with unsealed radioisotopes had required and received drastic revision was explained by N. G. Trott (Royal Marsden Hospital, Sutton), although he pointed out that the current revision had not fully kept abreast of recent changes in nuclear medicine technique. N. J. D. Smith (King's College Hospital, London) surveyed a large number of practices and revealed many with many unsatisfactory protection standards. Personnel monitoring had shown consistently high exposures to many dentists and ancillary staff, who were often unaware of the existence of the code of practice. It was reported that few dentists had taken advantage of a recent monitoring scheme launched by the National Radiation Protection Board. The need for a separate, explanatory supplement to the code for dentists was evident.

The afternoon session was devoted to problems in implementing the code, and the achievement of radiation safety in the hospital service. D. C. Holdsworth (United Hospital, Sheffield) thought that clinicians could make an effective contribution in reducing patient exposure, but they needed more information in order to weigh the risks of the radiation procedure against the hazards of omission. C. K. Warrick (Royal Infirmary, Newcastle upon Tyne) described his system for implementing the '10-day rule' in a survey 12 months ago; the rule was practised by only 20% of the departments sampled. Several hospitals had demonstrated that workable systems could be operated to reduce the number of unsuspected pregnancies irradiated.

The responsibilities of the Radiation Protection Adviser in achieving radiation safety were discussed by R. F. Farr (Queen Elizabeth Hospital, Birmingham), and N. Chesney, Farr's colleague, made a plea for a clear statement of the duties of the Radiological Safety Officer and, in many cases, appropriate training for these duties was required.

W. J. Meredith (Manchester Regional Hospital Board) spoke in the unusual guise of administrator, and pointed out that the code put a heavy responsibility on the controlling authority. Apart from the need to keep the numerous formal records required by the code, there was a continuing need to keep radiation safety committees alive and active.

R. D. Moore (Weston Park Hospital, Sheffield) described his attempts to evaluate the cost of protection measures. The annual cost in the United Kingdom of health physics services in the hospitals together with the costs of structural shielding amounted to some £580,000 per year. This resulted in a consequential saving of 140,000 man-rads, that is about £4 per man-rad saved.

Coulomb-nuclear effects

from our Nuclear Theory Correspondent

An interesting example of interference between Coulomb and nuclear scattering amplitudes has recently been found in the inelastic scattering of heavy ions by nuclei. This interference can be understood classically in a qualitative way, and can also be calculated accurately using the distorted wave theory.

This interference is made possible by the particular character of the field between heavy ions, which allows incident particles with different classical impact parameters to be scattered through the same angle. To see how this comes about, consider the behaviour of the scattering angle as the impact parameter is steadily reduced.

For large impact parameters the projectile interacts only with the repulsive Coulomb field of the target, and is deflected through a small angle that steadily increases as the impact parameter is reduced. When the distance of closest approach becomes comparable to the sum of the radii of the projectile and target, the nuclear force begins to attract the projectile, thus reducing the scattering angle. At still smaller impact parameters the projectile is repelled by the centrifugal force, thus increasing the scattering angle again. The resulting variation of scattering angle is shown in Fig. 1 for 60 MeV ^{16}O ions on ^{58}Ni.

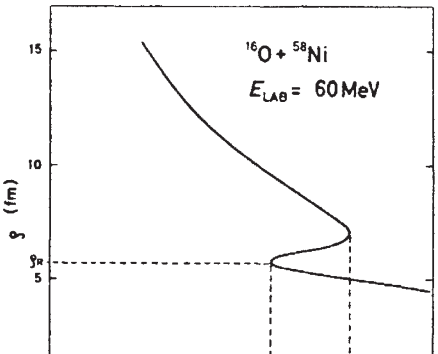

Fig. 1 Variation of the scattering angle θ with the impact parameter ρ for 60 MeV ^{16}O ions on ^{58}Ni (Malfliet, Landowne and Rostokin, *Phys. Lett.*, **44B**, 238; 1973).

In such cases there are three values of the impact parameter corresponding to each scattering angle between the critical scattering angles $\theta(R_1)$ and $\theta(R_2)$. The chief contribution to the scattering comes from angles around the critical angles, so a semi-classical theory can be made by adding the corresponding amplitudes, with appropriate phase and attenuation factors. The turning point corresponding to the larger impact parameter refers to the orbit further away from the nucleus where the projectile is moving mainly in the Coulomb field, whereas the other turning point refers to the orbit nearer the nucleus where the projectile is under the influence of both the Coulomb and nuclear fields. These amplitudes interfere, and because they vary with angle in a different way the interference is sometimes destructive and sometimes constructive.

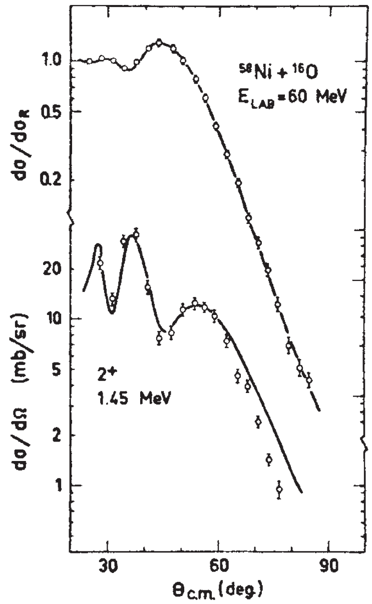

Fig. 2 Differential cross sections for the elastic and inelastic scattering of 60 MeV ^{16}O ions by ^{58}Ni showing the interference effects in the region of the critical angles. The curves are obtained using the distorted wave theory (Christensen, Chernov, Gross, Stokstad and Videbaek, *Nucl. Phys.*, **A207**, 433; 1973).

These effects appear in elastic scattering around the region of the critical angles, but are much more prominent in inelastic scattering. For small angles, the cross section for the excitation of the lowest $J^\pi=2^+$ state of the target is almost entirely due to Coulomb excitation, while for large angles it is mostly due to nuclear excitation. In the intermediate regions around the critical angles the interference effects are strongly marked as shown in Fig. 2.

The whole process can be described quantitatively by the distorted wave theory, using the appropriate vibrational model for the 2^+ state. The results of such calculations are also given in Fig. 2 and show that the interference effects are accurately given by the theory. Detailed fitting in the interference region gives improved values of the parameters of the distorting potential and of the nuclear dynamical deformation parameter.

This interference phenomenon is a good example of the way interactions between heavy ions can be understood semi-classically and then analysed by the distorted wave theory to give additional information on nuclear structure.