International Centre for Radio Astronomy Research

The Electromagnetic Spectrum –

Accompanying Teacher Resources

1. Astronomical Objects referred to in lesson:

Jupiter

- Object – Planet
- Distance (from Sun) – 778 million kilometres
- Size – 139, 822 kilometres in diameter
- Brief description – Largest planet in our Solar System. It sits beyond the main asteroid belt and is the first of the gas planets. It has a total of 95 moons (as of 2025), which includes Ganymede, the largest moon in the Solar System.

Crab Nebula

- Object – Supernova Remnant
- Distance – 6,500 light years
- Size – 11 light years in diameter
- Brief description – Remnant of a supernova explosion that occurred 1,000 years ago. At the centre of the nebula is a pulsar, the collapsed core of the star that is now incredible dense and energetic. The surrounding material are the remains of the star, a mixture of gases that are expanding outwards from the centre of the dead star.

Orion Nebula

- Object – Star Formation Region
- Distance – 1,344 light years
- Size – 26 light years in diameter
- Brief description – A nebula known as a 'stellar nursery', where over 700 stars are being formed. It is a mixture of gas and dust that is slowly condensing to create new stars. It is the closest region of massive star formation to our Solar System. It is one of the brightest nebula and is visible to the human eye, situated in the constellation of Orion.

Centaurus A

- Object – Galaxy
- Distance – 11-13 000 000 light years
- Size – 123 light years
- Brief description – A large galaxy that lies within the constellation of Centaurus, first discovered in Australia in 1826. It is known as a radio galaxy because large jets of radio light are being emitted from the centre of the galaxy, due to an active supermassive black hole at its core. These jets are over a million light years in size.

2. The science behind multiwavelength astronomy – breakdown of what we are observing in the Object Cards

Visible Light

We detect the objects that we see with our eyes, including planets, stars, gas and dust. When we observe galaxies (like Centaurus A), some have these dark patches across the plane of the galaxy – these are dust clouds that are so dense it is blocks out the surrounding starlight. Dust clouds are significant because these are the building blocks of star formation.

Infrared Light

Detects heat/thermal energy, so we are typically observing the "hot" objects in space in infrared (predominantly stars). The wavelength of infrared light is the right size to pass through dust clouds, so when we observe galaxies and nebulas in infrared light we are peering through the dust clouds and seeing all of the stars present.

Notably with Jupiter, we are observing the warmer parts of the atmosphere. We see the similar cloud bands as we do in visible light, but thanks to the fast rotation speed of Jupiter (once every 10 hours), that angular momentum creates an incredible amount of friction, which is what we are observing in infrared light.

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Radio Light

Typically detects the cooler/less energetic gas (like neutral hydrogen) present in objects. Hydrogen gas is present throughout the Universe and is significant for the formation of objects like stars and galaxies. However, observations in radio light also highlight objects with interesting physics at play, as we can see in the Jupiter and Centaurus A images. These emissions are bright in radio light but are completely invisible in visible light.

In Jupiter's image, the beams of radio light create a lizard-shaped emission. This is due to charged particles interacting with Jupiter's large magnetic field and creating a ring of radio emissions around the centre of the planet.

In Centaurus A we see jets of radio light emitting from the centre of the galaxy as material is being ejected from the black hole's accretion disk and interacting with the surrounding material at the galaxy's centre. Not all galaxies behave like this though, and scientists are still trying to understand why this is the case.

X-ray Light

Detects objects in the Universe that are emitting high forms of energy. These emissions are typically associated with some of the most chaotic objects in the Universe, like supernova explosions and supermassive black holes.

Jupiter's image is highlighting the permanent aurora phenomenon that occurs on this planet. The aurora are created by energetic particles from the Sun being caught up in the planets magnetic field and being directed back towards the poles. The aurora are permanent on Jupiter (unlike the Earth) because of its large magnetic field.

In Centaurus A, a bright jet of x-ray radiation is being emitted from the core, likely aligned with the supermassive black hole at the centre of the galaxy. Objects such as these are called Active Galactic Nuclei (AGN), but the physics behind these objects are still being understood.

Multiwavelength Astronomy is so significant, because each wavelength forms part of the puzzle that tells us a complete story of the Universe. So much information is missing, if we simply relied on the part of the electromagnetic spectrum that our eyes can detect.

And furthermore as humans we have been able to create machines (telescopes) that detects the light we can't observe with our eyes, to help us better understand what we discover.

3. Vocabulary list

Light – Light is a form of electromagnetic radiation (energy) that allows us to see the world. It behaves both as a particle (photon) and a wave.

Spectrum – A scale used to classify things between two points e.g. longest to shortest.

Light spectrum (Electromagnetic spectrum) – The spectrum that classifies light between two points, from longest to shorted wavelength. The typers of light are radio waves, microwaves, infrared, visible, ultraviolet, x-ray, and gamma rays.

Wavelength – How light travels to us, however something the human eye cannot detect. Wavelengths are represented as a wave and are measure from crest to crest (top peak of the wave form).

Galaxy – A system of billions of stars, together with dust and gas, held together by gravity.

Planet – A rounded astronomical body that has a clear orbit path around a star.

Nebula – A cloud of dust and gas found in outer space. A nebula can either be a region of star formation or the remnant of a supernova (massive star that has exploded).

COSMOS - The SAO Encyclopedia of Astronomy (general vocabulary resource) https://astronomy.swin.edu.au/cosmos/	

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4. Additional resources

ICRAR – Electromagnetic Spectrum https://spectrum.icrar.org/index.php https://spectrum.icrar.org/learn.php	
GLEAMoscope – see the night sky in every wavelength of light https://gleamoscope.icrar.org/gleamoscope/trunk/src/	
Crash Course Astronomy # 24 – Light https://thecrashcourse.com/courses/light-crash-course-astronomy-24/	
NASA Video Series and Companion Book – The Electromagnetic Spectrum https://science.nasa.gov/ems/	
Quick breakdown of Electromagnetic Spectrum in our everyday lives – FuseSchool https://www.youtube.com/watch?v=508Zsmsllno	
NASA – Science in a Different Light – more multiwavelength astronomy comparisons https://science.nasa.gov/mission/hubble/science/science-behind-the-discoveries/wavelengths/	