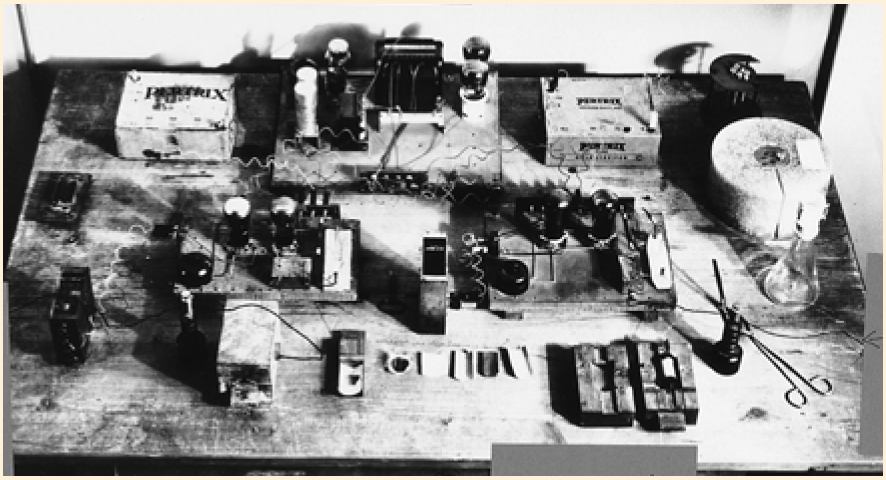
HISTORICAL CHEMISTRY

An Unexpected Finding

Historical Perspective

The discovery of the artificial transmutation of uranium in 1934 triggered great excitement in science. Chemists who were preoccupied with identifying what they thought were the final missing elements of the periodic table suddenly had to consider the existence of elements beyond atomic number 92. Physicists began to probe the stability of the nucleus more deeply. By 1939, nuclear investigators in both fields had collaborated to provide a stunning explanation for the mysterious results of uranium's forced transformation.



▲ *This apparatus from Otto Hahn's lab was used to produce fission reactions.*

Neutrons in Italy

In 1934, uranium had the most protons, 92, of any known element. But that year, Italian physicist Enrico Fermi believed he had synthesized elements that have higher atomic numbers. After bombarding a sample of uranium with neutrons, Fermi and his co-workers recorded measurements that seemed to indicate that some uranium nuclei had absorbed neutrons and then undergone beta decay:

$$^{238}_{92}\mathrm{U} + {}^{1}_{0}n \longrightarrow {}^{239}_{92}\mathrm{U} \longrightarrow {}^{239}_{93}? + {}^{0}_{-1}\beta$$

His report noted further, subsequent beta decays, by which he hypothesized the existence of a whole new series of "transuranic" elements, now called *transuranes:*

$$^{238}_{92}\mathrm{U} \longrightarrow {}^{238}_{93}? + {}^{0}_{-1}\beta \longrightarrow {}^{238}_{94}?? + {}^{0}_{-1}\beta \longrightarrow {}^{238}_{95}??? + {}^{0}_{-1}\beta$$

Unfortunately, Fermi and his group of scientists could not verify the existence of the transuranes because, according to Fermi, "We did not know enough chemistry to separate the products of uranium disintegration from one another."

Curiosity in Berlin

Fermi's experiments caught the attention of a physicist in Berlin, Lise Meitner. Knowing that she could not perform the difficult task of chemically separating radionuclides either, Meitner persuaded a colleague, radiochemist Otto Hahn, to help her explain Fermi's results. Joined by expert chemical analyst Fritz Strassman, Meitner's team began investigating neutron-induced uranium decay at the end of 1934.

From the onset, Meitner's team, as well as all other scientists at the time, operated under two false assumptions. The first involved the makeup of the bombarded nuclei. In every nuclear reaction that had been observed, the resulting nucleus had never differed from the original by more than a few protons or neutrons. Thus, scientists assumed that the products of neutron bombardment were radioisotopes of elements that were at most a few places in the periodic table before or beyond the atoms being bombarded (as Fermi had presumed in hypothesizing the transuranes).