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Hubblecast Episode 19: Bigger is better **FOR IMMEDIATE RELEASE 19:00 (CEST)/01:00 PM EDT 03 September, 2008**		
00:00 **[Visual starts]** **00:12** **[Intro]** **00:38** **[Woman]** This is the Hubblecast! News and images from the NASA/ESA Hubble Space Telescope. Travelling through time and space with our host Doctor J a.k.a. Dr. Joe Liske. **00:29** **[Dr. J]** Welcome to the second special episode of the Hubblecast, celebrating the International Year of Astronomy 2009. In the first episode, we learnt about the invention of the telescope and how it facilitated man's first steps out into the Universe. Today we will see how astronomers use bigger and bigger telescopes to see further than ever before. At night, your eyes adapt to the dark. Your pupils widen to let more light into your eyes. As a result, you can see dimmer objects, and fainter stars. Now imagine you had pupils one metre across. You'd look pretty strange but you'd also have supernatural eyesight! And that's what telescopes do for you. A telescope is like a funnel. Its main lens or mirror collects the starlight and brings it all together into your eye. The bigger the lens or the mirror of a telescope, the fainter the objects you can see. So size really is everything. But how big can you make a telescope?		Intro graphics Hubblecast logo Episode 19: Bigger is better Dr. J in virtual studio Dr. J text Panning image of starry night Enter virtual studio through window Camera settles on Dr. J Fade to white, reveal Dr. J in virtual studio with two telescopes Background animation of telescopes collecting light

Well actually not too big if it's a refractor. The starlight has to pass through the main lens. And so you can only support it around its edge. Now if you make the lens too big it becomes too heavy, and it starts deforming under its own weight. That means that the image will be distorted.		Image of mirror and then telescope Background illustration of refractor
The largest refractor in history was completed in 1897, at Yerkes Observatory outside Chicago. Its main lens was just over one metre across. But its tube was an incredible 18 metres long.		Cut to different view of Dr. J and the telescopes Photos of the Yerkes telescope
With the completion of the Yerkes telescope, the builders of refracting telescopes had pretty much reached their limit.		
You want bigger telescopes? Think mirrors.		Background illustration of reflector then photograph of mirror
In a reflecting telescope, the starlight bounces off a mirror instead of passing through a lens. That means that you can make the mirror a lot thinner than a lens, and you can support it from the back. The result is that you can build a lot larger mirrors than lenses.		
02:49 **[Narrator]** Big mirrors came to southern California a century ago.		Zoom into map of the Earth
Back then, Mount Wilson was a remote peak in the wilderness of the San Gabriel mountains. The sky was clear and the nights were dark.		Fade into photos of Mount Wilson
Here, George Ellery Hale first built a 1.5 metre telescope. Smaller than Lord Rosse's retired Leviathan, it was of much better quality. And at a much better site, too.		Photo of Hale Photo of man using the telescope
Hale talked local businessman John Hooker into financing a 2.5 metre instrument.		Photo of Hooker
Tonnes of glass and riveted steel were hauled up Mount Wilson.		Photo of telescope under construction
The Hooker telescope was completed in 1917. It would remain the largest telescope in the world for 30 years.		Photos of telescope interior
A big piece of cosmic artillery, ready to attack the Universe.		
03:42 **[Dr. J]** And attack it did.		Dr. J in virtual studio, next to large telescope
Along with the incredible size of the new telescope came transformations in the way the image was viewed.		
Astronomers no longer peered through the eyepiece of the new giant. But instead collected the light on photographic plates for hours on end.		Various astronomical images
Never before had anyone peered so far into the cosmos.		
Spiral nebulae turned out to be brimming with individual stars. Could they be sprawling stellar systems like our own Milky		

