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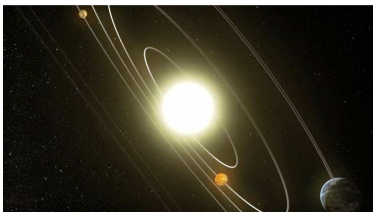
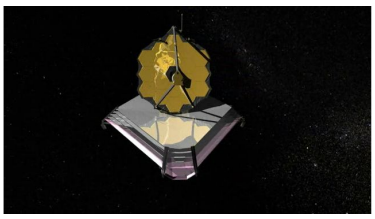
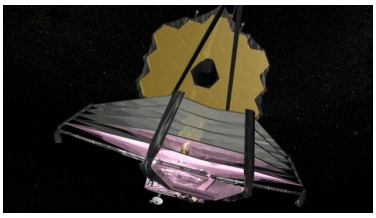
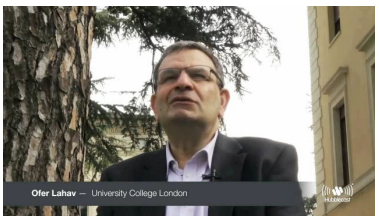
Hubblecast episode 83: A cosmic double act: Hubble meets James Webb	**Visual notes**
00:00 **[Narrator]** 1. How did the Solar System form? What was the Universe like when it was very young? What are planets around other stars like? Over the last 25 years, Hubble has provided answers for these and many other questions. However, even the best of telescopes needs a colleague... … and that's where the James Webb Space Telescope comes in.	 

	
00:40 **2. Intro**	
01:08 **[Narrator]** 3. Launched in 1990, the NASA/ESA Hubble Space Telescope has been incredibly successful, and has not only reached, but exceeded all of its targets. The telescope is perhaps best known for beaming back stunning pictures of the Universe — but it does much more.	 
01:36 **[Dr. J]** 4. Over the past 25 years, Hubble has proved to be on the most successful scientific instruments ever devised. From its vantage point, high above the Earth's atmosphere, it has made many discoveries. Among its achievements, is an accurate measurement of the age of the Universe. It has also played a key role in the discovery that the expansion of the universe is accelerating. It has analysed exoplanets, discovered supermassive black holes, and watched galaxies grow, collide, and merge. And that's just to name a few.	 

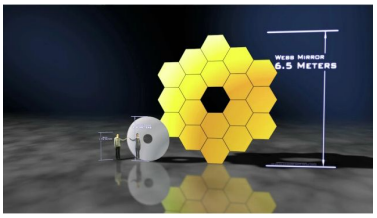
02:12 **[Mark Clampin, JWST Observatory Project Scientist]** *5. Well, Hubble was really the first telescope we put in space that could do optical and near-infrared imaging, so Hubble really kind of set the stage and made a number of game-changing discoveries in different fields of astrophysical science. But it's also raised a lot of questions as we've discovered new things, like the accelerating Universe, and how the distant Universe looks.*	
02:38 **[Narrator]** 6. Hubble has been undeniably brilliant, but there are some parts of the Universe that it just cannot see. Enter Hubble's future colleague, the James Webb Space Telescope! This magnificent telescope is a joint venture between NASA, the European Space Agency and the Canadian Space Agency. James Webb's infrared view of the Universe will peer through obscuring dust to reveal the delicate structures of the star-forming regions beneath, probe light from the first galaxies and stars, born when the Universe was still in its youth, and much, much more.	  
03:29 **[Ofer Lahav, University College London]** *7. We'll be able to see structure evolving with cosmic time in a much more profound way. We'll be able to map, to see for example, this effect of gravitational lensing, these tiny arcs around clusters, which tell us how massive clusters are, in fantastic level of detail. And actually also hopefully to constrain the nature of the dark matter.* **[Rachel Somerville, Professor at Rutgers University]** *It's almost hard to conceive, it's going to be a complete game-changer. It'll totally change the landscape of what we can do and what we can measure.*	 

04:08
[Dr. J]
8. So, what are some of the differences between Hubble and James Webb?

