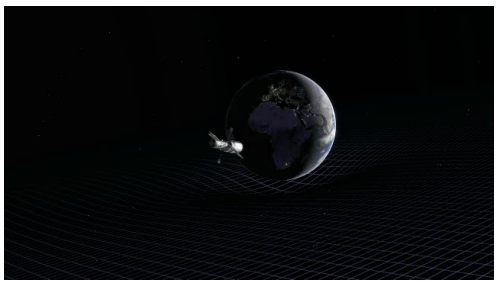
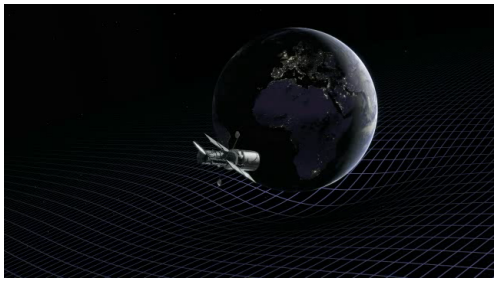
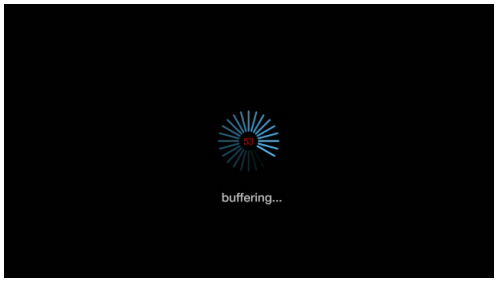
And then there is the issue of the "infamous fabric of space time".






09:47
[Public Question: Anon]
28. According to relativity space-time consists of fabric. What then is the size of this fabric and how can it be observed?



09:57 **[Dr. J]** 29. Many of you will have seen this illustration of the fabric of space being bent by a mass. Now the trouble is of course that space is not a fabric, or a sheet, or a trampoline. We just need this 2D analogy of a sheet to visualise the concept of a curved space, because a 3D curved space is something our mind has significant trouble with. Now don't feel bad about that! Physicists and astronomers work with these concepts all the time and they understand them really well, but even they have trouble visualising them. So we do need the analogies to help us develop our intuition, but the trick is to know where the analogies break down and which aspects of reality they capture, and which they don't.	  
10:46 **[Dr. J]** 30. And now to finish with the ultimate question: What is the meaning of life? Well, the meaning of life is obv- [buffering]. This is Dr J, signing off for the Hubblecast. Once again, nature has surprised us beyond our wildest imagination.	 

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