

Cosmic String: Cosmological Time in Perspective

The analogies most often used to convey to students the vastness of space and time often fail to impress – despite the best efforts of the instructor, they are difficult to visualize and easily go over students' heads. This hands-on exercise is designed to help students gain a more concrete picture of the timescale of the universe and see for themselves what scales we deal with when discussing the history of Earth and the Universe.

Supplies needed: Long roll of string (200 ft in this example), tape, metersticks, rulers.

Exercise

Unroll the string and wrap it around the edges of the room, taping to the wall as you go along. (At 61 meters it should wrap around the room at least a couple times.) Explain that the string is a "timeline" representing the history of the universe, with the Big Bang at one end and today at the other.

With the scene set, distribute to students on a handout (or write on the board) the time before present that several important events occurred. Examples (with corresponding model distances) might be:

- 13.8 billion years – Big Bang
- 13 billion years – first galaxies and globular clusters
- 4.75 billion years – beginning of contraction of Solar nebula
- 4.55 billion years – formation of Solar System and Sun
- 4.45 billion years – formation of Earth
- 4.2 billion years – volcanism begins on Moon
- 3.9 billion years – era of heavy meteor bombardment in inner solar system ends
- 3.8 billion years – earliest evidence of life
- 3.5 billion years – earliest fossils
- 3.1 billion years – geologic activity ceases on Moon
- 2.5 billion years – first eukaryotes
- 540 million years – Cambrian explosion: appearance of modern life
- 420 million years – First land plants
- 370 million years – First vertebrates on land
- 250 million years – Permian extinction
- 220 million years – First dinosaurs
- 65 million years – K-T extinction (dinosaurs and others), due to meteor impact
- 2 million years – Early hominids appear
- 10,000 years – Beginning of modern civilization

(These dates are approximate, only meant for helping students get a feeling for scale. If exact dates are important to the curriculum, important events should be researched individually to find a more accurate figure.)

You can write the names of these events on pieces of tape or other "attachables" and distribute them to groups of students around the room, and ask them to place them on the diagram at the appropriate points. Provide one or more metersticks and rulers. (This will require that the students understand scale models; you may need to help them with their calculations. Providing stickers for billion-year increments will probably help streamline tag placement.)

For a 61 m roll, Earth's history will last about 20 meters, hopefully less than one "wrap" around the room, and the Phanerozoic (from the Cambrian explosion on) will occupy 2.3 meters – conveniently about the length of an ordinary chalkboard, which would be a good place to affix that portion of the string. The dinosaurs went extinct 28 cm from the end, and hominids appeared with 1mm remaining. Modern history doesn't even register.

In addition to simply demonstrating the vastness of time, several other useful points can be taken away from this diagram: how quickly the Sun forms relative to how long it lives, the rapidness which with life arose after the end of meteor bombardment, the very long duration between the formation of life and "modern" life, the long duration of the age of dinosaurs relative to the amount of time since then. As this exercise is perhaps best for use very early in the semester it may not be worth emphasizing any of these facts in detail.

Alternate demonstration: Cosmic distance scales. The immense distance to the stars can be easily demonstrated – if the entire roll is the distance to Sirius, the distance from Earth to the Sun is 0.1 mm!