infection with recombinants with multiple gene exchanges produces less severe clinical illness. A multigeneic determination of virulence was also favoured by J. L. Schulman (Mount Sinai School of Medicine, New York) who found that in random recombinants of a low yielding and a high yielding strain of influenza virus the genes for proteins NP, M and NS were selected in recombinants which replicated in high titres while no such selection for P genes was observed. W. J. Bean (St Jude Children's Hospital, Memphis) found that virulent recombinants always contained the NP gene from the virulent strain and, in contrast to Schulman's findings, gene 3 which codes for one of the P proteins. J. Oxford (National Institute for Biological Standards, London) isolated a clone derived from recombinants of virulent and avirulent human influenza strains which contained all the genes, except the two coding for the surface glycoproteins, from the avirulent parent but which was virulent for man. It seems that some fine coordination exists between the genes for the internal proteins of influenza virus whose balance can be upset either by mutation or recombination. This set of genes is in turn dependent on the two surface antigens for its expression.

Defective particles

Defective interfering virus particles are aberrant virus particles which lack parts of the virus genome and are produced when virus is passaged at high multiplicities. These DI particles interfere with the replication of normal virus particles and could be a host defence mechanism. That a host function is required for DI particle formation was shown by C. Y. Kang (University of Texas, Dallas) who found that VSV DI particles could not be produced in cells pretreated with actinomycin D, while if present in the inoculum DI particles can be replicated in the presence of the drug. DI particles can be derived from either the 5' or 3' ends of the non-defective genome. Those derived from the 5' end are capable of only a very limited RNA synthesis *in vitro* and are thought to inhibit the non-defective virus at the replicase level. J. Perrault (University of California, San Diego) and D. Kolakovsky (University of Utah, Salt Lake City) described DI particles derived from the 5' ends of VSV and Sendai virus, respectively, with inverted complementary terminal sequences. These inverted complementary sequences at the 5' end presumably confer a replicative advantage on the DI particles, since synthesis of both plus and minus strands could be achieved by the same replicase which normally recognises the

sequences at the 3' ends of the minus and plus strands.

R. A. Lazzarini (National Institutes of Health, Bethesda) described another type of DI particle of VSV derived from the 3' end of the genome. This DI particle has a leader RNA sequence and the genome is transcribed into 12–17S mRNA *in vitro* and *in vivo* without a helper virus. It lacks the greater part of the L-protein gene which is nearest the 5' end of the non-defective genome. In mixed infections, in addition to interfering with the replication of the infectious virus, it can augment the production of virus proteins, a phenomenon which may in some way trigger an enhanced immune response by the host. Clearly DI particle formation and its mode of interference is a complex process and one which will become increasingly important from the point of view of their possible role in the treatment of virus diseases. □

Nuclear radii and magnetic moments by laser spectroscopy

from P. E. Hodgson

THE charge and matter distributions of nuclei, and their magnetic moments, are important features of nuclei, and many efforts are being made to determine them with increasingly high precision. It is often instructive to see how they change through a series of isotopes of the same element, but such studies are limited by the availability of the separated isotopes in sufficient quantities for accurate measurement. This makes it desirable to develop methods that are applicable to very small quantities of the isotope, so that measurements can be carried out on rare and on radioactive isotopes.

One of these methods uses high resolution laser spectroscopy, and the results of a determination of the nuclear radii and magnetic moments of ^{128}Ba and ^{131}Ba in this way has recently been reported by Nowicki and colleagues from the Nuclear Research Centre at Karlsruhe (*Phys. Rev. Lett.* **39**, 332; 1977).

The isotopes of barium were produced by (d,xn) reactions and subsequent β -decay from enriched ^{130}Ba and ^{134}Ba . The isotope ^{131}Ba was also produced by neutron irradiation of enriched ^{130}Ba in a nuclear reactor. The isotopes were enriched by an electromagnetic mass separator. This produced between 1 and 10 ng of the

isotope, sufficient for the laser method. The sample was in each case placed in an atomic-beam oven to produce a collimated beam of atoms. There is a second reference beam using the natural isotopic mixture. Light from dye lasers is passed through the atomic beams and this enables the hyperfine structure of a selected transition to be determined.

In this work the hyperfine structure of the 553.6 nm resonance transition $6s^2\ ^1S_0$ – $6s6p\ ^1P_1$ was measured by resonance fluorescence. The frequency of this transition, and indeed of all transitions, is slightly affected by the spatial extent of the nuclear charge distribution, and a quantum mechanical analysis shows that the shift in the frequency is proportional to the mean square radius of the charge distribution. The change in frequency from one isotope to another is thus proportional to the difference between their mean square radii.

This experiment gave for the mean square radius difference between barium 131 and 130 a value of -0.006 fm^2 and between barium 130 and 128 a value of 0.022 fm^2 . These results are shown in the figure, together with corresponding values for other isotopes. This shows that the general trend of the charge radii continues smoothly for the even isotopes and that the large odd-even staggering is markedly reduced at neutron number 75. The magnetic moment can also be calculated from the hyperfine splitting, and a value of $-0.714\ \mu_N$ is found for ^{131}Ba . □

Differences of mean square radii of the barium isotopes as obtained from optical isotope shifts. The straight line shows the dependence to be expected from a standard homogeneous sphere.