Fig. 2 The low-lying levels of cadmium isotopes ^{110}Cd – ^{120}Cd , as identified spectroscopically. E_x , excitation energy. The ground-state (0^+), one-phonon level (2^+) and triplet two-phonon levels (0^+ , 2^+ and 4^+) are shown, together with the additional 0^+ and 2^+ single-particle excitations close to the triplets. Closely lying states with the same symmetry become quantum-mechanically mixed, so that the additional levels take on some two-phonon character. The spectrum of ^{118}Cd also shows the five three-phonon levels (0^+ , 2^+ , 3^+ , 4^+ , 6^+) observed by Aprahamian *et al.* In spectroscopic notation, the number refers to the angular momentum of the nuclear state, and the superscript (+ or –) indicates its 'parity'.

The possibility of observing the three-phonon levels is somewhat surprising, as the excitation energy is close to the energy needed for the breaking up of nucleon pairs. For nuclei, such as cadmium, with approximately 50 protons (one of the 'magic' numbers of added stability in shell theory), the energy needed to break up pairs is about 2 MeV, twice the 'pairing-gap' energy. For cadmium, however, there being mainly one valence level involved (the $1g_{7/2}$ orbital), there are few such excitations possible at lower energy and these incoherent states are thus unlikely to perturb the coherent three-phonon levels. Other nuclei near a magic number, such as tellurium, have a more complicated single-particle spectrum, and the resultant complications easily destroy the underlying vibrational spectrum at the three-phonon level.

Aprahamian *et al.* point out that their spectrum can also be accounted for within the vibrational limit (or U(5) limit in the language of group theory) of the interacting boson model of F. Iachello and A. Arima (*The Interacting Boson Model*, Cambridge Monographs on Mathematical Physics, 1987). This limit allows for anharmonic effects in multi-phonon excitations and so describes a larger class of nuclei. Both the excitation energies and the splitting within multiplets are well reproduced, and there is some evidence of four-phonon excitations. Further work on these, as well as a full identification of the angular momentum of the three-phonon levels, should establish ^{118}Cd as a model liquid-drop-type nucleus. Perhaps a similar study of ^{120}Cd should follow. □

Kris Heyde is at the Nuclear Physics Laboratory, Gent State University, Proeftuinstraat 86, B-9000 Gent, Belgium.

Sir Peter Medawar (1915–1987)

PETER MEDAWAR, who died on 2 October, was the most distinguished British biologist of his generation. He founded transplantation biology as a scientific study, and thus laid a cornerstone of modern immunology. Under his influence, immunology became a respectable subject for biologists to enter.

His favourite experiment was to measure with meticulous precision the time taken for rejection of a skin graft. In this way he discovered that second-set grafts undergo accelerated rejection, and hence that rejection is brought about by an immunological response on the part of host lymphocytes against histocompatibility antigens in cells of the graft. This led on to identification of the lymphocyte as the immunologically reactive cell, and eventually to recognition

Sir Peter Medawar — distinguished discoveries.

that cellular immune responses are as important as antibodies to the immune system. Having identified the mechanism of rejection, he went on to discover, in the anterior chamber of the eye and elsewhere, sites where lymphocytes do not penetrate and which therefore enjoy 'immunological privilege'.

Medawar's greatest single discovery, made jointly with Rupert Billingham and Leslie Brent (and contemporaneously with independent work of Ray Owen's), was of immunological tolerance: the immune system is not pre-programmed to distinguish between self and non-self, but learns to do so as a result of exposure to self-molecules during early development. This

principle enables us to understand how the immune system is shaped, helps establish the working of clonal selection among lymphocytes, and leads on to a rational understanding of auto-immune disease. For this work, Medawar shared the Nobel prize for physiology or medicine in 1960. Thirty years later we are still arguing about just how much clonal deletion occurs in establishing a state of immunological tolerance.

The war effort and the needs of burn victims drew Medawar away from his first work, which was on the growth of embryos. He retained a strong interest in developmental biology, and his discovery with Billingham of pigment spread later persuaded him to follow the plasmagene will o'the wisp. What fascinated him was the possibility that pigmented cells might transmit into their non-pigmented neighbours self-replicating information for pigment production: alas, pigmentation turns out to spread only through cell movement.

As director of the National Institute for Medical Research between 1962 and 1971, his research focused on the development of anti-lymphocyte serum to prevent graft rejection — a sledgehammer used to crack a nut? After leaving the institute he returned finally to embryos and elegantly demonstrated cross-immunity between cancer cells and fetal tissue. He was devoted to the theory of anaplasia, which he claimed would have been widely accepted had not most cancer biologists believed her to be a defunct Imperial Russian princess.

Medawar and molecular biology is a subject that deserves an essay on its own. A good try, but a little too early? Let down by colleagues who should have made the connection (myself included)? Too difficult for an Oxford biologist of his generation, raised on genetics as a personal game played between Ford, Fisher and Haldane, to take the subject altogether seriously? Certainly Medawar warmly welcomed the advent of molecular genetics: witness his review of *The Double Helix*. But from the subject of transplantation immunology to its successor, immunogenetics, Medawar never personally quite managed to bridge the gap.

Peter Medawar was endowed with a sense of humour, a profound respect for the creative individual, and a dislike of pomposity. One has no difficulty in imagining what he would have made of current notions on "central initiatives" and "University Research Centres". His own research was invariably carried out within a small, personally devoted group.

N.A. Mitchison

N.A. Mitchison is in the Department of Zoology and Comparative Anatomy, University College London, London WC1E 6BT, UK.