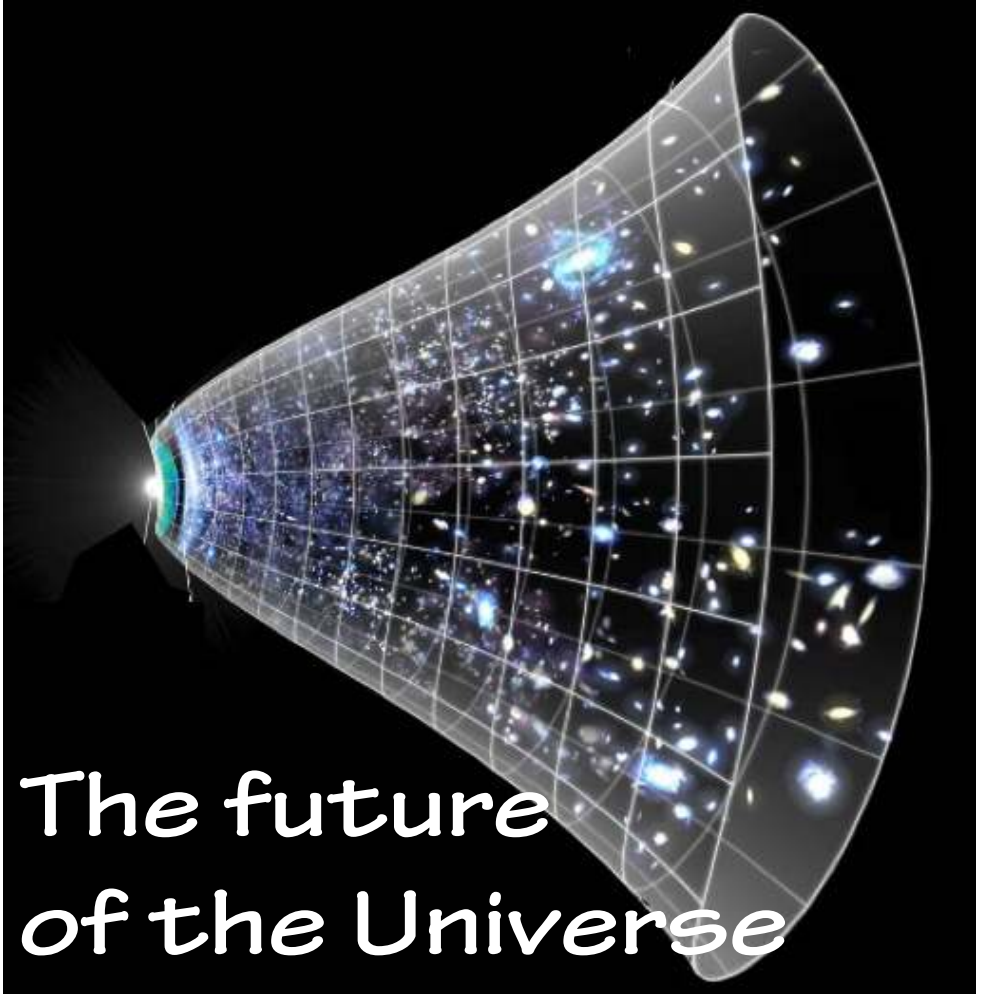


The Universe in my pocket



The future
of the Universe



Julieta Fierro
Institute of Astronomy,
UNAM, México



What would you think if someone told you that with this series of images they could predict your future? And what if later, someone else made the same offer, to foretell your future. It is possible that each

person would make up a different story for you. You might even make up a new one yourself, depending on your mood.

(Denise Linn/JF) 2

Predicting the future

For centuries humans have wanted to predict the future. All the great cultures devised ways to do so. For example, the ancient Greeks turned to the oracle at Delphi for a wide range of predictions; for example, a general might want to know if he would be victorious in battle.

There are people who believe that by reading cards or the wrinkles in the palm of their hand they can know what will happen to them in the future.

