experiments, many (in particular, see the work of Hyde et al. (29), have regarded these experiments as not providing a definitive characterization of the atomic number of the new species.

There is little doubt that Ghiorso, M. Nurmia, J. Harris, K. Eskola, and P. Eskola (Figure 18) did definitely produce isotopes of element 104 and identify their atomic number in experiments at Berkeley in 1969 (30). The nuclear reactions involved were

$$^{249}_{98}Cf + ^{12}_{6}C \rightarrow ^{257}_{104}Rf\ (t_{1/2}\ \sim 3.8\ \text{sec.}) + 4^{1}_{0}n$$

$$^{249}_{98}Cf + ^{13}_{6}C \rightarrow ^{259}_{104}Rf\ (t_{1/2}\ \sim 3.4\ \text{sec.}) + 3^{1}_{0}n$$

The atomic numbers of the isotopes of element 104 were identified by detecting the known daughters of $^{257}_{104}Rf$ and $^{259}_{104}Rf$, $^{253}_{102}No$ and $^{255}_{102}No$. This group later suggested the name of rutherfordium (chemical symbol Rf) for element 104 in honor of Lord Ernest Rutherford. These results were confirmed in subsequent work by E. E. Bemis et al. at Oak Ridge National Laboratory (31).

Studies at Berkeley (by R. Silva, J. Harris, M. Nurmia, K. Eskola, and A. Ghiorso) of the aqueous chemistry of rutherfordium have shown it to behave differently than the heavy actinides. Its solution chemistry resembles that of hafnium and zirconium, in agreement with the idea that rutherfordium is not an actinide but a Group IV element (32).

Controversy also exists over the discovery of element 105. In 1968 Flerov and co-workers (33) in Dubna reported production of two new alpha-emitters, assigned to be $^{260}105$ and $^{261}105$, in the reaction of $^{243}_{95}Am$ with $^{22}_{10}Ne$ ions. The element 105 radioactivities were claimed to be identified by detection of events in which the initial α-particles (9.7 and 9.4 MeV) emitted by the element 105 activities were said to be correlated in time with the α-particles emitted by the daughter (element 103) nuclides. A small number of such events (~10) was observed and the two element 105 nuclides were said to have half-lives in the range 0.1-3 and >0.01 seconds, respectively. The international groups who compile and certify nuclear data have generally considered this work to be inconclusive or possibly wrong because of the small number of observed events and the discrepancy between the reported element 105 alpha-particle energies of 9.7 and 9.4 MeV and those now known to be correct, i.e., 9.1 and 8.9 MeV, respectively.

In 1970 A. Ghiorso, M. Nurmia, K. Eskola, J. Harris, and P. Eskola (34) reported the observation of an isotope of element 105 with mass number 260 produced in the following reaction:

$$^{249}_{98}Cf + ^{15}_{7}N \rightarrow ^{260}_{105}Ha\ (t_{1/2} = 1.5\ \text{sec.}) + 4^{1}_{0}n$$