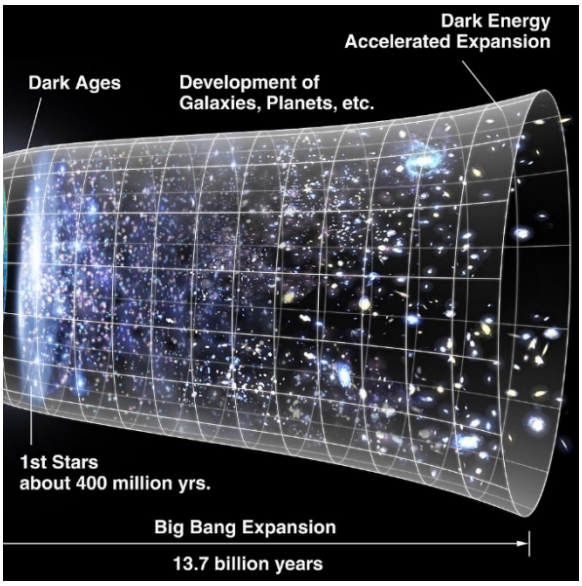
Composition of the Universe

Demonstration

This demonstration briefly explains the history of the universe using jars and colored beads. The jars represent matter/objects and the beads represent the composition of those objects.



NASA/WMAP Science Team

Number of Participants: 1-10

Audience: Middle School (ages 11-13) and up

Duration: 10-20 minutes

Difficulty: Level 1

Materials Required:

- 4 clear jars or containers with tight lids
- Small, identical, and colorful items, such as beads, to represent different elements in the following proportions:

Universe 10^{-12} s	**Universe 10 s**	**Sun**	**Human**
100% - elementary particle soup	75% – Hydrogen 25% – Helium	91.2% – Hydrogen 8.7% – Helium 0.1 % – Other	65% – Oxygen 18% – Carbon 10% – Hydrogen 7% – Other

Setup:

1. Fill one of your jars completely with a single color of your items. Pour out and use a scale mass this quantity of beads.
2. Based on the proportions above, measure an appropriate ratio of colorful items for each jar, as seen in Figure 1.
3. Print and affix the attached labels.

Presenter Brief:

Presenter should have an undergraduate-level understanding of these cosmology topics: the big bang, expansion, dark matter and dark energy, and star formation.

Physics & Explanation:

Middle School (ages 11-13) and general public:

Shortly after the big bang, the universe was extremely hot and dense – a plasma of elementary particles. It wasn't until the universe cooled that atoms could form. Once cooled, the universe was composed of about 75% hydrogen, 25% helium.

Show the "Universe 10^{-12} s" jar and the "Universe 10 s" jar.

After 380,000 years, matter was free to move under the influence of gravity. This matter cooled and formed large clouds which continued to collapse under gravity to form proto-stars. Once nuclear fusion begins, the proto-star becomes a star as the hydrogen is fused into helium.

A small star like our sun is made of about 91% hydrogen, 9% helium, and small traces of other elements like oxygen, carbon, nitrogen, silicon, magnesium, neon, iron, and sulfur. However, the elements heavier than hydrogen were not created in our sun. These elements were fused in larger stars and blasted through space in supernovae.

Show the "Sun" jar.

The most abundant elements assemble into molecules like water. Material combines to form more stars and even planets. Everything on Earth is composed of elements produced in stars. Humans are composed of 65% oxygen, 18% carbon, 10% hydrogen, 3% nitrogen, and 4% other elements.

Show the "Human" jar.

🔑 The atoms we're made of were created in the big bang and in stars.

Additional Resources:

- The Star In You – NOVA http://www.pbs.org/wgbh/nova/space/star-in-you.html
- Seeds, Michael A. *Foundations of Astronomy*, 2003.
- Kay, L., Palen, S., Smith, B. Blumenthal, G. *21st Century Astronomy*, 2013.