

Physics monitor

Physics from alpha particles

Last summer, alpha particles were stored in the CERN Intersecting Storage Rings and physics data on alpha-alpha collisions was gathered in a 60-hour run. This achieved a world record collision energy of 126 GeV (see July/August 1980 issue, page 194), and a luminosity of $2.8 \times 10^{28} \text{ cm}^2 \text{ per s}$. This was followed by a run with 63 GeV alpha particles in one ISR ring and 31.5 GeV protons in the other, giving a centre-of-mass energy of 89 GeV.

A CERN/Heidelberg/Lund collaboration (R418) working at the large Split Field Magnet mounted a special study of alpha particle collisions, and several other ISR detectors were also able to benefit from the alpha particle runs.

Elastic alpha-alpha scattering data from R418, combined with results from a CERN/MIT/Naples/Pisa/Stony Brook collaboration (R210), show a nice diffraction-type pattern with two dips, one at squared momentum transfer about 0.1 GeV^2 , and the other at about 0.4 GeV^2 . Elastic alpha-proton scattering shows only one dip. Analysis of this data could provide valuable information on the scattering properties of compound nuclei to improve the current formalism.

Data on inelastic reactions with low transverse momentum came from R210 and from the Brookhaven/CERN/Copenhagen/Lund/Rutherford/Tel-Aviv team (R807) using the Axial Field Spectrometer. In these reactions, it is found that the multiplicity of leading fragments seen emerging from the collisions is much higher than would be expected on the basis of multiple hadron collisions within the interaction region. This indicates that at the high colli-

sion energies in the ISR, the duration of the main interaction appears to be so short that particles are formed only after the main interaction is over. Such effects are best described by quark-parton models, so that the alpha particle results could supply new information on quark dynamics.

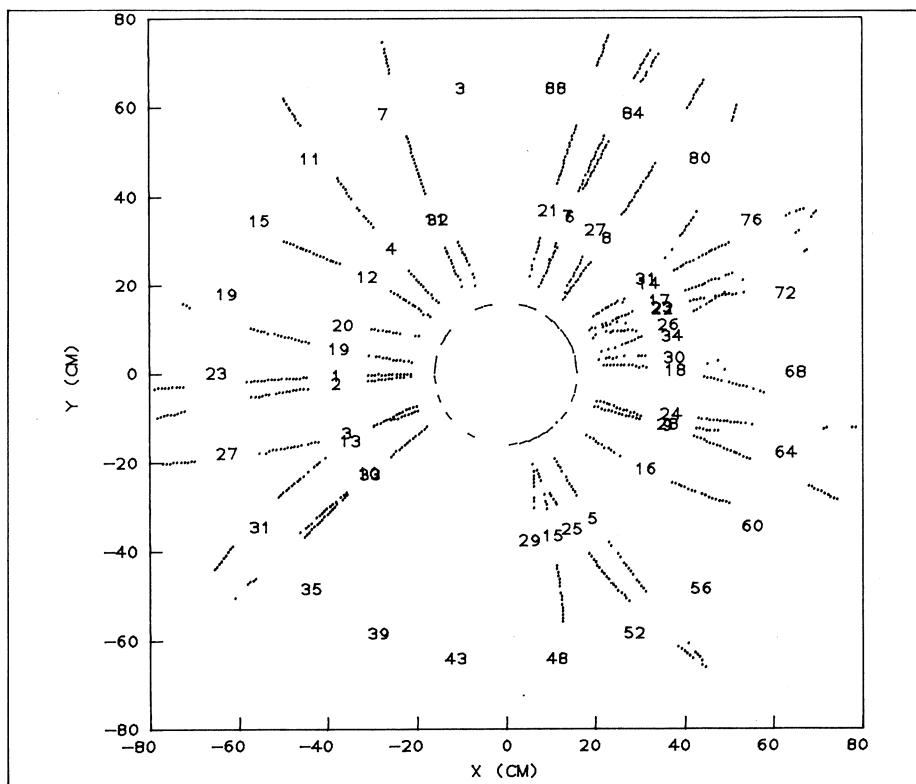
High yields were also obtained of secondary particles with large transverse momentum, resulting from the violent collisions between component quarks. Here spectacular effects were found. The production rate of large transverse momentum particles (say greater than about 5 GeV) turns out to be about 30 times that for proton-proton collisions at the same energy per nucleon. Earlier experiments at Fermilab had shown that in proton-nucleus collisions, the production rate of large transverse momentum particles appears to increase faster than just the mass

number of the target nucleons. However the nucleon-nucleon collisions show even more violent effects, and could be the result of multiple scattering among the many quarks involved in alpha-alpha collisions.

Interesting results from R807 show that the multiplicity of produced particles tends to increase more with the overall transverse energy than is expected from proton-proton data. This could be used in the interpretation of other results from a fixed target experiment (see page 155).

Despite increases in multiplicity, interesting events are still not very frequent and more alpha particle data seems to be required before more definite conclusions can be drawn.

