TEACHER NOTES – ASTRONOMY IN THE NEWS #47

SQUARE KILOMETRE ARRAY CONSTRUCTION BEGINS

Slide 2 – Background Science: Square Kilometre Array

The format of this bulletin is slightly different this week as the article that will be discussed will be introduced in the first slide. This week construction of the world's largest telescope array, the Square Kilometre Array (SKA), will begin in Australia. To be more precise, construction on one of the two largest telescope arrays will start this week as there will be two arrays built, one low frequency in Australia and one high frequency in South Africa.

The two telescopes will be radio telescopes, with the Australia low-frequency array operating in the frequency range 50 to 350 MHz (or 0.86m to 6m) and the South Africa high-frequency array in the range of 350 MHz to 15.3 GHz (19 mm to 0.86m). The South African dishes will look a lot more traditional, with a total of 197 radio dishes spread of a maximum baseline of 150 km. The Australia telescope will look a little less traditional. The stations will be antennas, some of which will look like Christmas trees, with 131,000 of them spread across 512 stations.

This will be the first of many SKA posts so I will add more details as we move forward with them!

The articles that this resource was built on can be found here:

https://www.bbc.co.uk/news/science-environment-63836496

Guardian - Western Australia Radio Telescope

IMAGES:

1. (Top left) Artist's impression of the South Africa and Australia facilities side by side.
2. (Bottom left) Image of the Christmas tree antenna at the Australia array. These currently form part of the Murchison Widefield Array. This array is a pathfinder facility for the SKA.
3. (Bottom middle) An example of the radio dishes to be used in the South Africa high-frequency array. This current dish forms part of the MeerKAT pathfinder telescope that is currently running.
4. (Right) The locations in Australia and South Africa for the low and high frequency arrays, respectively.

Slide 3: Nature of Dark Energy

There are multiple science goals of the SKA, and I will cycle through these on the posts about the SKA which will inevitably come over the next few months and years. The first topic to be addressed will be part of the "Galaxy Evolution, Cosmology, and Dark Energy" science working group and will be the nature of dark energy.

The Universe is made up of billions of galaxies, which contain billions of stars, which may house billions of planets. However, the matter that we can see (of which we are included), only makes up 4.9% of the Universe's mass-energy reserve. The rest is made up of dark matter (26.8%) and dark energy (68.3%). Dark energy is the name given to a force that is speeding up the expansion of the Universe, whereas dark matter is a form of matter we don't understand and cannot see due to its lack of electromagnetic radiation. The only interactions we have witnessed are gravitational.

This dark energy, as mentioned above, is responsible for the acceleration to the Universe's expansion. To study it, large-scale surveys of both high redshift and more nearby galaxies are required to determine the nature of the cosmology of the Universe. There are two approaches to this. The first is to observe a large number of galaxies in atomic hydrogen emission, which is usually at 21cm but would be redshifted. By observing a very sample, subtle changes over multiple redshifts can be detected.

The second approach is to observe more nearby galaxies which would distort the light from background galaxies via gravitational lensing. By mapping these galaxies, and their distribution across the sky (namely their mass), we can map the dark matter distribution across the cosmos. The dark matter distribution is strongly influenced by the properties of dark energy. This distribution can then be compared to cosmological models to attempt to map these potential properties to the actual observed Universe.

IMAGES:

1. (Left) Atomic hydrogen (HI) emission from a serious of nearby galaxies. Atomic hydrogen is the most abundant gas in the Universe and is almost ubiquitous in our own Milky Way.
2. (Top right) Pie chart of the makeup of the Universe displaying the relative abundances of dark matter, dark energy, and standard, baryonic matter.
3. (Bottom right) Cartoon of the Universe depicting the expansion since the Big Bang. This shows that early in the Universe, after the first batch of star formation, the expansion slowed and it has since accelerated.

Slide 4 – Activity: What SKA science are you most looking forward to?

This week's activity is a discussion and research activity for the students. They should use the SKA science website (https://www.skatelescope.org/science/) to research the science goals (such as galaxy evolution, star formation and magnetic fields). They can then discuss and decide which results they are looking forward to the most.

GCSE Specifications:

Specification	Knowledge Point
Pearson Edexcel Astronomy	13.25, 13.26, 15.9, 15.13, 16.1, 16.4, 16.10, 16.11
Pearson Edexcel Physics	7.13
OCR Physics B	6.5.7, 6.5.8
AQA Physics	4.8.2
WJEC Physics	2.6(c)
CCEA Physics	2.5.14
CCEA Double Award	P2.5.14

A-Level Physics Specifications:

Specification	Knowledge Point
Pearson Edexcel Physics	161, 162, 163
OCR Physics A	5.5.3(e,f,h)
AQA Physics	3.9.3.1, 3.9.3.2
SQA Higher Physics	The expanding Universe
CCEA Physics	2.7.1, 2.7.2