which until recently was mere workshop practice has now moved out of the engineer's domain to take its place as a regular branch of physical chemistry. A study of its fundamental aspects by physicists and chemists applying all the modern techniques available to them would thus appear to be essential for further progress in the design and maintenance of almost every type of machinery.

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ULTIMATE CONSTITUENTS OF MATTER *

PROF. CARL D. ANDERSON, of the California Institute of Technology, has presented the accompanying table of elementary particles of matter as known in March, 1951. He points out that all the particles discovered since 1932 are unstable; after a short time, they either undergo spontaneous decay or are captured by atomic nuclei.

Elementary Particles of Matter and Some of Their Interactions

Particle	Mass in electron masses	Year discovered	Average lifetime against spontaneous decay	Products of spontaneous decay
Electron ..	1	1896	Stable	..
Proton ..	1845	1890–1900	Stable	..
Neutron ..	1848	1932	About 20 min.	Proton and electron
Positron ..	1	1932	Stable	..
Positive μ Meson ..	210	1936	2×10^{-6} sec.	Electron and two neutrinos
Negative μ Meson ..	210	1936	2×10^{-6} sec.	Electron and two neutrinos
Positive π Meson ..	276	1947	10^{-8} sec.	μ meson and neutrinos
Negative π Meson ..	276	1947	10^{-8} sec.	μ meson and neutrinos
Neutral π Meson ..	264	1950	Less than 10^{-13} sec.	Two photons
Positive V-Particle ..	Unknown	1947	Less than 10^{-9} sec.	Unknown
Negative V-Particle ..	Unknown	1947	Less than 10^{-9} sec.	Unknown
Neutral V-Particle ..	Unknown	1947	10^{-10} sec.	Probably mesons and photons
Photon ..	0	..	Stable	None
Neutrino ..	0	..	Stable	None

The 'elementary' character of the particles is rather uncertain; for, according to modern physical theories, particles may exist in "virtual" states in which they may have observable effects while not existing actually as independent observable particles. Dr. Anderson quotes Dr. Robert Oppenheimer as saying in this connection:

"An elementary particle is one that is so simple that one has no understanding of it whatsoever."

Besides the fourteen listed by Prof. Anderson, a fifteenth particle is also expected, *viz.*, the *anti-proton*, of negative charge but with the same mass as the proton. According to a recent report the track of such a negative proton has already been tentatively identified in a cosmic ray disintegration photograph by Dr. Robert B. Leighton at Pasadena.

* By courtesy of the *American Scientist*.

UTILISATION OF MONAZITE

IN the course of his address to the Research Club at the Harcourt Butter Technological Institute, Kanpur, Sir S. S. Bhatnagar, Secretary, Ministry of Natural Resources and Scientific Research, observed that examination of the monazite sand from Travancore was taken up by the Government of India after World War II, and that it was found to contain cerium, thorium, and 0·14% uranium. An agreement, he said, has now been reached with the Society of Rare Earths, Paris, for setting up a factory in India, treating 1,500 tons per year. There is already at present a pilot plant of 250 to 500 tons capacity, fetching about Rs. 15 lacs per year. In the course of a few months the factory will start functioning with full capacity. As cerium with small amounts of zirconium and magnesium has recently found use in the conversion of cast iron into steel, it is expected that when it is produced here, there is bound to be a great demand for it at very high prices.