relatively long lived intermediate particle in early shower interactions. But they stress the preliminary nature of their conclusion.

HISTORY OF SCIENCE

Crystalline Species

from a Correspondent

CRYSTALLOGRAPHY is usually associated with chemistry, but when Dr Seymour Mauskopf of Duke University, North Carolina, addressed the British Society for the History of Science last week, he traced its origins to biology. Not until the seventeenth century was the growth of crystals seen to be different from that of animals or plants, and only then did the independent science of crystallography (as opposed to practical skills connected with mining) arise. In the eighteenth century, moreover, the chief concern of biologists was with taxonomy, and this interest in the classification of animals and plants naturally spread to the study of minerals. It is no coincidence that the earliest interests of the French Abbé R. J. Haüy, the first great crystallographer, were in botany.

Dr Mauskopf's principal concern last week was with the growing interaction between crystallography and chemistry in the early nineteenth century, which proved so fruitful for both and has led to their close association ever since.

It is now a commonplace to say that Dalton's atomic theory was merely a formal and quantitative statement of a belief implicitly held by all chemists: that matter is particulate. Nor was this belief confined to chemists; in the hands of the Frenchmen de Lisle and Haüy it became the basis of crystallography. But whereas Dalton was interested in the weight and chemical nature of his particles, the crystallographers were concerned almost exclusively with the geometrical shapes of theirs. Daltom's atoms were spherical; Haüy's "integrant molecules" were polyhedral building blocks which formed macroscopic crystals.

Like Linnaeus, Haüy was a firm believer in the fixity of species. As criteria for the determination of crystal species, he used the two properties of shape (any individual mineral substance will exist only in forms that can be built up from a single type of building block) and chemical purity. These two criteria correspond closely to the chemical doctrine of definite proportions, which was almost contemporaneous. This correspondence was apparent at the time; Berthollet, the most ardent opponent of the chemical law, also attacked Haüy's crystallographic system. The establishment of chemically definite proportions lent weight and acceptance to the crystal theory. Berzelius attempted to integrate mineralogy and chemistry, and Ampère tried to construct a whole theory of matter based on Haüy's "integrant molecules" and thus arrived at an independent statement of what we know as Avogadro's hypothesis.

Various anomalies in Haüy's system were corrected in the 1830s with the discovery of isomorphism and polymorphism by the German chemist Mitscherlich. But probably more important than all these interactions between chemistry and crystallography was the fact that by his investigation of the isomeric tartrates Pasteur, who was trained as a crystallographer, opened up the whole of stereochemistry. His interest in the tartrates led to the study of fermentation, and ultimately to the germ theory of disease. Crystallography, originally an offshoot of biology, again contributed, by this tortuous route, to biological progress.

HYBRID CELLS

Human Ribosomal RNA

from our Cell Biology Correspondent

THE technique of cell hybridization—the fusion of two or more different cell types from the same or different species—is one of the most promising techniques for the elucidation of the intractable problems of gene expression in higher organisms. Inevitably the properties of any particular hybrid cell depend largely on the properties of the parental cells which are fused together. In the latest issue of the *Journal of Molecular Biology* (**41**, 253; 1969), for example, Eliceiri and Green report a curious property of human–mouse hybrids which may throw some light on the control of ribosomal RNA synthesis. The 28*S* ribosomal RNAs of mouse and human cells have identical mobility when subjected to polyacrylamide gel electrophoresis, but if the RNAs are heated before electrophoresis the mobility of the human ribosomal RNA changes whereas that of the mouse RNA is unchanged. Using this technique to distinguish between the two sorts of RNA, Eliceiri and Green have found that only mouse 28*S* ribosomal RNA appears to be made in human–mouse somatic cell hybrids which contain up to thirty-five human chromosomes per hybrid cell.

There are obviously several possible explanations of this odd phenomenon. It is possible that all the human ribosomal RNA genes are clustered in the human chromosomes missing from the hybrid, but this seems unlikely because ribosomal RNA genes occur on at least five different human chromosomes and there is no reason to suspect that these chromosomes are selectively lost in the hybrids. Another explanation, that human ribosomal RNA is made but rapidly breaks down, has also been eliminated by pulse labelling experiments. The formal possibility that human ribosomal RNA is acted on by mouse cell enzymes so that it acquires the electrophoretic mobility of mouse ribosomal RNA is inherently unlikely. And because human ribosomal RNA is not altered when incubated with extracts of mouse cells this possibility can be dismissed.

That leaves the most likely explanation, namely that in the hybrids some regulatory mechanism prevents transcription of human ribosomal RNA genes but not their mouse counterparts. In other plant and animal cell hybrids the function of the nucleolar organizing chromosomes of one of the parental cells is suppressed while the comparable chromosomes of the second parental cell function. In the human–mouse somatic cell hybrids there are up to a dozen nucleoli: whether they are all mouse nucleoli remains to be seen.

NUCLEAR PHYSICS

Three Quarks or Five?

from a Correspondent

ONE of the most encouraging features of high energy physics in recent years has been the classification of