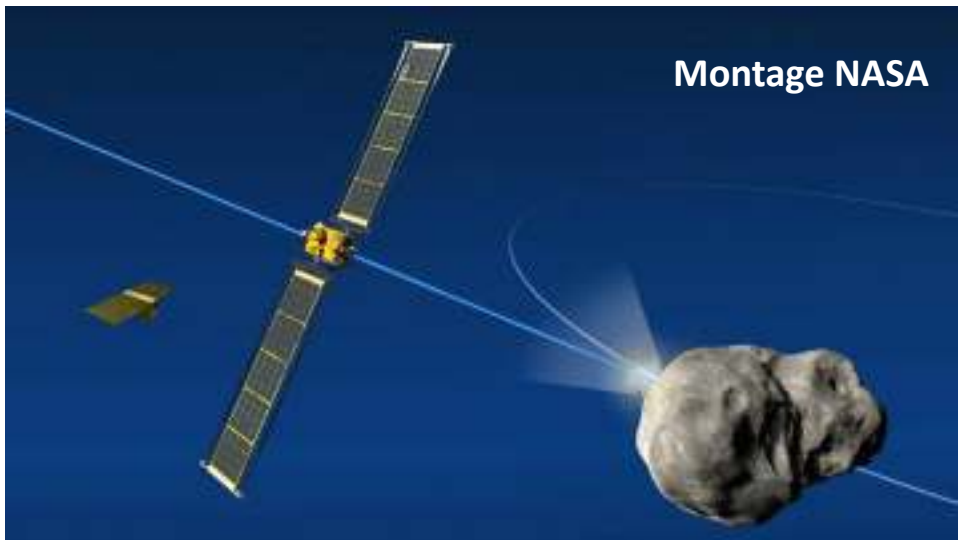
In general, these supposedly divinatory practices end up comforting people and do not predict anything concrete.

In contrast, science can predict many things with great certainty, for example how fast a parachutist will fall or where a thrown ball will land?



Illustration Gaceta UNAM

The impact of an asteroid on Earth caused the extinction of the dinosaurs.



Montage NASA

NASA succeeded in deflecting an asteroid from its orbit through an impact.

Asteroid impacts on the Earth

You may have heard that the extinction of the dinosaurs was caused by a huge asteroid colliding with the Earth 70 million years ago. The impact was so powerful that it created huge tsunamis and our planet was covered by a thick layer of dust from both terrestrial and asteroid fragments pulverised during the impact.

Now we worry that something similar might happen in the future. That is why astronomers constantly monitor the skies to see if any asteroids or comet nuclei will hit us (see TUIMP 21).

Science can help us to prepare for adversity. NASA has already succeeded in deflecting an asteroid from its orbit.



Model of the Templo Mayor. In the past, different cultures were concerned that the Sun might be extinguished.

For example, the Mexica of pre-Hispanic Mexico thought that to avoid this, every 52 years a new pyramid layer had to be built on top of the previous layer.



NGC 7293 NASA/ESA/HST



NGC 6720 ESA/Webb

In about 5 billion years the Sun will become a nebula similar to those in the images above.

What if the Sun goes out?

Ancient cultures thought that the Sun could be extinguished, for example, during eclipses (see TUIMP 28).

We now know that it will shine for another 5 billion years or so (for more about the Sun see TUIMP 26). Later it will become a planetary nebula (see TUIMP 36).

The Sun will grow in size and shed its atmosphere, which will then move out into space until it mixes with other clouds of gas and dust, where new planetary systems may form. The core of the Sun surrounded by this expanding envelope will be about 40 000 °C and slowly cooling. Perhaps by then humans will have evolved into another species.



When the Sun is in the planetary nebula phase the Galaxy will merge with the Andromeda Galaxy. The montage of images above shows how this merger might begin (NASA; ESA; STScI).



Images of galaxies in the process of merging. Left: The antennae galaxies. Right: NGC4676A and B. With powerful modern telescopes it has been possible to find hundreds of similar galaxy mergers.

The future of the Galaxy

Our Galaxy will merge with the Andromeda Galaxy in about 4.5 billion years. Very few stars will collide with one other because the distances separating them are immense. On the other hand, clouds of gas and dust will form clusters where there will be bursts of star formation.

We know when the Milky Way and Andromeda will merge because we know how fast they are approaching each other and we know the distance between them.

