**The Doppler Effect and the expansion of the Universe**

Cette activité repose sur 2 vidéos, une transcription avec questionnaire et un diaporama.

1. **Activité préparatoire**

Vidéo du site HowStuffWorks: “Assignment Discovery: Doppler Effect” (1min 18) :

<http://science.howstuffworks.com/27963-assignment-discovery-doppler-effect-video.htm>

Cette courte vidéo est l’occasion de revoir les connaissances sur l’effet Doppler. Elle est très explicite.

1. **The Doppler Effect and the expansion of the Universe**
   1. Video “Stephen Hawking: The expanding Universe” (4min13):

<https://www.youtube.com/watch?v=DClEXO0pCZ4>

* 1. Transcript with questions + slide show

**The Doppler Effect and the expansion of the Universe**

“So now is a good time to be alive, I think. We may only be an advanced breed of monkey living on a small planet, but we are able to contemplate the Universe as a whole, which makes us very special.

My goal has always been simple, to work out how the Universe works and why it exists at all. Luckily, there are clues everywhere, and the most important one is right above our heads. Examine any patch of the night sky, even one as small as the head of a pin and this is what you will find: a tiny part of the vast web of galaxies. It is less than a millionth of what we can see of the cosmos from our little planet, but even this tiny sample is enough to find a clue, the key to the past, the present, and perhaps the future, too.

The clue is that, seen from Earth, all these distant galaxies are slightly red in color. They appear almost as if we were looking through rose-tinted glasses. It is this very redness that reveals how the Universe was born. And to show you why, I need a straight road and a noisy car.

Listen to the sound as it passes by. As the car approaches, the pitch of its engine rises. As it goes away, the pitch of its engine falls. This phenomenon is called a Doppler shift and the exact same [phenomenon] happens with light. If our eyes were more sensitive to color, we could see that the car is actually very slightly blue as it approaches and very slightly red as it goes away.

The same rules apply in space: [*to make it simple, let’s say that]* all distant galaxies are slightly red in color. So, by the exact same piece of basic physics, they must all be moving away too! In fact, the whole Universe is expanding in all directions getting bigger and bigger, like a balloon inflating. I admit this sounds strange, but to cosmologists, it is like winning the lottery! Because, to work out where the Universe came from, all we need to do is to stop time and make it run in reverse. Rewind far enough and everything gets closer together. A lot closer together!

All the galaxies! In fact, every single thing converges to a single point, the start of everything 13.7 billion years ago. So it is quite simple, really. Follow the clues, and we can deduce that a very long time ago, the Universe simply burst into existence.

An event called the Big Bang.” *From A Brief History of Time by Stephen Hawking*

1. What do you know about renowned scientist Stephen Hawking? What is his field of expertise? In which university is he an honorary professor?
2. Comment on Hawking’s first sentences.
3. What is Hawking’s goal?
4. When you were in tenth grade *(2nde)*, you studied how it is possible to get information about the chemical nature of the Sun or distant stars. Please explain.
5. Explain the Doppler Effect (or Doppler shift). Does it affect sound waves exclusively?
6. What do cosmologists deduce from the Doppler redshift of galaxies? (*Hawking explains the Doppler redshift of galaxies in a very simple way. Later on, you will go deeper into the subject).*
7. Explain how the expansion of the Universe leads to the Big Bang.

**CORRECTION**

1. **What do you know about renowned scientist Stephen Hawking? What is his field of expertise? In which university is he an honorary professor?**

Stephen William Hawking, January 8th 1942, is a British theoretical physicist. Hawking was a Professor at the University of Cambridge between 1979 and 2009.

Hawking has achieved success with works of popular science in which he discusses his own theories and cosmology in general; his [*A Brief History of Time*](http://en.wikipedia.org/wiki/A_Brief_History_of_Time) stayed on the British [*Sunday Times*](http://en.wikipedia.org/wiki/The_Sunday_Times) best-sellers list for a record-breaking 237 weeks. Hawking has a [motor neurone disease](http://en.wikipedia.org/wiki/Motor_neuron_disease) related to [amyotrophic lateral sclerosis](http://en.wikipedia.org/wiki/Amyotrophic_lateral_sclerosis), a condition that has progressed over the years. He is now almost entirely paralysed and communicates through a [speech generating device](http://en.wikipedia.org/wiki/Speech_generating_device). He married twice and has three children.

1. **Comment on Hawking’s first sentences.**
2. **What is Hawking’s goal? *Text.***

My goal has always been simple, to work out how the Universe works and why it exists at all.

1. **How is it possible to get some information about the chemical nature of the Sun or distant stars? (*10th grade)***

Absorption lines in the spectrum of the light emitted by a star give us information about the chemical nature of a star.

1. **Explain the Doppler Effect (or Doppler shift). Does it only apply to sound waves?**

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| An increase (or decrease) in the frequency of sound, light, or other waves as the source and observer move toward (or away from) each other. The effect causes the sudden change in pitch noticeable in a passing siren, as well as the redshift seen by astronomers |

(The Doppler shift affects all waves: mechanical waves such as sound waves or electromagnetic waves such as light.)

1. **What do cosmologists deduce from the Doppler redshift of galaxies?**

(*Hawking explains the Doppler redshift of galaxies in a very simple way).*

1. **Explain how the expansion of the Universe leads to the Big Bang.**

*Read text thorougly!*