Simulating our Universe with a Balloon

Our Sun is just another star.

Stars group together to form galaxies.

Galaxies are moving away from each other.

(The only exceptions are galaxies so close to each other that the gravity between them is strong enough to keep them together.)

As our universe ages, all points in three-dimensional space get farther away from each other.

That means our universe is expanding through time.

Our universe has no edge or centre in space, only a beginning in time.

1

A 2-D Universe on the Surface of a Balloon

A balloon universe has two space dimensions (the surface of the balloon) and one time dimension (running from the centre of the balloon outward).

As the balloon universe ages, all points in its two-dimensional surface get farther away from each other: the balloon is expanding through time.

The start of time (the Big Bang) was when all points in this universe were infinitely close to each other.

This universe has no edge or centre, only a beginning in time.

2

Activity: A Balloon Universe

For your universe, you will need:

A balloon (lighter colours are best)

Confetti (the lighter the confetti, the better)

A marker

A ruler

Each balloon is a two-dimensional universe.

The confetti pieces are galaxies in those universes.

3

Create Your Balloon Universe

Place confetti on desk, table, plate or shallow bowl.

Inflate the balloon, and hold it closed.

Rub balloon on your hair about 10 times, slowly, to build up static electricity on the balloon.

Roll balloon over confetti; confetti will stick.

Gently deflate the balloon.

Now inflate the balloon again and watch: confetti pieces stay the same size, but move farther apart, just like galaxies in our own universe.

4

Viewing and Studying Your Expanding Universe

Make sure a few galaxies are visible to you as you blow up the balloon. **Focus on one galaxy**, and you will see all other galaxies moving away from it. **Focus on a different galaxy**, and you will see all other galaxies moving away from your new galaxy!

If a universe started contracting (shrinking):

what would galaxies do?

what would happen to the wavelength of light?

Make predictions for the above, then slowly deflate the balloon and watch what happens.

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Additional Activities with Your Balloon Universe

Draw a wave on the balloon: ~~~~ …as the balloon expands, the wave stretches with it.

In our expanding universe, light does the same thing: its wavelength increases with time.

To measure distances between confetti-galaxies, inflate balloon to small and large sizes. At each size, measure distances between two pairs of galaxies. For each pair, divide the large-size distance by the small-size distance to get an expansion ratio. How do the expansion ratios for each pair compare?

6

Lessons for our Universe

In our experiment, we imagined that the 3rd space dimension was actually the time dimension.

The balloon expands in time.

At the beginning of time, all points in an ideal balloon universe were infinitely close to each other, and the same is true in our universe.

We call that point in time the **Big Bang**.

The Big Bang was a point in time, not in space.

That means the Big Bang took place everywhere in space at the same point in time!

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