NEWS AND VIEWS

How to Find Needles in Haystacks

LIKE the objects to be found at the end of the rainbow, the superheavy elements have long been regarded enviously but with disbelief. The report from the Rutherford High Energy Laboratory on page 464 of this issue of *Nature* may change the balance between hope and scepticism. What Dr C. J. Batty and his colleagues at Chilton, with their associates at Manchester and Risley, have done is to bombard a tungsten target with a 24 GeV proton beam in the CERN accelerator in circumstances in which they have reason to expect or at least to hope that the nuclei of elements with atomic number well above the present limit of 105 may have been produced. By careful radiochemical treatment of the irradiated targets, they have separated those fractions which seem chemically related to mercury. Among the residues, they have found traces of alpha activity which cannot be accounted for by the known activities of isotopes of lighter elements, and their material seems also to contain fission activity which cannot easily be explained away. The question now is whether the inference can be substantiated that the nuclear activity not so far identified can be attributed to the artificial element 112. The authors of the research are properly undogmatic in their interpretation of their results, for this is clearly a field in which the reality or otherwise of each new element beyond the known limit must be confirmed by a string of independent observations. No doubt the team which has now provided a hint of the existence of element 112 will itself have much to say.

The device of bombarding tungsten with protons in the hope of making superheavy elements is not as much a matter of hit or miss as it might seem to be. By now, it is clear enough that the manufacture of ever heavier nuclei by the successive addition of nucleons is bound to be subject to the law of diminishing returns. This indeed is why Professor G. L. Ghiorso's group at Berkeley has invested ingenuity and money in a linear accelerator for producing high energy beams of atomic nuclei such as helium, carbon and oxygen, but even here the problems of producing sufficiently energetic beams of atomic nuclei sufficiently heavy to span the gap between, say, uranium and element 112 are formidable to contemplate. This is why the new work at CERN has been designed around the expectation that in the interaction between fast protons and tungsten nuclei, the recoil nuclei will often carry between 1.0 GeV and 5.6 GeV of energy. But the potential barrier between tungsten nuclei is reckoned to be about 1.0 GeV, so that there will often be occasions when pairs of tungsten nuclei are made to coalesce. By the loss of particles from such an assembly, so the argument goes, a whole range of lesser atomic nuclei should be produced. What Dr Batty and his colleagues have done is to search for radiochemical evidence of the existence of element 112 which should lie beneath mercury in the periodic table and which may be lent stability against decay by radioactivity and fission by the symmetry of its assemblage of nucleons.

Quizzical experimenters will be most of all concerned with the radiochemistry, at once intricate and delicate. The amounts of material involved are in the best tradition of radiochemistry, with microgram quantities of mercury being added as a carrier. The target carried most quickly to the laboratory bench was irradiated with 7×10^{17} protons, one for every half a million tungsten atoms. After the separation of mercury and other chemically related elements, the presence of something unexpected was indicated chiefly by the existence of a peak in the spectrum of alpha radiation which cannot be attributed to the decay of a known isotope of some other element likely to have been present. The authors themselves point out that the possibility of contamination with thorium is a potential pitfall, one they consider they have avoided. No doubt other people will describe other potential snags. That, inevitably, is how the interpretation of experiments like this must be carried out. To be sure, the signs that there may be spontaneously fissile nuclei in the products of the experiment will help to bolster up the view that something new has been uncovered. In the long run, however, the belief that element 112 has indeed been manufactured in the CERN accelerator will be best of all sustained by a thorough characterization of the isotopes concerned. The estimate of a half-life of 500 years for the new material which Dr Batty and his colleagues put forward is at this stage more a point for further discussion than a potential test of what the theoreticians have calculated.

The notion that there may be nuclei containing many more particles than uranium nuclei which are nevertheless comparatively stable against spontaneous fission and radioactive decay owes its existence to the attempts in the past fifteen years to account for the energetic properties of the nucleons in familiar nuclei by means of comparatively stable shells of particles comparable with, although more complicated than, the electron shells surrounding atomic nuclei. In familiar circumstances and for stable nuclei, for example, the predictions of the shell model work well enough. Just as the electronic shells of atoms with two and ten electrons are exceptionally stable, so too are nuclei such as those of the isotopes oxygen-16 and lead-208, for eight protons and eight neutrons, or 82 or even 126 of either, constitute magic numbers in the construction of atomic nuclei. One result is that, for example, nuclei with atomic number 50 (another magic number) are expected to be exceptionally stable, which goes a long way to explain why tin, the element concerned, is so prolific in its isotopes. Unfortunately, but predictably, the calculation of the magic numbers is much more hazardous with nuclei than with electronic shells, for an assembly of nuclear particles in a nucleus must provide its own self-attractive potential energy, whereas comparatively simple atomic systems have a central dominating nucleus to provide a pattern of potential energy.

One complication is that for heavier nuclei, the magic numbers probably differ for neutrons and protons and are in any case only known approximately. In circumstances like these, the difficulties in calculating and predicting nuclear properties must necessarily be formidable. On some occasions the uncertainties have been so many that only the faithful have kept the dream of the superheavy nuclei alive. The new results should give them courage.