Uranium ($^{238}$U) is the heaviest element that occurs naturally on the Earth. All other elements heavier than Uranium do not exist naturally on the Earth because of their short half lives compared to the age of the Earth. These heavier elements are called Transuranic elements, or as the Encarta Encyclopedia ([2], 2004) defines them, ”elements with atomic number greater than 92”. Because of this, they have to be produced artificially in reactors through a process called transmutation. Some reactors are specially designed for Plutonium (Pu), a tranuranic element used for fission processes such as in nuclear power plants and nuclear weapons[1]. The currently accepted upper limit of transuranic elements is 112 (which is yet to be named, see Appendix A for a list of Transuranic elements at the time of writing) and with claims for the discovery of elements 113 & 115 being currently verified[9].

The transuranic elements are important for the understanding of internal nuclear structure. By studying how and why these elements are so unstable, the internal mechanism for holding the nucleons together maybe further understood. These elements are also important in the study of nuclear decay processes such as \(\alpha\)-decay and \(\beta\)-decay. It has been noted (through observations) that \(\alpha\)-decay predominantly occurs in elements heavier than Bismuth (Bi, having the atomic number 83) and \(\beta\)-decay occurs more commonly in elements lighter than Lead (Pb, having the atomic number 82)[3]. Spontaneous fission is another type of nuclear decay that often occurs and is a favourable process of decaying at around elements with atomic number 98 (Californium, Cf). All these decay processes are also used to predict the half-lives of undiscovered isotopes, and this information is important for experimentation. The above mentioned observations means that any
theory pertaining to the structure of atomic nuclei must be in accordance to this phenomena of transuranic elements. There are a number of models of the nuclei such as the Liquid Drop Model (where the nucleus is a uniform charged drop of liquid) and the Shell Model (in which each of the nucleons occupy certain energy levels and the magic numbers of nucleons are in fact closed shells). Both of which have shortcomings, especially towards transuranic elements.

As mentioned before, transuranic elements are produced by transmutation. This is a process by which a nucleus is irradiated by neutrons, absorbs some of them and becomes an heavier element. A special type of reactor, called a Breeder Reactor, is designed to produce Plutonium (Pu) in this way\(^1\). Another important process for creating transuranic isotopes is to bombard heavy nucleons with light charged particles (such as $\alpha$-particles) from particle accelerators. If both the target and the projectile are neutron rich, the product is likely to be neutron rich also. Once the heavy elements are produced, they need to be separated from the reactants and identified. These new heavier elements have different chemical properties to that of the reactants and so they can be extracted using this property. The chemical property can be predicted by the position of the element in the periodic table. Just as the Halogens are located at a specific part of the periodic table, so are different transuranic elements located in their different groups. For example, it was predicted and demonstrated that actinides (atomic numbers 89-103) have similar chemical properties to Lanthanides (atomic numbers 57-71)\(^3\). The second major method of identification of transuranic elements is through ion-exchange reactions. Here, reactions use the phenomena of complex molecules that have charge, attract equal but opposite charged ions and are able to exchange these ions for other equal and oppositely charged ions to separate the heavier elements. Other methods, when the above major methods are not possible, include the inference of the identity of the particle through the method of production, elements resulting from its decay and its nuclear decay systematics\(^3\).

The claim of discovering a transuranic element is verified before it is accepted. Once the transuranic elements are verified to be discovered, they have to be named. This is a very controversial issue with a tainted history. In the 1960s, a great controversy started and eventually resolved in 1997 when multiple groups (from different parts of the world) claimed discoveries simultaneously. Consequently, the International Union of Pure and Applied Chemistry (IUPAC) is
the governing authority on naming new transuranic elements and they their procedure is as follows

1. A temporary name is given, where this name is systematically chosen. The names are allocated based on the atomic number of the element and the conventions for 0,1,2,3... etc. with nil, un, bi, tri, ... etc with the suffix of "ium". For example, element 112 would be Unumbium (Uub).

2. An appropriate name is then agreed upon

The resultant from this procedure is the current provisional name for element 111 of Roentgenium (Rg) (see Appendix A for more details) and the temporary names of elements 113-115.

In closing, transuranic elements play an important role in understanding nuclei structure (as these elements are relatively short lived) and the nuclear decay processes. They are in general identified by their group chemical properties and ion exchange processes. Subsequently, these elements are currently of great interest and research is still revealing newly discovered elements.
A The Transuranic Elements

The currently accepted list of transuranic elements[4][5], as of time of writing:

- 93 Neptunium Np
- 94 Plutonium Pu
- 95 Americium Am
- 96 Curium Cm
- 97 Berkelium Bk
- 98 Californium Cf
- 99 Einsteinium Es
- 100 Fermium Fm
- 101 Mendelevium Md
- 102 Nobelium No
- 103 Lawrencium Lr
- 104 Rutherfordium Rf
- 105 Dubnium Db
- 107 Bohrium Bh
- 108 Hassium Hs
- 109 Meitnerium Mt
- 110 Darmstadtium Ds
- 111 Roentgenium Rg (provisional)
- 112 Ununbium (temporary)
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