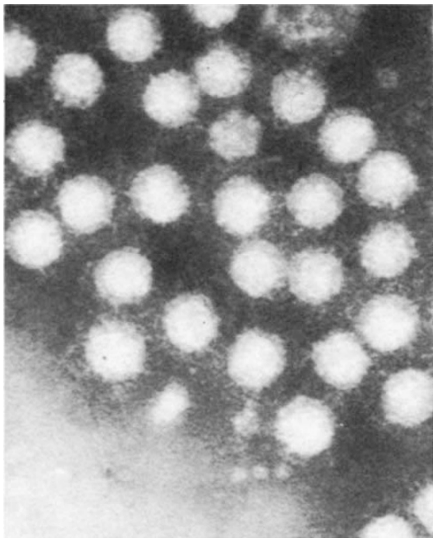


Fig. 2 Virus-like particles measuring 27 nm in diameter found in faecal extract from a chimpanzee infected with human hepatitis A. Original magnification ×275,000. (Electron micrograph from a series by A. Thornton, A. J. Zuckerman and J. D. Almeida.)

conversion to hepatitis A was not found in any of these patients (Feinstone *et al., New Engl. J. Med.*, **292,** 767; 1975). A new term was coined; non-A : non-B hepatitis.

Feinstone and his colleagues were unable to implicate infection with cytomegalovirus or Epstein-Barr virus, which are known to induce liver damage as part of the generalised infection caused by these herpes viruses. Recently, Alter and his associates (*Am. J. med. Sci.*, **270,** 329; 1975) pointed out that in the United States when blood obtained from volunteer donors is pretested by radioimmunoassay for hepatitis B surface antigen approximately 90% of the remaining cases of post-transfusion hepatitis are serologically unrelated either to hepatitis A or hepatitis B viruses. It was considered, therefore, that a previously unrecognised human hepatitis virus may exist. This agent may be hepatitis virus C, a term introduced by Prince and his colleagues (*Lancet,* **2,** 241; 1974). They noted that an agent other than hepatitis B was the cause of 71% of 51 cases of post-transfusion hepatitis identified during a prospective serological study of 204 patients in New York. The incubation period was relatively long and the clinical and epidemiological features of the infection were not consistent with hepatitis A.

It is thus evident from these studies that a hepatitis virus C may indeed exist, although the precise criteria which would be virologically acceptable for a new infective agent have not yet been satisfied, despite the application of a battery of modern virological techniques. □

Wigner cusps in nuclear reactions

from P. E. Hodgson

WHEN a proton is incident on a nucleus, many different reactions can take place. It may be elastically or inelastically scattered, it may be captured to form a compound nucleus which subsequently emits neutrons, protons or other particles, it may undergo (p,n) charge exchange, it may pick up a neutron to form a deuteron, it may knock out an alpha particle and so on. The relative probabilities of these processes depend on how easily the particles can get in and out of the nucleus (barrier penetration factors) and on the structure of the nucleus. The penetration factors depend on energy, and as the energy of the incident particle increases more and more reactions become possible.

At low energies the compound nucleus processes dominate, and then the cross section for all the non-elastic reactions depends on the penetration factor for the incoming particle, and this increases smoothly with energy.

As this energy increases this cross section has to be shared out among more and more of the reaction processes. The situation is rather like steadily increasing the flow of water into a closed tank, and at the same time making more and more holes of different sizes in the side of the tank. If we then concentrate our attention on the water coming out of one particular hole, we still see that at first it increases because of the increasing flow of liquid into the tank, and then decreases because more and more of the water is flowing out of all the other holes.

If we look very carefully, we may notice another effect: the flow of water out of our one hole falls slightly just after another hole has been made. This is because at any one time the total flow out must be the same as the total flow in, since the tank is closed and water is incompressible.

