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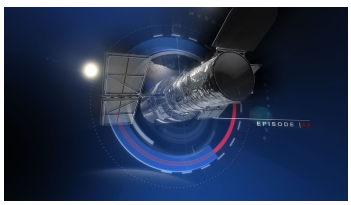
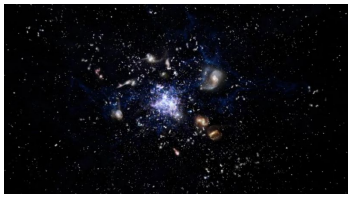
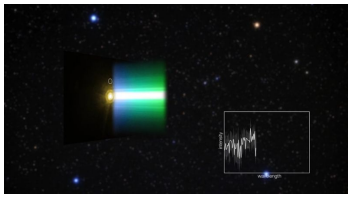
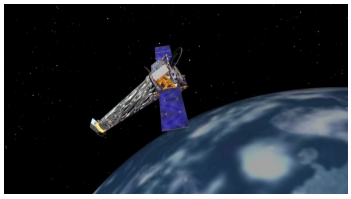
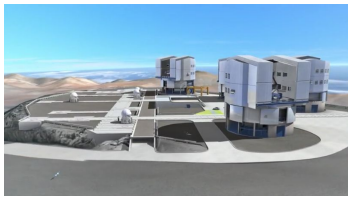
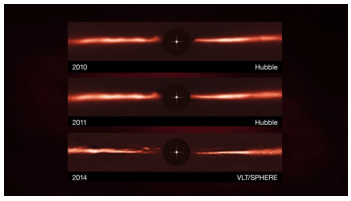
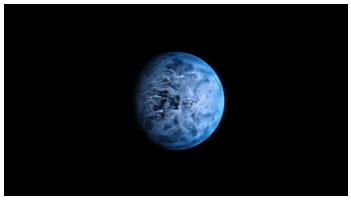
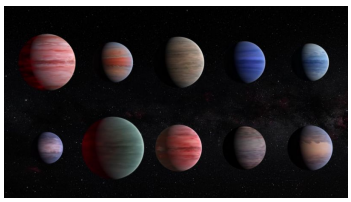
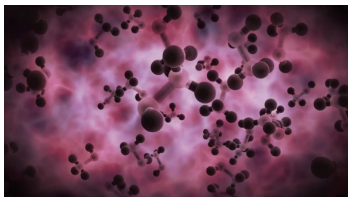
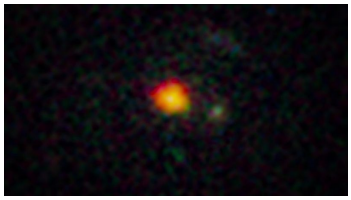
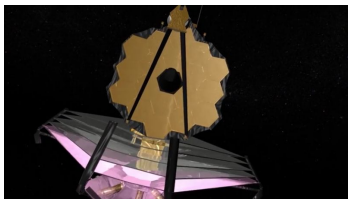
Keywords:

Hubblecast Episode 93: Telescope Teamwork	**Visual notes**
00:00 [Narrator] 1. The Universe reveals itself in a multitude of colours. Even though Hubble can see a large part of the electromagnetic spectrum — from the ultraviolet to the near-infrared — it still cannot see the whole cosmic kaleidoscope. So astronomers need different kinds of telescopes, both in space and on the ground, to fully unveil the mysteries of the Universe. And Hubble plays a key role in this essential telescope teamwork.	  
00:36 2. Intro	

00:53 [Narrator] 3. The Universe looks very different in the light of different wavelengths. And many scientific questions can only be answered by studying objects in specific parts of the spectrum. Modern telescopes are often built to study a very specific wavelength range — a small part of the electromagnetic spectrum in which they are the experts. With the current state of technology, no telescope, not even Hubble, can see *all* wavelengths. Only by using data obtained with different telescopes can astronomers study the Universe in maximum detail.	  
01:40 [Narrator] 4. The history of galaxy formation and the chemical structure of galaxies are just two of the many astronomical puzzles that scientists would like to solve. Progress towards answers is only possible by mapping the emission coming from all the different players: stars, dust and gas. Each one leaves its signature in different wavelengths. For instance, the same portion of space studied by Hubble can be observed by the instrumentation aboard the Chandra X-ray space observatory. Hubble and Chandra have teamed up many times in the past. An example is this image of the spiral galaxy ESO 137-001. Thanks to Hubble's contribution, the stars and nebulae in the galaxy are made visible. Chandra, on the other hand, can show up the hot gas streams, as they are only visible in the X-ray part of the spectrum.	   
02:55 [Narrator] 5. But Hubble is not only working together with other	

space telescopes; it also cooperates with ground-based ones. And while telescopes in orbit have the advantage of being immune to atmospheric turbulence, instrumentation on the ground can be continuously updated and often show a bigger field of view. A good example is ESO's Very Large Telescope on Cerro Paranal — in the Chilean Atacama desert. The galaxy cluster Abell 2744 — nicknamed Pandora's Cluster — was observed with these two very different eyes. The combined data showed that Pandora's Cluster is in fact not one cluster, but the result of a pile-up of at least four separate galaxy clusters. Many requests for telescope time are to follow up studies of targets investigated previously: in 2015 astronomers combined older Hubble data with new observations from ESO's Very Large Telescope. The latter had just been used to discover some previously unknown structures within the dusty disc surrounding the nearby young star AU Microscopii. Only on comparison with earlier Hubble images of the same object was it discovered that the features on the disc had changed over time. It turned out that those ripples are actually moving — and very fast — a sign of something truly unusual going on, and still today an unsolved mystery.	    
04:58 [Narrator] 6. In the last twenty years the hunt for exoplanets has become a crucial and very prolific field of study in astronomy; a field in which almost all telescopes try to make their mark.	 

For this hunt Hubble teamed up with the Spitzer infrared space telescope. Together they produced the largest comparative study ever of ten hot Jupiter-sized exoplanets. The multiple observations of their atmospheres allowed astronomers to extract the signatures of various elements and molecules — including water — and to distinguish between cloudy and cloud-free exoplanets.	 
05:57 [Narrator] 7. Sometimes, more than two telescopes have to work together to achieve a common goal. To witness the earliest stages of a massive galaxy forming in the young Universe, astronomers used the power of four large telescopes: Hubble, Spitzer, ESA's Herschel Space Observatory and the Keck Observatory in Hawaii. Together the four telescopes observed the early growth of a galactic giant as it appeared eleven billion years ago, just three billion years after the Big Bang.	 
06:40 [Narrator] 8. The next big partner of Hubble will be the forthcoming NASA/ESA/CSA James Webb Space Telescope. It is scheduled for launch in 2018. While Hubble can see ultraviolet, visible, and some infrared light, James Webb is specialised for the infrared. With this capability it will be the perfect complement to Hubble. Together they will write another chapter in the story of successful telescope teamwork.	  

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