Finding francium

Eric Scerri recounts the story of element 87, which after a number of false starts was finally tracked down in France — and named in its honour.

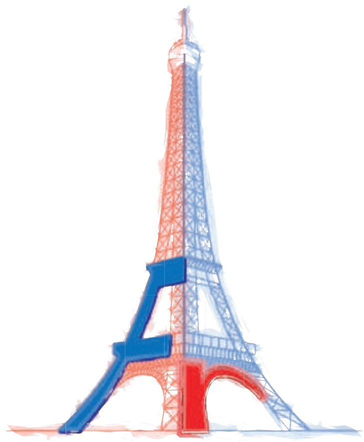
One of the most remarkable things about element 87 is the number of times that people have claimed to have discovered it after it was first predicted by Mendeleev in 1871 and given the provisional name 'eka-caesium'.

It was recognized early on that the periodic table more or less fizzles out after element 83, bismuth. All subsequent elements are radioactive and therefore unstable, with a few notable exceptions such as uranium and thorium. But this fact did not deter a number of scientists from searching for element 87 among natural sources and, in many cases, from claiming to have isolated it. For example, Druce and Loring in England thought they had identified the element by using the classic method developed by Moseley for measuring the Kα and Kβ lines of any element's X-ray spectrum. But it was not to be.

Estimates suggest that there is only about 30 g of francium in the whole of the Earth's crust.

In the 1930s it was the turn of Fred Allison from the Alabama Polytechnic Institute (now Auburn University). Allison developed what he called a magneto-optical method for detecting elements and compounds based on a supposed time-lag in the development of the Faraday effect, whereby the application of a magnetic field causes a beam of polarized light passing through a liquid solution to be rotated.

He mistakenly thought that every element gave a particular time lag, which incidentally was observed with the naked eye, and that this effect could be used to identify each substance. He boldly claimed in a number of journal articles and even in a special feature in *Time Magazine* that he had observed elements 87 and also 85, both of which were missing at the time. Dozens of papers were published on this effect, including a number of studies arguing that it was spurious. These days the Allison effect is often featured in accounts of pathological science, alongside the claims for N-rays and cold fusion[1].



The next principle claim came from Paris and was supported by Jean Perrin, the physicist who is perhaps best known for confirming Einstein's theory of Brownian motion and, as a consequence, provided supporting evidence for the existence of atoms. Horia Hulubei, a Romanian physicist working with Perrin, claimed to use highly accurate X-ray measurements and that this enabled him to record several spectral lines with precisely the frequencies expected of element 87, which he promptly named moldavium. But alas, these lines also turned out to be spurious.

The eventual discovery of element 87 was made in 1939 by a remarkable Frenchwoman, Marguerite Perey, who began life as a laboratory assistant to none other than Marie Curie in Paris. Perey quickly became skilful in purifying and manipulating radioactive substances and was asked to examine the radioactivity of actinium, which is element number 89 in the periodic table. She was the first to observe the α and β radiation produced by actinium itself — rather than its radioactive daughter isotopes — and thereby discovered a weak, yet significant, branch in one of the three main radioactive decay series.

Her analysis of the data revealed a new element with a half-life of 21 minutes. When she was later asked to name the element she chose 'francium' to honour the country of her birth[2]. It was also an appropriate choice in marking the continuing contribution made by French scientists to the study of radioactivity. Not only was the phenomenon itself discovered by Becquerel, but other landmark achievements in the field included the isolation of the radioactive elements polonium and radium by the Curies, as well as actinium by Debierne — all of which happened within a few years, and all in France.

As it turns out, francium was one of the last natural elements to be discovered, and is the second rarest after astatine. Estimates of the abundance of francium suggest that there is only about 30 g in the whole of the Earth's crust. It is one of a very few elements that has no practical applications, mainly because it has such a short half-life.

Nevertheless, the fact that the francium atom has the largest diameter of any element, at a huge 2.7 ångströms, and the fact that it has just one outer-shell electron, has made it the object of considerable attention among researchers wanting to probe the finer details of current theories of atomic physics. In 2002, a group in the US succeeded in trapping 300,000 atoms of francium on which they performed several key experiments of this kind[3]. ❐

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