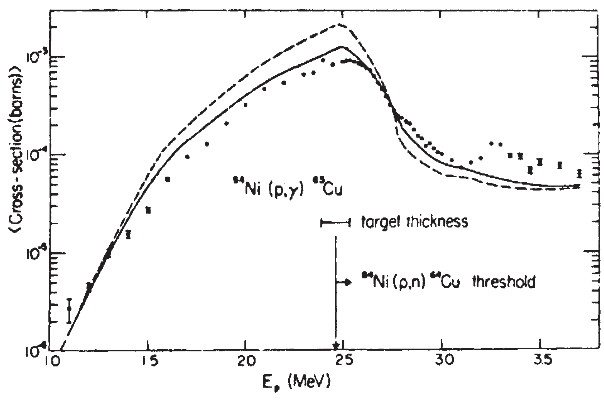
A very similar effect in nuclear reactions was predicted by Wigner in 1968 (*Phys. Rev.*, **73,** 1002). Each reaction process has a threshold energy: if the incident particle is below this energy the reaction cannot take place, but as soon as it is exceeded the cross section increases rapidly from zero. (This is the counterpart to punching another hole in the tank.) But since the total flux is constant, this must produce a small reduction in the cross section for all the other processes, and Wigner calculated the shape of the resulting cusps in the cross section as a function of incident energy.

It is interesting to try to observe these cusps as they would provide a delicate test of nuclear reaction theory but they are not easy to see. Usually there are so many hundreds or thousands of reactions taking place at the same time that the opening of another reaction channel, as it is called, does not make any perceptible difference.

The best conditions for observing Wigner cusps occur in the reactions of light nuclei, for in this case the level density is smaller and hence there are fewer channels. The effects of opening another channel are then more prominent, and indeed several cusps have been observed in light nucleus reactions, associated with the crossing of thresholds in neutron-induced reactions.

It is also interesting to look for Wigner cusps in proton reactions on heavier nuclei, and a remarkable example has recently been found in the ^{64}Ni(p,γ)^{65}Cu reaction by Mann and his colleagues at the California Institute of Technology (*Phys. Lett.*, **58B,** 420; 1975).

This reaction was chosen because even though it is on quite a heavy nucleus it provides especially favourable conditions for the observation of



Excitation function for the ^{64}Ni (p, γ) ^{65}Cu reaction showing the Wigner cusps due to the crossing of the neutron threshold at 2.46 MeV. The curves show the results of Hauser–Feshbach statistical model calculations with (full) and without (dashed) the width fluctuation correction.

a Wigner cusp. These are that the new channel opens quickly, absorbing an appreciable fraction of the total flux, and that there are very few channels open already to share the resulting decrease in flux. These conditions are very well satisfied for the (p,γ) channel on ^{64}Ni at the opening of the neutron threshold. The lowest excited states of ^{64}Ni are at relatively high energies and this, together with the low energy of the neutron threshold (opening of the (p,n) channel), reduces the contribution of the inelastic scattering and compound elastic processes to the total reaction cross section. A possible competing reaction, alpha particle emission, is strongly inhibited by the Coulomb barrier, so that the total reaction cross section below the (p,n) threshold is mainly composed of the (p,γ) channels. Another favourable feature is the high density of low-lying states in ^{64}Cu, the final nucleus in the (p,n) reaction, which ensures that the total (p,n) cross section increases very rapidly, producing a strong depletion in the (p,γ) cross section.

The measurements of the (p,γ) cross section were made from 1.1 to 3.7 Mev in 100 keV steps, and the yields for the reaction to the first three excited states of ^{65}Cu were summed to give the results shown in the figure. It is notable that the cross section increases steadily from 1 to 2.5 MeV and then drops dramatically by a factor of 10 over the next 0.5 MeV as a result of the opening of the (p,n) thresholds. In this case the Wigner cusp is not a tiny perturbation but a major feature of the cross section. Many neutron thresholds are passed above 2.5 MeV, and these all contribute to the drop in the (p,γ) cross section.

A small resonance is visible in the (p,γ) cross section at about 3.27 MeV. This is attributed to the state in ^{65}Cu that is the analogue of the first excited state of ^{65}Ni.

