'ecozone patches', it proved impossible to extricate the pure area influence from that of habitat heterogeneity. Evidently this aspect of the island biogeographic model needs more attention in order to understand the area/richness relationship whether at the urban lot or the Hawaiian island level of organisation. □

Mapping the nuclear potential

from P.E. Hodgson

THE special characteristics of nuclear heavy-ion interactions enable the nuclear surface to be probed in detail, and this has recently been used by Nees and Guidry of Oak Ridge and Donangelo and Rasmussen of Berkeley (*Phys. Lett.* **85B**, 201; 1979) to map the deformed potential of the nucleus ^{160}Gd.

To do this, they analyse the inelastic scattering of ^{40}Ar by ^{160}Gd at energies comparable with that of the Coulomb barrier. This interaction excites several states in the ground-state band, and there is strong interference between the Coulomb and the nuclear forces. At these energies, the wavelengths of the ions are small, so that semi-classical theory can be used to understand the interaction. This shows that since both Coulomb and nuclear forces contribute to the excitation, both the charge and the matter distributions influence the interaction, and are thus both probed by it. At energies below the Coulomb barrier few non-elastic processes take place, and so the effects of the real and imaginary parts of the potential can easily be separated.

From the uncertainty principle we know that localisation in angle requires a large uncertainty in the momentum. If we consider the experimental situation as shown in Fig. 1, when scattering is restricted to backward angles, we find that the transfer of multiple rotational quanta implies a localisation in the orientation angle of the deformed rotor during the interaction, and hence a localisation in the part of the nuclear surface probed by the projectile. Classical phase space arguments show that each classical angular momentum I_f is associated with a range of initial orientations obtained by projecting two units of I_f on the angular axis, as shown in the figure. This spread in spin corresponds to a definite range of initial orientation angles, so that a particular spin state probes specific regions of the deformed nuclear surface.

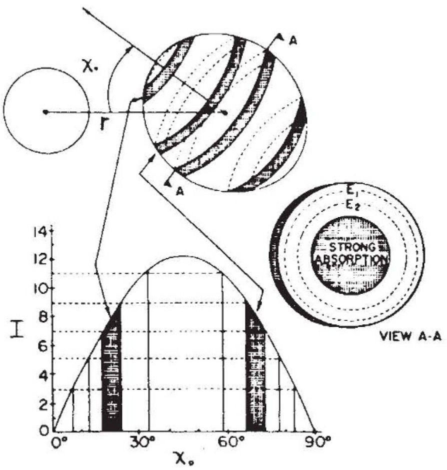

Fig. 1 Schematic illustration of the radial and angular localisation in heavy ion reactions. The more classical the system the more the surface interaction is localised in angle and in radial distance.

Similar arguments show that a large radial angular momentum implies localisation in the radial coordinate. Thus the initial width of the radial wave packet for ^{40}Ar on a heavy nucleus at the energies of these measurements is about 0.1 fm. The projectile spends most time in the region of the classical turning point, and so the interaction probes this region of the nuclear surface. As the incident energy increases the turning point moves inwards and with it the region being probed, until the particle is absorbed by the strong interaction in the nuclear interior.

These qualitative arguments are of course confirmed by numerical calculations that are fitted to the cross-sections for the inelastic scattering with the excitation of the low-lying states of the ground-state rotational band. A complex deformed Saxon-Woods potential was used, with fixed potential depths, and the radius and diffuseness parameters refer only to the localised region probed by the particular interaction.

From the results of these calculations the real part of the potential is constructed piece by piece, assuming axial and reflection symmetry. It is found that for each quadrant the classically allowed states (4^+ and 6^+) sample two regions while the classically forbidden ones (8^+ and 10^+) sample one broad region. The first three diagrams in the figure show the partial contributions of each state, and the final one the sum. It is notable that the contours overlap and join very smoothly, even though each comes from an independent analysis of a different part of the potential.

These potential contours can easily be parametrised in terms of an expansion in spherical harmonics to give a precise description in the usual form. They are closely related to the contours of the nuclear density distribution itself through a simple folding calculation with the nuclear interaction. Conversely, they may be used to check the accuracy of any particular form of the nuclear surface. This method of analysis of heavy ion interaction thus gives a very direct and clear description of what it means for a nucleus to be deformed, and should have many useful applications to studies of nuclear structure. □

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Bird colours

from John R. Krebs

MOST biologists, if asked to hazard a guess about the possible significance of the brilliant plumage adornments of many bird species, would probably say that bright colours evolved in the context of ritualised display between rival males or as attractants to lure females. They would point to the fact that male birds are usually brighter than females, and exotic male plumage is especially highly developed in polygamous birds. Males generally compete for females, and this competition is more intense in species where one male can acquire a larger number of mates, so sexually selected colours are expected to be found in males, and especially in polygamous males. This was the line of argument put forward by Darwin, and although a number of alternatives have been proposed from time to time, the first serious attempt to examine Darwin's idea by means of a large scale comparative survey has recently been published by Baker and Parker (*Phil. Trans. R. Soc.*, **B287**, 63-120; 1979). As a result of their analysis, Baker and Parker reject the sexual selection hypothesis and replace it with what at first sight may seem a surprising idea: that bright colours have evolved in response to selection pressures exerted by predators.

More than 30 years ago, Cott published an extensive study showing that bright coloured birds are often distasteful (*Proc. Zool. Soc., Lond.* **116**, 371-524; 1946). His work started with an observation made while preparing museum skins in the Middle East. Cott noticed that hornets readily ate the flesh of cryptic birds such as the palm dove (*Streptopelia senegalensis*) and ignored the carcass of a conspicuous pied kingfisher (*Ceryle rudis*). This lead Cott to a study of the hornet's preferences for the flesh of 38 Middle Eastern birds ranging from the very cryptic wryneck (*Jynx torquata*) to the conspicuous white crowned black wheatear (*Oenanthex leucopyga*). These, and later tests with cats, and a survey of human gastronomic preferences, confirmed Cott's thesis that bright colours are often associated with unpalatability. The phenomenon of warning (aposematic) colouration is well known in insects, and Cott extended the idea to birds. Baker and Parker point out that distastefulness is not the only basis for aposematic colouration: if a prey item is hard to catch, bright colours may evolve as a signal of unprofitability. They suggest that this might be especially applicable to birds, which once they have seen a predator can manoeuvre fast enough to be almost certain of escape. Thus the bright colours of many birds might signal not only "I am distasteful" but also (or alternatively) "I am hard to catch" or "I have seen you". As with the conventional theory of aposematic colouration, Baker and Parker's thesis assumes that bright, as opposed to

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