A high energy alpha particle collision, as recorded in the Axial Field Spectrometer at the CERN Intersecting Storage Rings last summer.



Element 107

A new isotope of the 107th element in the periodic table (the heaviest yet seen) has been discovered at GSI Darmstadt. With mass number 262, it decays with a half-life of $4.2 \pm 2.0 - 1.4$ ms by alpha particle emission of an energy 10.38 ± 0.03 MeV. This element was discovered in 1976 in an experiment at Dubna, which saw the mass 261 nuclide.

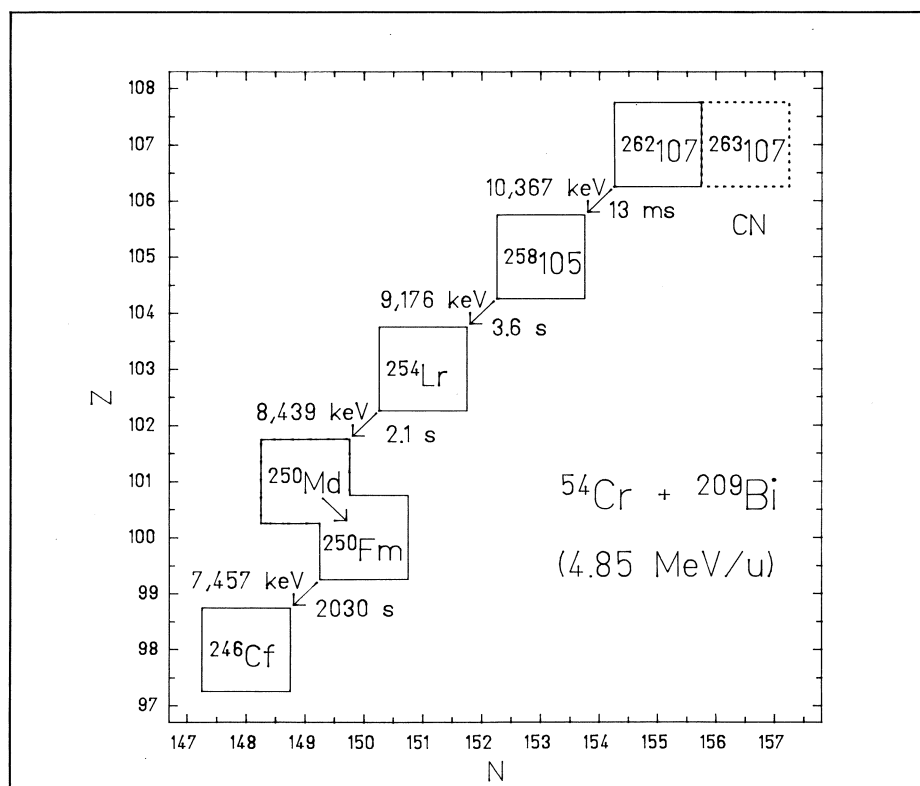
The mass and atomic number of the Darmstadt nuclide are uniquely determined thanks to two major experimental advances. The new nuclide is produced in the fusion of chromium-54 and bismuth-209 at 262 MeV using a beam of 10^{12} per s chromium-54 projectiles. The nuclide is filtered out by making use of the velocity difference between projectiles and fused compound nuclei. A separation factor of 10^{11} is

obtained between the projectiles and the few evaporation residues hidden in the beam using the special SHIP (Separator for Heavy Ion reaction Products) velocity filter. The evaporation residues produced – separated with a 30 per cent efficiency – are implanted into the bulk silicon of a bench of position-sensitive surface barrier detectors. In a recent experiment about two nuclides per day have been implanted and their subsequent decay detected and analysed.

The events of interest are characterized by the velocity determined by the filter, and the energy, position and time of implantation obtained in an additional time-of-flight measurement. Furthermore, the alpha energies in the decay chain are determined in a position-time correlation experiment. In this way 17 parameters are measured. All positions of a decay sequence are shown

to be within ± 0.02 mm, and the last members of the decay chains agree with data known from previous measurements. The profusion of 17 parameters, partly preset by the above boundary conditions, is sufficient to identify the nuclide uniquely. Six decays have been found in an irradiation of 0.8 mg/cm² bismuth targets with 1.6×10^{17} chromium-54 projectiles.

The new techniques have been developed during a period of many years by the SHIP's 'crew' under the captaincy of G. Münzenberg, which is hoping to go on to search for heavier elements using their unique experimental tools and the excellent beams now available at the Darmstadt accelerator.



Alpha-decay chain of the newly discovered isotope of mass number 262 of the transuranic element 107. The numbers give the alpha energies and the times between the decays with the time of implantation as time zero. The isotope is produced via a single neutron fusion channel in the reaction of a 262 MeV chromium-54 projectile on a bismuth-209 nucleus. The excitation energy of the compound nucleus of element 107 with mass number 263 was less than 13 MeV. This is the smallest internal excitation ever seen in a fusion reaction between heavy nuclei.