

Topic Overview

Background and suggested aims

Aims

- To support teachers in presenting the scientific aspects of the Big Bang theory to students;
- To encourage cross-curricular links with RS and Philosophy;
- To encourage teachers and students to discuss and debate the significance of the scientific account of the creation of the universe and the deep questions related to it.

Lesson summary

Lesson	Content summary	National Curriculum links	Activities
Lesson 1: <i>Basic Astronomy</i>	Content summary. Overview information about our solar system and the galaxy.	Space Physics: the main features of the solar system.	PowerPoint – basic Astronomy.
Lesson 2: <i>Evidence for the Big Bang 1</i>	Evidence for the Big Bang – redshift, helium production, cosmic microwave background.		PowerPoint – The Big Bang.
Lesson 3: <i>Evidence for the Big Bang 2</i>	Discussion of the evidence for the Big Bang, and wider issues.		Discussion.
Lesson 4:	Discussion groups with RS and Philosophy classes.		Discussion with other classes.
Lesson 5:	Discussion groups with RS and Philosophy classes.		Discussion with other classes.

Background

Science syllabuses suitable for students in Years 9 - 11 generally have two basic aims:

1. To support and prepare students who wish to go on to study science at a more advanced level;
2. To educate students in science to a level expected of a well-educated workforce and effective members of society.

When considering the second of these aims, it is helpful to itemise the 'grand stories' of modern science. In such a list, we would expect to see the genetic basis of inheritance, the theory of evolution by natural selection, the atomic theory of materials, the nature of chemical reactions, the nature of force and movement and the modern understanding of the creation of the universe.

The Big Bang theory is the widely accepted framework for understanding the creation of the universe. Convincing observational evidence exists for accepting the basic tenets:

1. The universe has existed for a finite period of time.
2. The early universe was radically different to that we observe today.
3. The universe has evolved from an essentially simple initial state, forming complex structures along the way.
4. Observing the modern universe gives us clues as to the manner in which it evolved.

Students should be familiar with this as part of some GCSE syllabuses, but outside of that basic factual knowledge, this topic raises profound questions. Some students of this age will be contemplating such basic questions of existence as part of their maturing outlook on life. All young people should have the opportunity to hear and engage with sensible debate on such topics. In the context of physics, teachers may not have confidence in their philosophical knowledge to support such debate. In RS & Philosophy, teachers may not be sufficiently familiar with the scientific ideas to be able to discuss them with fluency. This topic aims to bridge the gap between the two camps and equip teachers and students to discuss their views.

Teacher background knowledge

The three interconnected pieces of evidence for the Big Bang are:

1. The expansion of the universe demonstrated by Hubble's law.
2. The abundance of helium in the universe is too great to be explained by fusion inside stars and requires a hot, dense early state of the universe to account for its formation.
3. The existence of the Cosmic Microwave Background radiation points to a hot dense early phase of the universe with matter and electromagnetic radiation.

Some teachers may not be completely familiar with the Big Bang theory and the evidence that has led to its adoption. The resources for this topic include reference material that will support teachers in refreshing and expanding their knowledge to a level somewhat beyond that needed for the GCSE syllabuses. Also included are PowerPoint presentations that can be used in lessons.

Cross-curricular links

Creation is a common topic on RS & Philosophy courses. Some students will be doing GCSEs of this type along with science, and so will naturally have questions and an interest in how the scientific and theological accounts relate to each other. This is also fertile ground for debates and discussions in co-curricular settings. If possible, classes can be joined for discussions around this topic.

It should be emphasised that the scientific account neither confirms nor denies basic religious beliefs. This point can be made on practical grounds (scientists are no more/less likely to be believers than non-scientists) and on philosophical grounds (the word 'creation' takes on different roles in different contexts).

Student background knowledge

In order to tackle this section of the syllabus, students should have covered the following:

- The electromagnetic spectrum, the existence and properties of microwaves and gamma rays;
- Wavelength, frequency and speed of electromagnetic waves;
- Some familiarity with the fusion of light elements into heavier elements inside stars (details of the process are not required);
- Basic motion equations of speed, distance and time;
- Gradients for linear graphs.

Resources

For teachers:

A series of support documents to aid teachers who may not have studied the latest thinking about the Big Bang, or who need a refresher:

- Teacher Support 1 – Cosmological Redshift
- Teacher Support 2 – Cosmic Microwave Background
- Teacher Support 3 – Helium in the Universe

Resources for discussion preparation:

Documents that support science teachers in providing philosophical answers to questions that may come up from students in discussion:

- Teacher Support 4 – Snappy Answers to Rather Profound Questions 1: Physics
- Teacher Support 5 – Snappy Answers to Rather Profound Questions 2: Philosophy & Theology

Lesson resources:

Presentations that can be used in lessons to deliver syllabus content and preparation resources for encouraging discussion lessons:

Lesson Resource 1 – PowerPoint Basic Astronomy

Lesson Resource 2 – PowerPoint The Big Bang PowerPoint

Lesson Resource 3 – Discussion Topics

For students:

Some worksheets for students to answer questions during the presentations. There is also a sheet containing some discussion prompts for groups working on specific questions:

- Student Resource 1 – Questions on the Basic Astronomy PowerPoint
- Student Resource 1a - Questions on the Basic Astronomy PowerPoint (answers)
- Student Resource 2 – Questions on the Big Bang PowerPoint
- Student Resource 2a – Questions on the Big Bang PowerPoint (answers)
- Student Resource 3 – Discussion Hints

Activities

The following notes are based on lessons of approximately 50 minutes' duration.

Lesson 1: Basic Astronomy

The PowerPoint 'Basic Astronomy' provides an overview of our solar system and some brief information about the Milky Way and beyond. It is designed to be used in a lesson and a student worksheet is provided that contains questions for the students to answer as the PowerPoint is progressing. An answer sheet is also provided.

Lesson 2 / 3: Evidence for the Big Bang

The PowerPoint 'The Big Bang' presents the three pieces of evidence for the Big Bang. Teachers can adapt the level of detail that they require by hiding some of the slides if they are not needed. A student worksheet with questions (and an answer sheet) is also provided for use with this PowerPoint.

This topic is intended to stimulate discussion between students and staff. To that end, teacher resources are provided to illustrate possible answers to typical questions that the students might pose. One of the resources deals with questions related to the science of the Big Bang and another some of the potential philosophical/religious issues. There is enough material in this aspect of the subject to extend over two lessons, especially if follow-up practice exam-style questions are explored as well.

Lesson 4 / 5:

While this is characterised as a lesson(s), a less formal structure could be adopted by holding a discussion group / club in an extra-curricular slot. It would be advantageous to have members of the teaching staff from RS / Philosophy present as well.

The students could be divided into groups and specific discussion topics posed to them. Suggested topics can be found in Lesson Resource 3 – Discussion Topics. There is also Student Resource 3, which has the topics, but with some additional associated talking points to trigger the conversations. Each group could be set a specific topic to discuss and feed back to the rest of the class. Discussion can be further promoted by teachers

moving from group to group and making suggestions. Students could be set the topics beforehand to give them an opportunity to carry out some independent research in order to be better prepared.

One lesson / meeting should be spent with the groups discussing and coming to conclusions, followed by a separate lesson where feedback is given, and further comments are made.