Way? In the Andromeda Nebula, Edwin Hubble discovered a particular type of star that changes its brightness with clocklike precision. From his observations Hubble was able to deduce the distance to Andromeda: almost a million light-years. Spiral nebulae, like Andromeda, were clearly individual galaxies in their own right. But that wasn't the only incredible thing. Most of these galaxies were found to be moving away from the Milky Way. At Mount Wilson, Hubble discovered that the nearby galaxies were receding at small velocities, whereas the distant galaxies were moving away at a much faster pace. The conclusion? The Universe was expanding. The Hooker telescope had given scientists the most profound astronomical discovery of the 20th century. **05:10** **[Narrator]** Thanks to the telescope, we have traced the history of the Universe. A little less than 14 billion years ago, the Universe was born in a huge explosion of time and space, matter and energy, called the Big Bang. Tiny quantum ripples grew into dense patches in the primordial brew. From these, galaxies condensed. A stunning variety of sizes and shapes. Nuclear fusion in the cores of stars produced new atoms. Carbon, oxygen, iron, gold. Supernova explosions blew these heavy elements back into space. Raw material for the formation of new stars. And planets! Someday, somewhere, somehow, simple organic molecules evolved into living organisms. Life is one miracle in an ever-evolving Universe. We are stardust. It's a grand vision and a sweeping story. Brought to us through telescopic observations. Imagine: without the telescope we would know about just six planets, one moon, and a few thousand stars. Astronomy would still be in its infancy. **06:37** **[Male voice]** Like buried treasures, the outposts of the Universe have beckoned to the adventurous from immemorial times. Princes		Settle on portrait photo of Hubble Photo of Hubble at telescope Photo of Andromeda Dr. J in front of monitor bank showing Hubble Image of galaxy Dr. J in front of monitor bank Zoom/pan of Hooker telescope Flying through galaxies Zoom out from map of Earth Animation of Big Bang Purple structures Nebula Flying through galaxies Zoom into star Atoms Supernova animation Newly formed planet Animated stream, people, planets etc. Close-up view of Saturn's rings Nebula Timelapse of observatory Timelapse of mountains and

and potentates, political or industrial, equally with men of science, have felt the lure of the uncharted seas of space, and through their provision of instrumental means the sphere of exploration has rapidly widened. **07:13** **[Narrator]** George Ellery Hale had one final dream: to build a telescope twice as large as the previous record holder. Meet the grand old lady of 20th century astronomy. The five metre Hale telescope at Palomar Mountain. Over five hundred tonnes of moving weight, yet so precisely balanced that it moves as gracefully as a ballerina. Its 40 tonne mirror reveals stars 40 million times fainter than the eye can see. Completed in 1948, the Hale telescope gave us unsurpassed views of planets, star clusters, nebulae and galaxies. Giant Jupiter, with its many moons. The stunning Flame Nebula. Faint wisps of gas in the Orion Nebula. **08:13** **[Dr. J]** But could we go bigger still? Well, soviet astronomers tried in the late 1970s. High up in the Caucasus mountains, they built the Bolshoi Teleskop Azimutalnyi – sporting a primary mirror six metres in diameter. But it never really lived up to its expectations. It was simply too big, too expensive, and too difficult. So did telescope builders have to give up at that point? Did they have to bury their dreams of even bigger instruments? Had the history of the telescope come to a premature end? Well, of course not. Today we have 10 metre telescopes in operation. And even bigger ones are on the drawing board. What was the solution? New technologies. Thank you for joining me in this second episode of the special series. Next time, we will see how advancing technology revolutionised astronomy. This is Dr. J signing off from the Hubblecast. Once again nature has surprised us beyond our wildest imagination. **09:12** **[Outro]**		traffic Timelapse of clouds Timelapses of mountains and the rotating night sky Various photographs of Hale telescope and observatory, fading from one to the other Jupiter Flame Nebula Orion Nebula Dr. J next to virtual telescope Video footage of observatory Back to Dr. J Background panning photos of the telescope Background photo of Keck telescopes New view of Dr. J, background timelapse of observatory Hubblecast is produced by ESA/Hubble at the European Southern Observatory in Germany.

09:35 END		The Hubble mission is a project of international cooperation between NASA and the European Space Agency. Credits