At such low energies the reaction is dominated by the compound nucleus process; the incident proton is captured by the ^{64}Ni nucleus to form a compound nucleus ^{65}Cu and after a long time on the nuclear scale it emits one or more gamma rays until it returns to the ground state. The cross sections for such processes can be calculated by the Hauser–Feshbach statistical theory, using barrier penetration factors calculated from the appropriate optical model potentials. Since the number of open channels is small, this reaction is a severe test of the theory.

The results of Hauser–Feshbach calculations are shown by the dashed curve in the figure, and are in qualitative agreement with the measurements. If account is also taken of the correlations between the partial widths in the entrance and exit channels by including the width fluctuation correction the improved results shown by the full line are obtained.

This comparison shows that the Hauser–Feshbach theory is well able to account for the Wigner cusps, and that it is important to include the width fluctuation correction. □

Disappearing habitats

from Peter D. Moore

It is believed that the Romans were responsible for the construction of an extensive series of draining channels in the low-lying coastal area between Newport and Cardiff in South Wales, commonly known as the 'Monmouthshire levels'. The value of this land, mainly for pasture, is maintained by a careful control of the water table, which has long been effected by these drainage ditches, locally termed 'reens'. The reens have an additional value in that they represent a diverse series of habitats for aquatic plants and animals and serve as an extensive refuge for a large number of plant and animal species.

Recently this area has come under threat from a number of quarters and an ecological survey of the area and the various interrelationships between such physical factors as water table and plant and animal communities was urgently required. Just such a survey has been conducted recently by P. M. Wade of the University of Wales Institute for Science and Technology, Cardiff, and some of the conclusions were presented during a recent meeting of the British Ecological Society in Cardiff.

The floristic diversity of the reens has been confirmed by Wade's study, in which he recorded over 400 plant species associated with the waterways and their adjacent hedges and meadows. He feels, however, that recent land use changes in the area are combining to reduce this diversity.

The drainage channels are arranged in a rectangular grid system, where subsidiary reens coalesce into main reens which ultimately discharge their load into the Bristol Channel through simple, one-way sluice gates. These gates are not always perfectly efficient and there is an occasional movement of estuarine water back into the reens, which serves to diversify yet further the habitats within these channels. The fields which are bordered by the reens are drained by small furrows on their surface, from which run-off water reaches the reens.

Recent land-use changes have included the installation of sub-surface drainage pipes which have resulted in a more efficient water-ridding system and a consequential improvement of the meadows for pasture. This has meant that field size can be increased by reducing the number of reens, either by allowing them to silt up or by actively filling them. It has also allowed an increase in stock density to take advantage of the improved pasture yield.

Historically, the reens have served the subsidiary function of providing water for the resident cattle. This practice has also brought its problems, because the trampling of stock around the ditches has damaged banks and increased the rate of silting. An increased stock density, of course, makes this an even more serious problem. An answer has been found in the provision of water troughs situated in the centres of fields which attract animals away from the ditches.

At this stage a farmer is bound to ask the question whether he needs the reens any more. Their maintenance is expensive; at one time they were dug out by hand, but now excavation can be carried out mechanically. This, however, has involved the removal of most of the accompanying hedgerows which themselves provided food and shelter for wildlife. The growth of emergent aquatic plants can be controlled by spraying herbicides and this reduces the need for frequent ditch clearance, but spraying is itself an expensive process particularly because of the labour involved. So, since the reens are no longer useful as a water resource for livestock, it seems advantageous to lower the water levels within them or even to empty them completely. The use of mechanical pumps to replace the earlier crude sluice system has now made this possible.

Inevitably these changes have become more widespread until the traditional management of the reens has practically disappeared and subsequently the character and the biotic richness of the habitats which they represented is also vanishing. At this point one can predict that naturalists and wildlife conservationists will begin to muster and cry out for the retention of the old system in at least a portion of the area occupied by these low-flying levels. It is not difficult to summon up sympathy for such views, especially since they emanate from a part of the country where man's recent activities have reduced biological diversity to an extraordinarily depauperate level. The remaining fragments must assume a particularly high status in the eyes of those members of the local populace who appreciate such things. One cannot help reflecting, however, upon the