
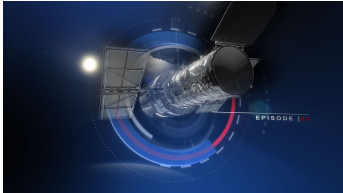




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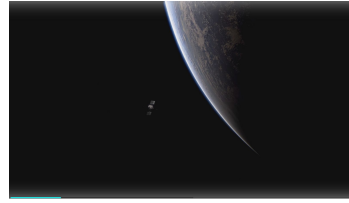
**Keywords: Gyroscope, reaction wheels, fine guidance sensor, orientation**

<b>Hubblecast Episode 114: How does Hubble orientate itself in space?</b>	<b>Visual notes</b>
<p>00:00 [Narrator] Since its launch in 1990, the NASA/ESA Hubble Space Telescope has been exploring the Universe. To obtain crystal clear images of distant galaxies and faint nebulae, Hubble relies on sophisticated hardware to keep its gaze locked onto its target.</p>	
<p>00:22 2. Intro</p>	

00:33

[Narrator]

3. From its vantage point above Earth's atmosphere Hubble observes the Universe 24/7. Whirling around Earth at 28 000 kilometres an hour, Hubble has to rely on its finely tuned Pointing Control System to make sure its scientific instruments are looking directly at its remote targets.

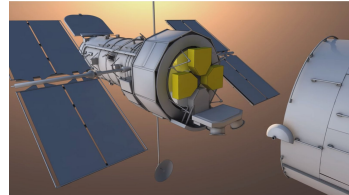


00:57

[Narrator]

4. To ensure its gaze never falters, Hubble uses three Fine Guidance Sensors located around the circumference of the telescope.

These sensors provide precise pointing information for Hubble. They look out for auxiliary guide stars which enable Hubble to determine its orientation in space and to stay focused on one point. When the telescope drifts by even a minuscule amount these sensors will detect it.

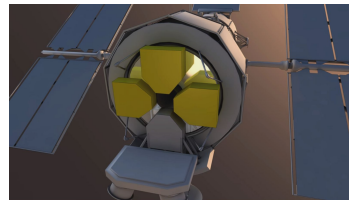


01:30

[Narrator]

5. To change its orientation and to correct for drifts Hubble does not use propellants. Their fumes could contaminate Hubble's observations and limit its lifetime.

Instead, Reaction Wheels steer the telescope, using the elegant principle of Newton's third law: if one of the wheels turns clockwise, Hubble will turn counterclockwise.

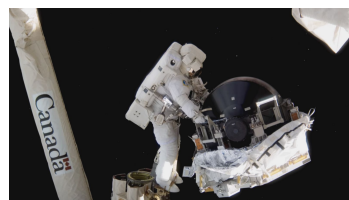



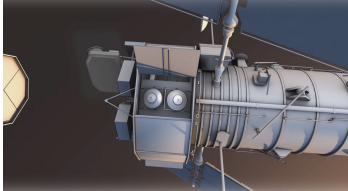

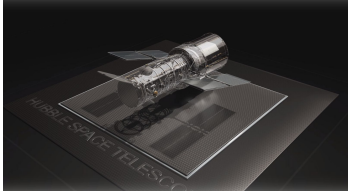
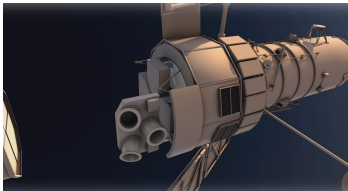
01:56

[Narrator]

6. These four large, massive flywheels spin rapidly under the control of Hubble's computer and move the telescope using the immense torque generated by their spinning.

But even at its fastest, Hubble only rotates as quickly as the minute hand of a clock — just 90° in 15 minutes.



	
<p>02:23 [Narrator] 7. Detecting such minute movements requires the best and most sensitive gyroscopes in the world; Hubble has six of them. They constantly measure if and at what speed the telescope is turning.</p> <p>In combination with the fine guidance sensors, they keep the telescope precisely pointed for long periods, enabling Hubble to produce its spectacular views of the Universe.</p>	
<p>02:54 [Narrator] 8. To operate with optimal efficiency, Hubble needs three of its six gyroscopes — but even if just one was available, its scientific capabilities would not be affected in the slightest.</p>	 
<p>03:11 [Narrator] 9. Together these three systems have allowed Hubble to perform its outstanding scientific mission over the last 28 years. And many more new discoveries can be expected in the years to come.</p>	

**Ends 04:20**