The changing colours of the universe

April 28 2014, by Michael J. I. Brown

A Hubble Space Telescope image of the distant universe.

We know we live in an expanding universe but it's also changing colour and has been doing so for billions of years.

Take a look at a Hubble image of the distant universe and you will see hundreds of galaxies that come in a variety of shapes and colours. So what are we seeing?

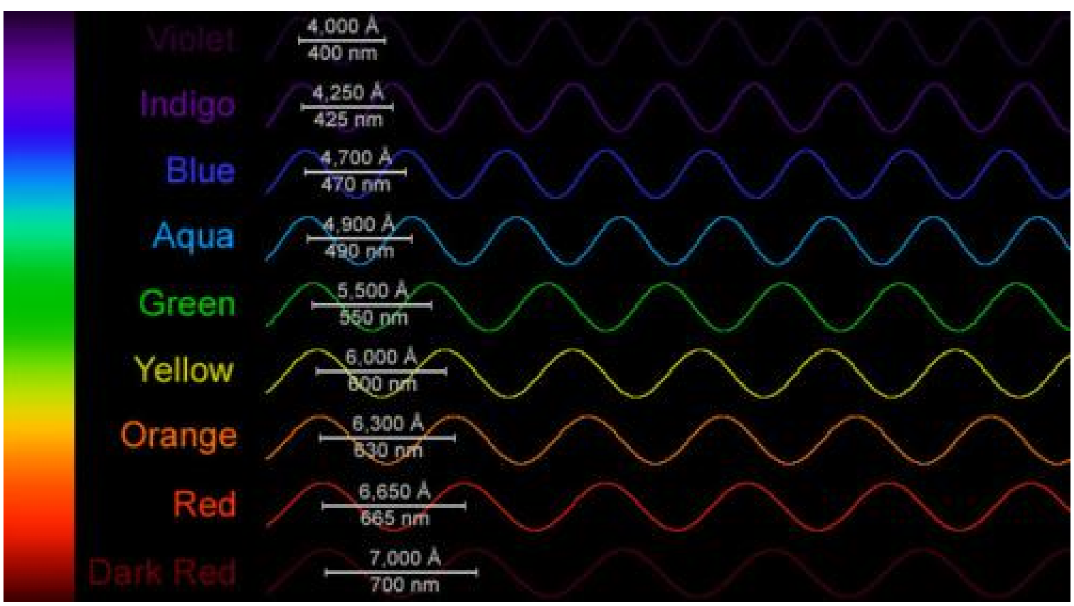
Stretching light

In our expanding universe, galaxies are rushing away from us at vast speeds. Nearby galaxies, only millions of light years from Earth, are speeding away at hundreds of kilometres every second. More distant galaxies, billions of light years away, are rushing away at speeds in excess of 100,000 kilometres every second.

A natural consequence of this rapid expansion is the stretching of light via the Doppler Effect.

This stretching of light is similar to the stretching of sound waves here on Earth. The pitch of the sound from a motorcycle is lowered as it moves away from you. Just as sound waves are stretched (lower pitch) as a motorcycle races away, the light waves are stretched (redder light) as a distant galaxy races away.

When we look at distant galaxies, we are looking into the past, as light can take billions of years to travel across the universe. This presents an opportunity for astronomers to directly observe the ancient universe.



The wavelength of light (measured here in Angstroms and nanometres) varies with colour. The expanding universe can stretch blue light so it is received as red light on Earth. Credit: Windows to the Universe/Randy Russell.

But the Doppler Effect presents a problem. When we take a visible light image, we can detect ultraviolet light from the most distant galaxies that has been stretched (by the expanding universe) into the visible part of the spectrum.

Astronomers using visible light images to study nearby and distant galaxies thus risk comparing apples and oranges when trying to understand how the universe evolves.