Well, first of all, James Webb is incredibly big for a space telescope. While Hubble's 2.4-metre mirror is already quite large, it is simply dwarfed by James Webb's 6.5-metre mirror.

James Webb stand a much better chance of detecting the faint light from the first galaxies..

Another difference is that Hubble was designed to be visited by astronauts for a service once in a while, swapping out instruments and faulty components. This will not be possible for James Webb. Once it's launched, it will have to fend for itself.



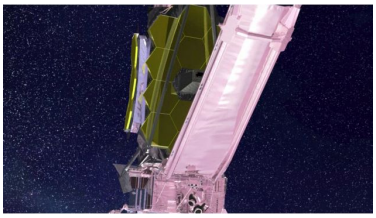
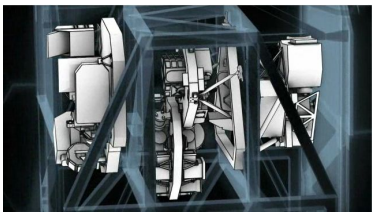
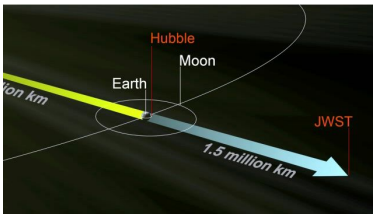
04:57
[John Grunsfeld, NASA Associate Administrator for Science/Astronaut]
9. The amazing thing about the Hubble Space Telescope is it was designed to be serviced, and so over 5 space shuttle missions we've upgraded the telescope, the last time in 2009 — I was lucky enough to be on that mission — and we've put new instruments on Hubble, new solar arrays, new computers, new memory sticks, everything you need to have a long life left in the telescope left. So I think Hubble has a lot left in it because the Universe provides us plenty of mysteries to solve. I'm convinced that maybe even the greatest discovery of Hubble is still to come.

05:30
[Dr J]
10. The reason for the different design is that James Webb will look at a different kind of light compared to Hubble.

While Hubble can see ultraviolet, visible, and some infrared light, James Webb is specialised for the infrared, and that means it has to be a cold telescope — a very cold telescope.

In fact, James Webb will have to operate at something like minus 230 degrees celsius — just about 40 degrees above absolute zero.

The reason is that warm objects emit infrared heat radiation. So, if you want you your infrared telescope to be exceptionally sensitive, you

have to cool it down to very low temperatures. Otherwise, it will simply blind itself with its own heat radiation.	
06:25 **[Narrator]** 11. Because it has to operate at incredibly cold temperatures, James Webb can't be built in the same way as Hubble. In particular, it has to carry its own huge sunshield to keep the telescope cool. The telescope and the sunshield are so big that James Webb will have to unpack itself once launched. It is a great feat of engineering, as everything for the telescope has to be built at room temperature, but still needs to be aligned and working properly when it is cooled down — which changes the size of the components inside.	 
07:24 **[Mark Clampin, JWST Observatory Project Scientlst]** *12. Just the act of having to get something to 40 K is non-trivial. With JWST, we have a big sunshade, so everything's in the shadow, but we still have a lot of hardware that has to be covered in multiple layers of blankets, and they're cryogenic blankets which means they have to be specially designed, specially tailored, and it's very hard to install them, so it really moves you away from the serviceability or modularity idea that Hubble was built with.*	
07:53 **[Narrator]** 13. Keeping James Webb cold is the reason behind another big difference between it and Hubble. Whilst Hubble orbits the Earth at around five hundred kilometres, James Webb has a very different path — not in orbit of the Earth — that will keep it one and a half million kilometres from Earth.	
08:19 **[Dr. J]** 14. And astronomers have an additional bonus to look forward to — when James Webb is launched, Hubble will still be active. So, for some period of time, astronomers will be able to use both telescopes to explore the cosmos. Who knows what they will find? This is Dr. J, signing off for the Hubblecast. This time, engineering surprised us beyond our wildest imagination.	

Ends 09:39