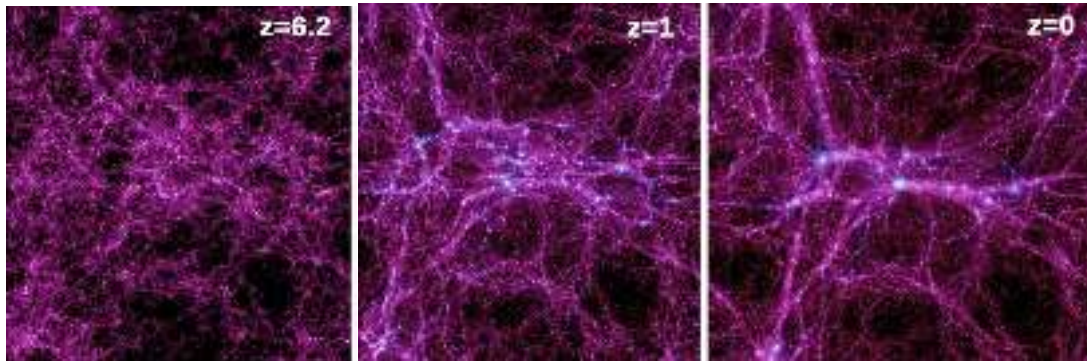
Many galaxy mergers have been observed, some are only now approaching each other, while others are in full collision, forming a new, huge galaxy.

Gradually the gas where new stars form will be used up and the galaxy resulting from the merger will have mostly old stars. 9



DESI/NSF

This is how the cosmic web looks in a section of the sky, when observed from Earth. The part closest to Earth is in blue. At the far side, galaxies formed when the Universe was 10 billion years old.



Numerical simulations of the cosmic web at different ages of the Universe (one thousand, three thousand and 13.7 billion years). The gaps are seen to increase in size as time passes.

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(Millenium Simulation)

The cosmic web

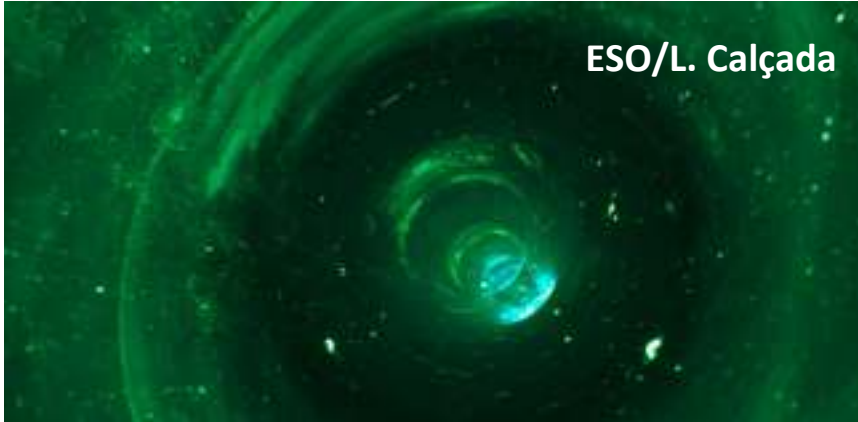
There are over one hundred billion galaxies; on average each one has a hundred billion stars. They are distributed in the 'cosmic web' which is made up of a series of filaments and walls where matter clumps together. The stars and clouds of gas and dust that form the cosmic web make it shine. In the gaps of the web there are almost no stars (see TUIMP13).

It is possible to measure the speed of groups of galaxies and this shows that they are moving away from each other faster and faster. In other words, the cosmic web is expanding more and more rapidly as the Universe evolves. As time goes by, the gaps without matter become larger and larger.



Drawing Detlev Van Ravenswaay

It is possible that parallel universes exist: structures in other spaces and times that may be similar - or totally different - from our own.



ESO/L. Calçada

This drawing depicts a wormhole, a shortcut in space-time that, according to Einstein's general theory of relativity, could exist. Wormholes are popular in science fiction.