A GALEX ultraviolet image of the Whirlpool galaxy Messier 51. The appearance of galaxies in the ultraviolet differs from what we see in visible light. Credit: NASA/JPL-Caltech/Michael Brown

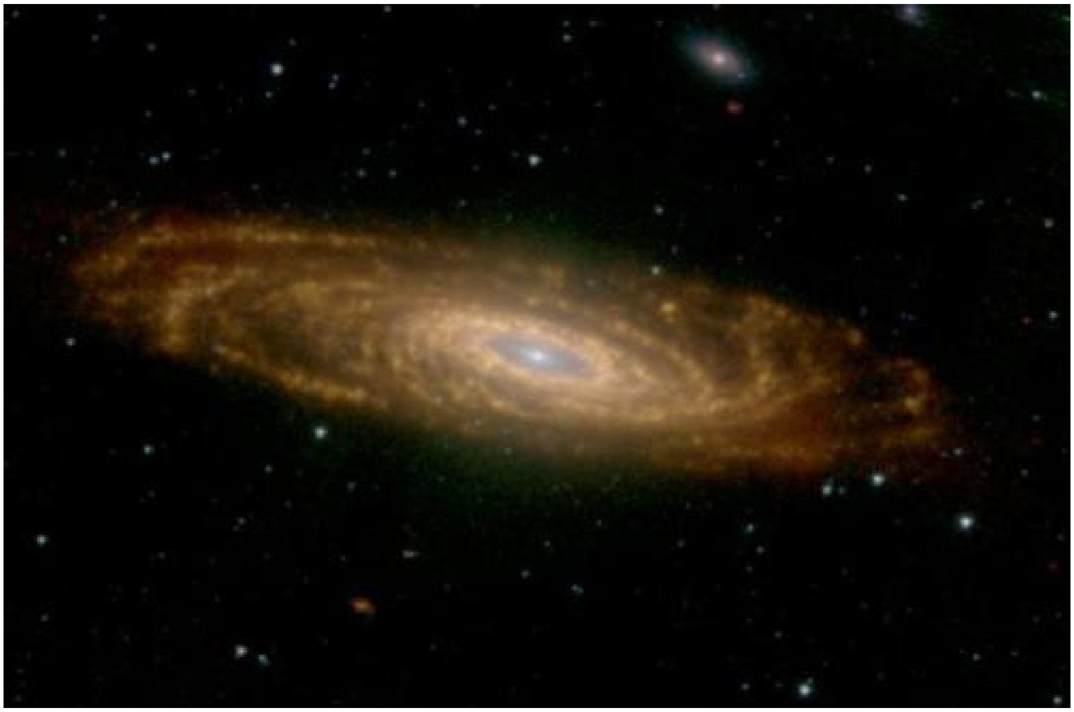
This visible light image of Messier 51 shows details that are obscured by dust in the GALEX ultraviolet image. Credit: Sloan Digital Sky Survey/Michael Brown

We need a Galaxy Atlas

If you precisely measure the light emitted by galaxies across the spectrum (including the ultraviolet, visible and infrared light) you can can correct for the Doppler Effect. You can also compare light from nearby and distant galaxies that was emitted in the same part of the spectrum of light.

Collaborating with colleagues from across the globe, I have produced a new atlas of 129 galaxies that includes images and spectra taken in ultraviolet, visible and infrared light. Our atlas will be published in the May volume of the Astrophysical Journal Supplement Series.

As ultraviolet and infrared light is largely blocked by our atmosphere, the atlas incorporates data from the GALEX, Swift, Akari, WISE and Spitzer spacecraft.

