Can I Date Your Ancient Pot?

What Nuclear Physics Can Tell us About our Past and Present

Scientists have been dating ancient pottery and other relics for decades, to uncover the stories of lost civilisations and forgotten traditions. Of the methods used, it turns out that it is a nuclear technique which best preserves these valuable pieces of history, while other techniques risk destroying them. The process, called *Neutron Activation Analysis,* (NAA), can not only find when and where a sample is from, but exactly what isotopes it is made up of.

NAA involves 'activating' a chosen sample – an old pot, for example – by blasting it with billions of neutrons, until it becomes radioactive. The atoms in the pot absorb the neutrons, and their nuclei become unstable, quickly ejecting high energy electromagnetic waves called gamma rays, to reach stability again. The frequencies of the gamma rays are unique to each isotope and can be analysed to uncover it's exact composition, and when and where it has been. The pot could remain radioactive for several days or weeks afterwards, but can eventually be safely returned to its owner.

For example, a leading research scientist at Imperial College London, Judit Nagy, was able to use neutron activation analysis to date ancient Hungarian pottery to unearth the trade routes travelled by early European merchants. This technique is also used all the time in present day investigations too. Because NAA can reveal even minute traces of an isotope, materials such as bullet fragments, gunshot residue, DNA, and poison can be identified, rendering NAA particularly useful in forensic science and criminal investigations.

In the wake of the climate crisis, a further important application of NAA is environmental monitoring. Samples such as soil, plants and sediment can be analysed to assess the health of a particular environment. From this, we can see where human activities are causing harmful effects on ecosystems and learn the origins of pollution.

One issue that scientists run into with NAA, is that in order to get a high enough blast of neutrons, the sample usually needs to be placed into a special chamber in a nuclear reactor, which must then be moved to an analysis facility, such as a research centre or university. As you might imagine, transporting a highly radioactive sample is tricky. Furthermore, some of the radioactive isotopes created by activation decay so quickly, that any time delay between activation and analysis would mean that those isotope traces are lost.

Lund University has recently obtained a neutron generator; although it is far smaller and less powerful than a reactor, it should generate just enough neutrons to activate the samples. For my degree project, I will lay the groundwork for the setup of Lund University's own NAA facility, where both the activation and analysis are in immediate proximity. In the future, the University will be able to develop the setup to be suitable for environmental monitoring at the European Spallation Source in Lund, the world's most powerful neutron generator, due to open in the coming years. Once up and running, Lund University will be able to better analyse pollution, monitor the environment, and even date your ancient pot.