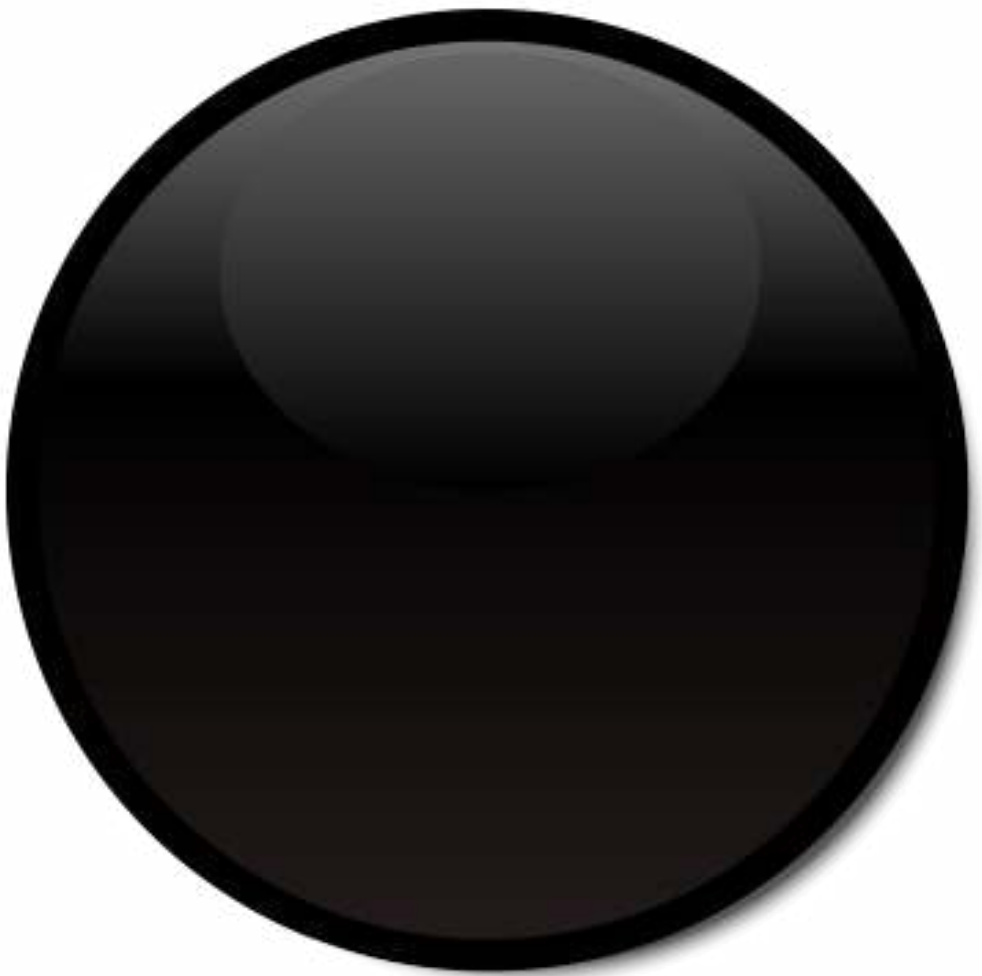
The future of the Universe

If the Universe continues to expand faster and faster it will be dilating forever.

It will get colder and colder and the time will come when all the stars run out of fuel and shut down and there will no longer be enough clouds of gas and dust for new stars to form.

But this will take a long time to happen. It is possible that, as is often the case in science, what we think today will change, and that astronomers in the future will find new explanations for understanding the evolution of the Universe.

In fact, some scientists think that parallel universes may exist, totally disconnected from our Universe - or possibly connected to it by "wormholes".



Riddle

Why is the Universe
thought to be dark in
the distant future?

Answer on page 15



Is it because there will be more starlight-absorbing dust as in this black cloud?



Is it because there will be more black holes like the one in the centre of this image (this image actually represents matter very close to a black hole and NOT the black hole).

Answer

It will be because all the stars have gone out. The Universe will have finished its evolution.

The Universe in my pocket number 37

The author of this booklet is Julieta Fierro from the Instituto de Astronomía de la UNAM in Mexico. The booklet was reviewed by Stan Kurtz (UNAM, Morelia) and Grażyna Stasińska (Paris Observatory).

The cover image, from NASA, depicts the timeline of the expansion of the Universe, where space is represented at each moment by the circular sections. It is an artistic concept; neither time nor size is to scale.



To find out more about this series and the topics presented in these booklets, you can consult <http://www.tuimp.org>.

Translation: Stan Kurtz
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