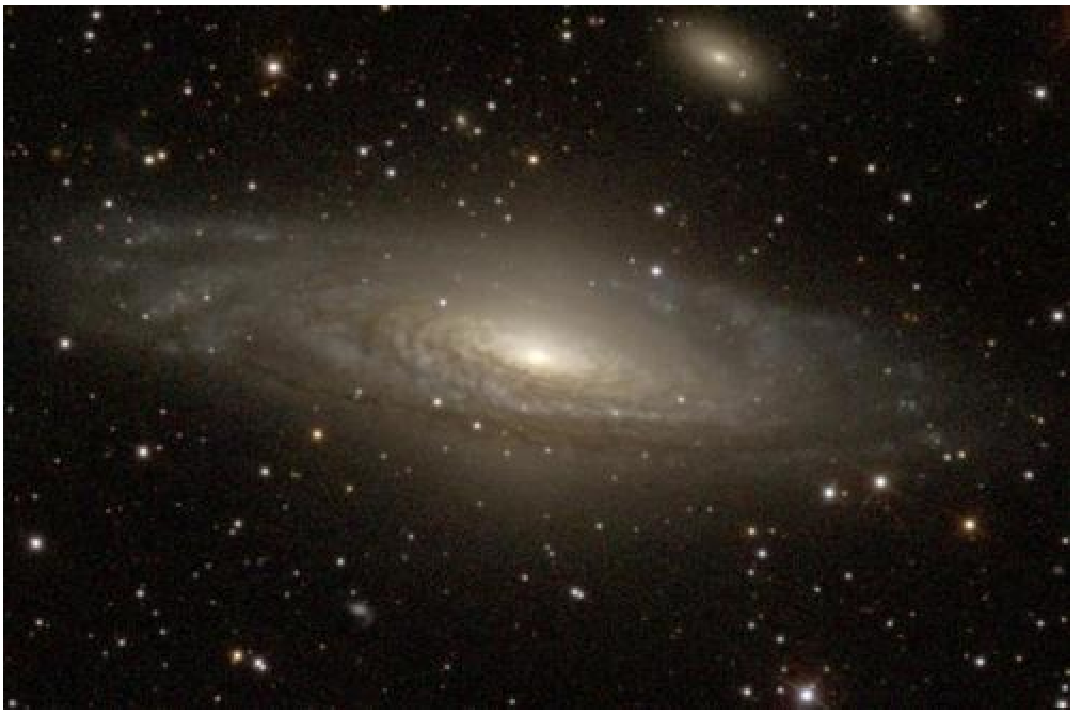


This Spitzer infrared image of galaxy NGC 7331 is dominated by glowing warm dust. Credit: NASA/JPL-Caltech/Michael Brown

Data from ground-based telescopes includes spectra from the University of Arizona's Bok 90-inch telescope and images from the Sloan Digital Sky Survey and 2MASS. My colleagues and I were fortunate to have this wealth of data (obtained for a variety of programs) for so many nearby galaxies.

Some of the data was archival and available online, but you cannot simply download it and "cut & paste" it together. Each set of data has its own strengths and weaknesses, which were carefully accounted for when producing the atlas.

For example, images from the GALEX and WISE satellites are somewhat fuzzy (low angular resolution), so faint galaxies can be swamped by light from neighbouring celestial objects.



NGC 7331 is a galaxy with many similarities to our home, the Milky Way. Credit: Sloan Digital Sky Survey/Michael Brown

Some galaxies in the atlas are similar to our own galaxy, the Milky Way. NGC 7331 is one such galaxy, and in the visible part of the spectrum we see blue tinged starlight and dark lanes of obscuring dust. This galaxy takes on a different complexion in the infrared, where glowing warm dust (heated by massive stars) dominates the view.

Chameleons in space

Not all galaxies look like the Milky Way and NGC 7331. For example, Messier 87 is far larger and redder than our galaxy, it has little obscuring dust and harbours a black hole that is four billion times the mass of the Sun.

The colours of individual galaxies are also changing. After correcting for the Doppler Effect, astronomers find that galaxies (on average) were bluer in the past than they are today. Ten billion years ago there were no big red galaxies like Messier 87. So why is the universe changing colour?

When stars are born inside giant clouds of gas and dust, they are born with a range of masses.

The biggest stars are very bright, very blue and use their hydrogen fuel so quickly that they die young. The smallest stars are quite dim, very red and sip away at their hydrogen fuel for tens of billions of years. Our Sun falls somewhere in the middle, and is half-way through its ten billion year life.

As the bluest stars have very short lifetimes, a galaxy will get progressively redder unless new stars are being formed. In some galaxies, like Messier 87, star formation finished roughly ten billion years ago and they have been getting progressively redder ever since.

Many galaxies, including the Milky Way and NGC 4631, are still forming stars today.

The Orion Nebula is a stellar nursery that is visible with a pair of binoculars, although Hubble Space Telescope does provide a better view. Credit: NASA/C.R. O'Dell & S.K. Wong (Rice University)

Even a cheap pair of binoculars will reveal the great nebula in the sword of the constellation Orion, a Milky Way stellar nursery where new stars are being born.

Star formation in our galaxy may come to an end after it merges with the Andromeda galaxy in four billion years.

Across the universe, star formation is in decline, and as the number of blue stars decreases our universe will become a duller and redder place.

So what is the current colour of the universe? Karl Glazebrook and Ivan Baldry measured the colours of thousands of nearby galaxies with the Anglo-Australian 2dF Galaxy Redshift Survey.

As our universe contains a mix of red and blue stars, with a pinch of dust thrown in, we live in a latte coloured universe. At least for now.

This story is published courtesy of The Conversation *(under Creative Commons-Attribution/No derivatives).*

Source: The Conversation

Citation: The changing colours of the universe (2014, April 28) retrieved 27 April 2024 from https://phys.org/news/2014-04-colours-universe.html