teachers guide

Cosmology 4
Shifted light

Components

	NAME	DESCRIPTION	AUDIENCE
	Shifted light teachers guide	This guide contains notes about how to use the video, *First light 2*.	teachers
	First light part 2 video	The first chapter of this video explains red and blue shift by analogy with the Doppler effect and shows how Hubble's law led to the expanding Universe theory. The second chapter recaps the explanation of red and blue shift before explaining how Hubble's law is used to measure astronomical distances.	students

Purpose

To **Explain** why light from astronomical objects is red and blue-shifted and how this is used in astronomy.

Outcomes

Students:

- understand that light from an astronomical object can be red or blue-shifted, depending on its relative motion to us;
- understand that high values of red-shift of light from distant objects are caused by the expansion of space;
- understand that red and blue-shift indicate the velocity which which an object is moving towards or away from us; and
- understand that Hubble's law can be used to estimate the distance to an object, based on its recessional velocity.

Activity summary

ACTIVITY	POSSIBLE STRATEGY
Teacher shows the first part of the video, *First light 2.1 – shifted light*. Class discusses ideas presented in the video.	whole class
Teacher shows the second part of the video, *First light 2.2 – an astronomical distance*. Class discusses ideas presented in the video.	whole class

Information for teachers

The video, *First light 2*, is presented in two chapters. Key ideas from chapter one, *Shifted light*, include:

- Sound waves from a source moving towards or away from an observer are shifted higher or lower in frequency.
- In an analogous way, light waves from a source moving towards us have their frequency shifted higher (blue-shift), whilst those from a light source moving away from us are shifted lower in frequency (red-shift).
- Measurement of hydrogen absorption lines in the spectrum of a light-emitting astronomical object shows the velocity with which it is moving towards or away from us.
- The velocity that an objects moves away from us is called its recessional velocity (objects moving towards us are sometimes described as having a negative recessional velocity).
- Hubble found that most galaxies are moving away from us, with the most distant objects receding the fastest.
- This led to the expanding Universe and Big Bang theories.

Key ideas from chapter two of the video, *An astronomical distance*, include:

- Hubble's law can be used to estimate how far away an object is, given its recessional velocity.
- Red-shift of light from the most distant objects is greater than expected because of expansion of the Universe.
- Measuring distances to many objects provides information on the large scale structure of the Universe.

Technical requirements

The video, *First light part 2*, is provided as a QuickTime movie. QuickTime version 7 or later is required to view the movie. This is a free download from www.apple.com/quicktime.

The teacher guide requires Adobe Reader (version 5 or later), which is a free download from www.adobe.com.

CC The video contains closed captions.

Video credits

Shifted light

- 'Milky Way over Chajnantor' by European Southern Observatory, CC-BY-3.0, www.eso.org/public/videos/chajnantormilkyway/
- 'Four ALMA antennas on the Chjnantor plain' by European Southern Observatory/José Francisco Salgado (josefrancisco.org), CC-BY-3.0, www.eso.org/public/videos/alma4anttimelapse2/
- 'Six-degree-Field Galaxy Redshift Survey Flythrough' by Associate Professor Paul Bourke, iVEC@UWA, The University of Western Australia. Data credit: www.aao.gov.au/local/www/6df/
- 'La Silla 3.6m Telescope' by European Southern Observatory, CC-BY-3.0, www.eso.org/public/videos/lasilla36mtel5/
- 'The control room of the MPG/ESO 2.2m Telescope on La Silla, European Southern Observatory' by ESO, CC-BY-3.0, www.eso.org/public/videos/lasillalsobservations6/
- 'Edwin Hubble looking through the Newtonian focus of the 100 inch telescope'. The Huntington Library, Art Collections and Botanical Gardens. Used by permission.
- 'The velocity-distance relation'. The Huntington Library, Art Collections and Botanical Gardens. Used by permission.
- 'Dark energy expands the Universe' by NASA, PD-USGOV-NASA, svs.gsfc.nasa.gov/vis/a010000/a010100/a010135/
- 'Ring formation around extrasolar planet' by European Space Agency /Hubble (M. Kornmesser & L. L. Christensen), CC-BY-3.0, www.spacetelescope.org/static/archives/videos/mpg_medium/astro_am.mpeg
- 'The radial velocity method' by ESO/H. Zodet, CC-BY-3.0, www.eso.org/public/videos/eso0915g/

An astronomical distance

- 'Edwin Hubble in front of the model of the 100 inch telescope'. The Huntington Library, Art Collections and Botanical Gardens. Used by permission.
- 'Plate ir12723 on M44', Harvard-Smithsonian Center for Astrophysics, tdc-www.harvard.edu/plates/gallery/
- '2dFGRS top view' by the 2dF Galaxy Redshift Survey Team, used by permission, magnum.anu.edu.au/~TDFgg/Public/
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music

- CC Mixter,'Guess' by DoKashiteru, CC-BY-NC, ccmixter.org/files/DoKashiteru/21648

Associated SPICE resources

Cosmology 4: Shifted light may be used in conjunction with related SPICE resources to address cosmological concepts within the broader topic of Unit 3BPHY: Particles, waves and quanta.

DESCRIPTION	LEARNING PURPOSE
Cosmology (sequence overview) This learning pathway shows how a number of SPICE resources can be combined to teach the topic of cosmology.	
Cosmology 1: History of the Universe This resource introduces students to Big Bang theory and events that have occurred since that time to create the Universe we see today.	**Engage/Explain**
Cosmology 2: Evidence for the Big Bang This resource introduces major pieces of evidence that led to the development of Big Bang theory, and discoveries that have since added further support to it.	**Explore/Explain**
Cosmology 3: Future of the Universe This resource introduces students to the principles by which scientists predict possible scenarios for the future of the Universe.	**Explore/Explain**
Cosmology 4: Shifted light A video explains red and blue-shift of light, and how it is used in astronomy to measure velocity and distance.	**Explain**

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