**teachers guide**

**Cosmology 1**

**History of the Universe**

# Components

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|  | NAME | DESCRIPTION | AUDIENCE |
|  | *History of the Universe*teachers guide | This guide contains presentation notes and questions to promote discussion about the history of the Universe. | teachers |
|  | *History of the Universe*presentation | This presentation is designed to engage students in a conversation about the history of the Universe, including the evolution of fundamental interactions and matter, and formation of stars and galaxies. | students |
|  | *Timeline of the Universe*fact sheet | This timeline summarises the events cosmologists believe have occurred since the Big Bang. | students |

Purpose

To **Engage** students’ interest and provide information on the history of the Universe.

# Activity summary

Outcomes

Students:

* describe and explain Big Bang theory and the history of the Universe, and
* describe and explain the expansion of the Universe.

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| ACTIVITY | POSSIBLE STRATEGY |
| Teacher introduces the notion of how the Universe began by asking questions, such as:* How did the Universe begin? Likely answers include ‘Big Bang’ or ‘an act of creation’.
* What happened after the Big Bang?
* Is there any evidence today that the Big Bang occurred?

Teacher explains that information in this presentation is the best explanation we have of the history of the Universe, that is supported by scientific evidence. | whole class, teacher- directed questioning |
| Teacher shows slides 1–7, then pauses for students to discuss any questions about what the Big Bang was, and what it wasn’t.Teacher shows slides 8–11 on the evolution of fundamental interactions. The presentation could be stopped at this point to allow a discussion of interactions and forces, such as how these fundamental interactions explain pushes and pulls, magnetic attraction and electrostatic forces in everyday life.Teacher shows slides 12–17 on the evolution of matter, including quarks, leptons, hadrons, matter and anti-matter, through to the formation of deuterium and helium nuclei, and eventually stable atoms of hydrogen and helium. | small group discussion or whole class sharing of ideas |
| The presentation could be stopped at this point to allow a discussion of the evolution of matter, or to consolidate students’ understanding of the Standard Model of particle physics.Slides 18–22 describe the formation of stars, galaxies and Solar System, and briefly touches on the synthesis of elements, from carbon to iron, by fusion of lighter elements. | group activity |
| Teacher distributes the fact sheet, *Timeline of the Universe*. |  |

ast0701 | Cosmology 1: History of the Universe (teachers guide) developed for the Department of Education WA

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| SLIDE | NOTES |
| 7 | The Planck era (the first 10−43 seconds after the Big Bang) is the earliest period in the history of the Universe during which quantum effects of gravity were significant. Planck time (approximately 10−43 s) is thought to be the shortest interval of time that could be measured.As of 2010, the shortest time interval measured directly was about 10−17 s (about 1026 Planck times).Research into the timeline of events that followed the Big Bang provides a range of responses, which while generally supporting a consistent sequence of events, frequently differ in their timing — especially during the first 10 seconds or so. This presentation has drawn together information from a number of sources into the sequence presented in [http://en.wikipedia.org/wiki/Timeline\_of\_the\_Big\_Bang.](http://en.wikipedia.org/wiki/Timeline_of_the_Big_Bang) |
| 8 | Any force you can think of, whether it’s friction, magnetism, gravity, or nuclear decay, is caused by one of the four fundamental interactions: gravity, electromagnetism, the strong and the weak interactions.* Gravity is an interaction that exists between all matter in the Universe.
* Electromagnetism determines how electrically charged particles interact with each other and with magnetic fields.
* The strong interaction holds quarks together in protons and neutrons. Residual strong interactions hold the nuclei of atoms together by overcoming electrostatic repulsion between protons.
* The weak interaction is responsible for radioactive decay of some nuclei by controlling the beta decay process in which neutrons split into protons, electrons, and antineutrinos.

What is the difference between a force and an interaction?* A force is the effect on a particle (attraction, repulsion) due to the presence of other particles.
* An interaction includes all forces that affect a particle, and any decays and annihilations that it may experience.

While some interactions give rise to conventional forces they don’t always do so. For example, the weak interaction never gives rise to forces – it simply mediates nuclear decay. Similarly, the electromagnetic interaction sometimes is responsible for phenomena that aren’t forces, such as when an electron and a positron annihilate to produce two photons. |
| 9 | 10−43 seconds after the Big Bang, gravity separated from the unified interactions. Grand Unified Theory (GUT) describes interactions between electromagnetism, the strong and the weak interactions. |
| 10 | The GUT era ended when the strong interaction separated from the electromagnetic and weak interactions, 10−35 seconds after the Big Bang. Separation of the strong interaction set off a rapid expansion (inflation) of the Universe.Inflation theory was developed in the 1980s to explain how very distant parts of the Universe could once have been in close contact. It proposes that the linear size of the Universe expanded by a factor of 1025 in a fraction of a second. Inflation theory is considered to be an extension of Big Bang Theory. |
| 11 | 10−12 seconds after the Big Bang, the final separation occurred. The four fundamental interactions were now distinct, as they remain to this day. |
| 12 | For further information on the Standard Model and sub-atomic particles, including hadrons, quarks, leptons, neutrinos and a range of anti-particles, see the SPICE resource, *Matter and relativity 1: Quarks*. |
| 15 | The annihilation of an electron and a positron creates two gamma ray photons. |
| 17 | Some photons from this era are still evident in the Universe today in the form of cosmic microwave background radiation (CMBR). For more information on CMBR, see the presentation in the SPICE resource, *Cosmology 2: Evidence for the Big Bang*. |

# Technical requirements

The guide and fact sheet require Adobe Reader (version 5 or later), which is a free download from [www.adobe.com.](http://www.adobe.com/) The presentation is provided in two formats: Microsoft PowerPoint and Adobe PDF.

# Image credits

Presentation, *History of the Universe*

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* Albert Einstein, photo by Ferdinand Schmutzer, commons.wikimedia.org/wiki/File:Einstein1921\_ by\_F\_Schmutzer\_2.jpg

# Associated SPICE resources

*Cosmology 1: History of the Universe* may be used in conjunction with related SPICE resources to address cosmological concepts within the broader topic of Unit 3BPHY: Particles, waves and quanta.

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| 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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In preparing these SPICE resources, the resource Cosmology: The Study of the Universe from the Wilkinson Microwave Anisotropy Probe has been used as a significant source. These materials can be found at [http://map.gsfc.nasa.gov/universe/.](http://map.gsfc.nasa.gov/universe/)

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