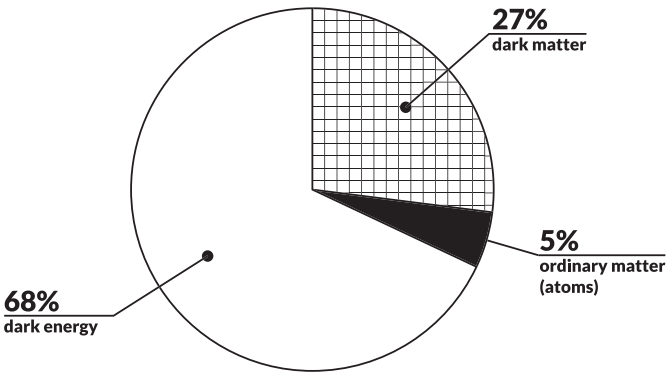
70 YEARS / ANS CERN

COMPOSITION of the Universe

INGREDIENTS



Scientists discovered that the universe is made of three main ingredients: ordinary matter, dark matter, and dark energy. While we understand ordinary matter rather well, the two latter ingredients are still mysterious.

Ordinary matter consists of quarks and electron-like particles, which are the constituents of atoms that make up stars, planets, human beings and every other visible object in the universe.

Dark matter is a still unknown form of matter, only similar to ordinary matter in that it gravitationally attracts other objects. Dark matter does not emit or absorb light (hence its name). By studying the Milky Way and many distant galaxies, scientists found that the gravitation of visible matter alone cannot account for how fast stars rotate in them.

Dark energy is an unknown form of energy that causes the universe to expand at an increasing rate. Dark energy is sprad out uniformly in empty space and works against the pull of gravity.

HOW TO BAKE A UNIVERSE

Preparation time: 13.8 billion years

1. Prepare an extremely hot and dense soup of quarks and electron-like particles and let it expand. Wait 13.8 billion years, while watching how this soup becomes our universe today.
2. While the space expands very rapidly, the cosmic soup starts to cool. In the first fraction of a second, quarks bind in groups of three to form protons and neutrons.
3. During the next 3 minutes, some of the protons and neutrons stick together to form very light nuclei (mainly helium, but a few others too).
4. Now you have to wait about 370,000 years (patience!) until the universe has cooled to about 4000 degrees. The positively charged protons (as well as the helium nuclei) bind with electrons to form hydrogen (and helium) atoms.
5. This mixture, hitherto opaque, starts to glow as bright as our sun: since all charged particles are bound in (neutral) atoms, radiation can roam freely. Over the next billions of year, this radiation will turn into a much less energetic microwave radiation (the 'cosmic microwave background', corresponding to a very cold 'oven' at a temperature of 2.7 degrees above absolute zero).
6. Now wait for about 200-300 million years (even more patience!) to see how gravity pulls clouds of hydrogen and helium atoms together to form the first stars.
7. Inside these stars, the temperature is so high that nuclei of hydrogen and helium can fuse together to form heavier elements. At the end of their life, stars die in giant explosions, and even heavier element are produced and are ejected, forming nebulae of cosmic dust.
8. These dust nebula are breeding grounds for a new generation of stars. During their formation, they also produce disks of matter containing many elements that are the building blocks of planets. Some of these planets may provide the conditions for the evolution of life, such as our Earth formed about 4.5 billion years ago.

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Universe chocolate cake

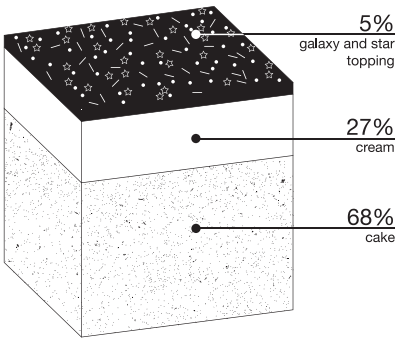
INGREDIENTS

CAKE

4	large eggs
120 g	sugar
105 g	flour
10 g	potato starch
4 g	baking powder
25 g	cocoa powder

CREAM

210 g	66% dark chocolate
120 g	cream
120 g	milk



Baking a cake is considerably easier than baking a universe: all ingredients are made of ordinary matter and are readily avaible; the preparation time is much shorter, and you can start the recipe at room temperature.

There are four typical main ingredients for a cake: structure building flour and eggs, structure-weakening butter and sugar. Eggs are 75% water and provide much of the moisture, but milk (or buttermilk) may be included as well. The mixing process produces many small air bubbles trapped in the batter. Some recipes suggest adding baking soda, which reacts with the acid (eg. in buttermilk) to produce more gas (carbon-dioxide) bubbles.

So what happens after the batter is put into the oven?

1. As the temperature climbs, the air bubbles captured in the batter expand and the baking powder starts producing carbon dioxide which makes expand the cake butter (quite analogous to the dark energy making the universe expand). Above 70°C, water starts to steam off rapidly, inflating the bubbles further.
2. At 80°C, egg proteins unwind and reform into a firm gel. They provide the brackets that give cake its texture and chew.
3. Between 80-140°C, starches in the flour soak up water, making the cake's soft crumb.
4. Above 140°C, sugar and proteins react through Maillard* reactions and produce the golden-brown crust of the cake. Water escapes and egg proteins shrink, causing the cake to reduce in size. At 160°C, sugars on the surface start to caramelize (nutty flavour), but at 180°C, the surface starts to burn (timing is important).

CAKE

1. Heat oven to 170°C. Butter the base and sides of sandwich tin and line the base with baking parchment.
2. Whisk the eggs and the sugar together over a bain-marie until the temperature reaches 70°C, continue whisking the mixture diligently until it cools down.
3. Mix in all the other ingredients and pour the batter into a cake form.
4. Bake for 20 mins or until a skewer inserted into the centre of the cake comes out clean.
5. Leave to cool in the tin for 10 mins, then turn out onto a wire rack to cool completely.

CREAM

6. Bring the milk and cream to the boil and pour it over the chopped chocolate, mix well and leave the mixture cool down completely.
7. Whisk the cream until it forms soft peaks.
8. Spread the cream on top of the cake.galaxy and star topping