we the curious
Workshop

Atoms to Astrophysics KS3 & KS4

Duration: 1.5-hour, max capacity: 30 students

A story of the journey from the centre of the atom to the outer limits of the universe, told using particles, waves, and energy. Students experiment with illuminating practical activities, participate in demos, and use a portable cloud chamber to directly observe alpha particles and appreciate how understanding of the universe starts with understanding its smallest particles.

Key Words:

Atoms. Atomic structure. Light. Wavelength. Space. Magnetic fields. Van de Graaff generator. Cloud chamber. Universe.

Learning objectives

KS3 & KS4
Recall the basic structure of an atom, including scale of atom and charges of protons, neutrons and electrons.
Demonstrate how electric fields are formed and the force they exert on charged particles.
See how elementary particles can be detected, tracked and identified using various kinds of particle detectors.
Recognise that particle accelerators have applications in research.
Understand the impact of magnetic fields and some practical applications of magnetism.
Understand how different kinds of electromagnetic radiation help us understand more about the universe.
Recognise the value of 'multi-wavelength astronomy' as a tool for obtaining a range of information.
Illustrate that infrared (IR) radiation can be sensed as heat and can show information which visible light cannot.

Content

Describe the structure of an atom and its charged particles and perform calculations to scale-up a hydrogen atom.
Learn how the Higgs Boson was discovered by CERN.
Observe various electric field effects around a Van de Graaff generator and plasma ball using student volunteers.
Investigate magnetic field lines around magnets.
Recognise the importance of the Earth's magnetic field as a shield from the Sun's harmful radiation.
Use a basic particle detector (cloud chamber) to detect alpha particles emitted from a thorium rod.
Identify the parts of the electromagnetic spectrum and analyse images of a deep sky object taken at different wavelengths.
Use Hubble and other space telescopes' images to see how they combine to provide more information and enable us to 'look back in time'.
Observe infrared radiation through an IR camera and learn how it allows us to see through gas and dust in space.

Curriculum Links:

KS3
Chemistry
Atoms, elements and compounds: A simple (Dalton) atomic model

Physics
Static electricity: separation of positive or negative charges when objects are rubbed together: transfer of electrons, forces between charged objects. The idea of electric field, forces acting across the space between objects not in contact
Magnetism: magnetic poles, attraction and repulsion; magnetic fields, representation by field lines; Earth's magnetism, compass and navigation

Light waves: light waves travelling through a vacuum; speed of light.
Space physics: our Sun as a star, other stars in our galaxy, other galaxies; the light year as a unit of astronomical distance
Forces: forces between magnets and forces due to static electricity; forces being needed to cause objects to stop or start moving, or to change their speed of direction of motion

KS4
Light and electromagnetic waves - Give examples of some practical uses of electromagnetic waves in the infrared, visible and ultraviolet regions.

Electricity - *Static electricity - forces and electric fields* **-** production of static electricity and evidence that charged objects exert forces of attraction or repulsion on one another when not in contact; explain how transfer of electrons between objects can explain the phenomena of static electricity.
Explain the concept of an electric field and how it helps to explain the phenomena of static electricity.

Atomic Structure - *Nuclear atom and isotopes* **-** Describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with almost all of the mass in the nucleus.
Recall the typical size (order of magnitude) of atoms. Describe how the atomic model has changed over time.
Recall that atomic nuclei are composed of both protons and neutrons, and that the nucleus of each element has a characteristic positive charge.

Forces - *Forces and their interactions* **-** Recall examples of ways in which objects interact: by gravity, electrostatics, magnetism and by contact, and describe how such examples involve interactions between pairs of objects which produce a force on each object.

Magnetism and electromagnetism - *Permanent and induced magnetism, magnetic forces and fields* **-** Describe the attraction and repulsion between unlike and like poles for permanent magnets.
Describe the characteristics of the magnetic field of a magnet, showing how strength and direction change from one point to another.

Potential Hazards and accessibility:

A Van de Graaff generator will be used during the workshop. Dry ice and a source of alpha radiation (from a thorium rod) will be used to construct a cloud chamber.