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Hubblecast Episode 75: Dwarf galaxies that pack a punch	**Visual notes**
00:00 **[Narrator]** 1. Many galaxies across the Universe are forming stars. But none are more prolific than starburst galaxies, which create stars at a furious rate. Now, astronomers have used Hubble to explore some of the smallest and most numerous of these starburst galaxies, from a time when most of the stars in the Universe were formed. These are the starbursting dwarf galaxies of the early Universe, and they are even more crucial than we imagined.	 
00:36 **2. Intro**	

01:04
[Dr. J]
3. The Universe is full of stars. But where did they all come from? Well, they formed inside dense gas clouds in galaxies, and this is a process we can actually see going on right now, both in our own galaxy, the Milky Way, as well as many other nearby galaxies. We can even measure how many new stars are being formed per year.

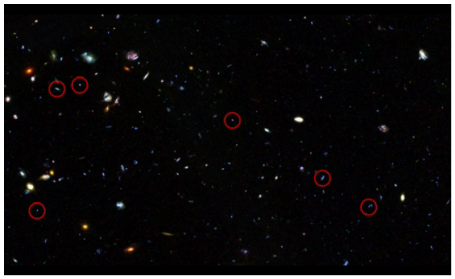
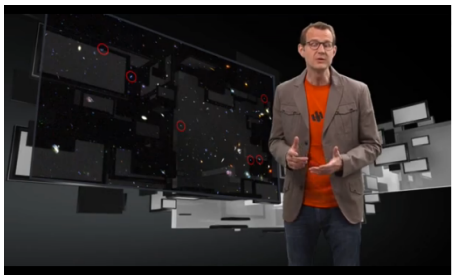
Now let's assume that, on average, all galaxies have been forming stars at their current rate throughout the history of the Universe. In that case we would expect far *fewer* stars in the Universe today than we can actually observe. Now that means that galaxies must have been producing stars in the past at a much higher rate than today.

And indeed, when we look at very distant galaxies in the early Universe we can see that they were forming stars at about ten times the rate than today's galaxies.

With the help of Hubble we've even been able to trace out the entire history of star formation of the Universe. And it turned out that most of the stars were formed between two and six billion years after the Big Bang.

So we pretty much know *when* the stars formed. In this episode we'll explore the *where* and *how*.



02:22
Narrator
4. Do galaxies form stars gradually and continuously over their lifetime? Or in sudden and short-lived bursts? And does the size of a galaxy dictate the number of stars it forms?

Astronomers have looked at galaxies in the Universe's youth in the hope of answering these questions. The most-studied galaxies are the most massive and brightest, because they are the easiest to observe. What they found was that the star formation in these huge galaxies can account for a good fraction of the stars we see today.

But we cannot get the full picture by only looking at these giant galaxies. We need to look at galaxies of all sizes.	
03:18 **Dr J** 5. Astronomers have now used Hubble to study some dwarf galaxies in the early Universe. These are the lower-mass siblings of the giant galaxies that were studied earlier. Now these dwarfs are faint and small, and hence they are quite difficult to study when you're looking halfway across the observable Universe. But it turns out that they were well worth finding, because some of these dwarfs are putting on quite a show.	 
03:44 **[Narrator]** 6. About a third of these dwarfs were forming stars so quickly that they could actually double their entire mass of stars in only 150 million years. This is only a tiny fraction of their age and is in fact incredibly quick given that for most normal galaxies to double their stellar mass would take billions of years. Clearly, these dwarfs will not be able to sustain their incredibly high star formation rate for very long — they must be experiencing a short-lived burst of star formation. But, the sheer number of dwarf galaxies throughout the Universe means that this rampant starburst activity translates to a staggering number of stars.	 

04:45
[Dr J]
7. So how did they do it? How could the astronomers measure the star formation activity in these very faint and distant dwarf galaxies?

Well, they used Hubble's highly-sensitive Wide Field Camera 3 in its *grism spectroscopy mode*.

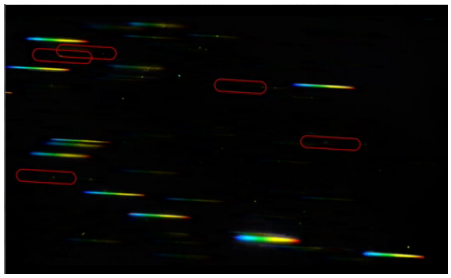
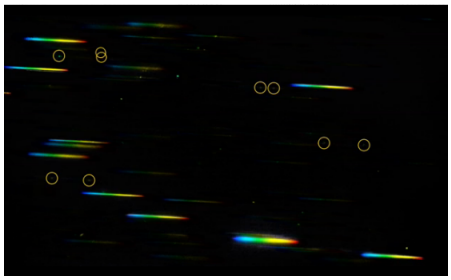
A grism is a combination of a grating and a prism, and it splits up the light from a galaxy into its constituent colours, producing a spectrum. The point is that this is done extremely efficiently, losing hardly any photons in the process, and covering many galaxies in a single observation.

Now, once you have a spectrum you can look for the light emitted by the hydrogen gas in the galaxy. If there are stars being formed in the galaxy then the intense radiation from the newborn stars heats up the hydrogen gas and makes it glow.

Importantly though, all of the light from the hydrogen gas is emitted only in a small number of very narrow and bright emission lines. And these are much easier to detect than than the faint light from the stars themselves.

And the beauty is that the amount of light in just one of these lines tells you exactly how much star formation is going on in the galaxy.



06:03
[Narrator]
8. Finding and studying different sizes of starburst galaxies gives us new insight into the Universe's history and helps to unravel the secrets of galaxy evolution.

At the moment, we cannot be sure what processes make these dwarf galaxies form stars so actively.

06:32 **[Dr J]** 9. In principle, a starburst can be triggered by a number of different events in a galaxy's recent past. For example, this could be a merger or just a tidal interaction with another galaxy, or a shockwave from a supernova. For our sample of starbursting dwarf galaxies in the early Universe, we just don't know yet what triggered them. All we know for now is that you don't have to be large to pack a star-forming punch. This is Dr J signing off for the Hubblecast. Once again, nature has surprised us beyond our wildest imagination.	 

Ends 07:10