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**Keywords: reionisation, cosmology,**

| **Hubblecast Episode 118: How the first stars transformed the Universe** | **Visual notes** |
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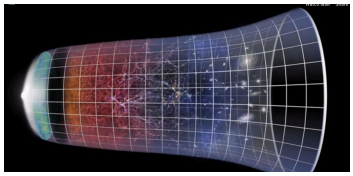
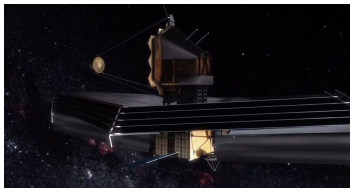
| 00:00<br>1. Understanding the evolution of the early Universe is an important aspect of modern astronomy. One particularly important era in those early days was the time of reionisation, during which the first stars were born.<br><br>Hubble has allowed us a first glimpse into that time, but the James Webb Space Telescope will push the door wide open. |  <br>  <br>  |

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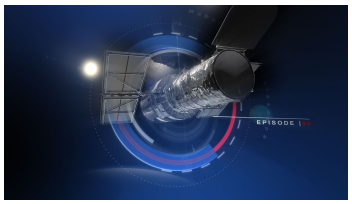
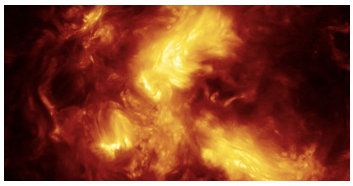
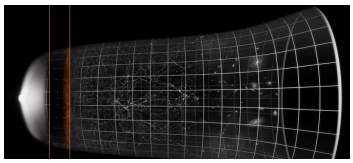
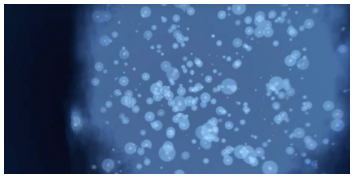
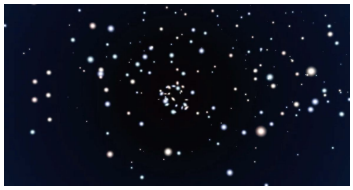
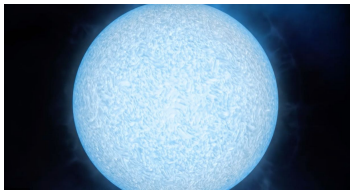
| 00:28<br>2. Intro |  |
| 00:33<br>3. 13.8 billion years ago, the Universe started with the Big Bang. Initially the Universe was a melting pot of hot, free particles. As it started to cool down, the protons and neutrons combined and attracted free electrons to form neutral atoms — mostly hydrogen but also some helium. |  <br>  |
| 01:06<br>4. This event, called recombination, left the Universe with no free electrons and a hydrogen fog distributed throughout it. The clouds of hydrogen would eventually collapse to form the first stars, but this process is very gradual. For millions of years the Universe would have no sources of light. The cosmic dark ages had begun. |  <br>  |
| 01:34<br>5. Then the gravity of denser regions began to attract the matter around them. These regions collapsed to become the first stars and galaxies, eventually beginning to shine. Thanks to recombination, there were no free electrons to scatter the starlight, so it could travel freely throughout the Universe, ending the cosmic dark ages. |  <br>  |
| 02:01<br>6. The first stars were massive and energetic enough to strip the surrounding hydrogen atoms of their electrons again. This time is called the epoch of reionization.<br><br>This era began probably as early as 400 million years |  |

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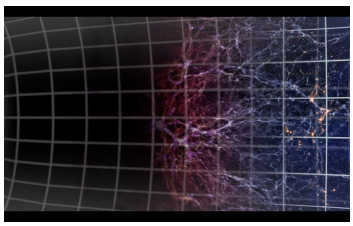
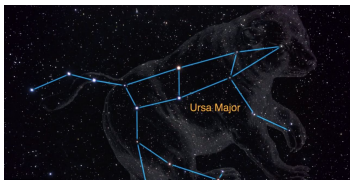
| after the Big Bang and it lasted for several hundred million years. |  |
| 02:25<br>7. There is much we don't know about this time in the Universe's history. And even Hubble's extraordinary cameras are only able to spot a few, bright galaxies from that time.<br><br>Still, Hubble has provided some of the most detailed information we have about the abundance and properties of the earliest star-forming galaxies. |  <br>  |
| 02:51<br>8. While providing some answers, the results Hubble delivered also raised more questions:<br><br>When and how did the first stars form? And when did the first galaxies appear?<br><br>How did the radiation of the first stars escape the dusty environment of their parent galaxies, to ionise the matter in between galaxies?<br><br>Were the first stars really powerful enough to reionise the Universe, or did active black holes play a role as well? |  <br>  <br>  <br>  |

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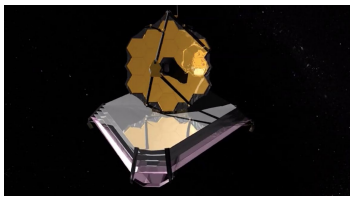
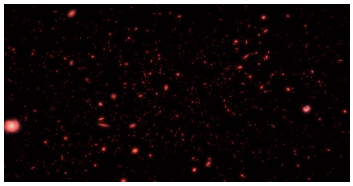
| 03:30<br>The forthcoming NASA/ESA/CSA James Webb Space Telescope, with its infrared-sensitive cameras and gigantic 6.5-metre mirror, will be able to teach us about these early days of the Universe.<br><br>James Webb will explore the Universe at long wavelengths, looking further into the past to gather information about exactly how and when the epoch of reionisation occurred. This will shed more light on this epoch during which the first stars started to illuminate the Universe.<br><br>We are ready to be surprised by nature beyond our wildest imaginations. |  <br>  <br>  |

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