microamorphous, and microphanitic, and further on a geometric basis into microgranular, microlamellar, and microfibrous. More recently, Klos et al. reported that, unlike microcrystalline quartz, microcrystalline quartz crystals generally show no sharp inversion point, and the inversion takes place over an interval of nearly 50°C. Their work suggests that it is best to describe the product of powdering quartz as microcrystalline quartz, which has an X-ray structure corresponding to quartz but is not normally detectable by d.t.a. unless carried out at high heating rates. In addition, this microcrystalline quartz coexists with chemisorbed H₂O.

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Image Formation by Induced Local Interactions: Examples Employing Nuclear Magnetic Resonance

An image of an object may be defined as a graphical representation of the spatial distribution of one or more of its properties. Image formation usually requires that the object interact with a matter or radiation field characterized by a wavelength comparable to or smaller than the smallest features to be distinguished, so that the region of interaction may be restricted and a resolved image generated.

This limitation on the wavelength of the field may be removed, and a new class of image generated, by taking advantage of induced local interactions. In the presence of a second field that restricts the interaction of the object with the first field to a limited region, the resolution becomes independent of wavelength, and is instead a function of the ratio of the normal width of the interaction to the shift produced by a gradient in the second field. Because the interaction may be regarded as a coupling of the two fields by the object, I propose that image formation by this technique be known as zeugmatography, from the Greek ζυγματογραφία, "that which is used for joining".

The nature of the technique may be clarified by describing two simple examples. Nuclear magnetic resonance (NMR) zeugmatography was performed with 60 MHz (5 m) radiation and a static magnetic field gradient corresponding, for proton resonance, to about 700 Hz cm⁻¹. The test object consisted of two 1 mm inside diameter thin-walled glass capillaries of H₂O attached to the inside wall of a 4.2 mm inside diameter glass tube of D₂O. In the first experiment, both capillaries contained pure water. The proton resonance linewidth, in the absence of the transverse field gradient, was about 5 Hz.

Assuming uniform signal strength across the region within the transmitter–receiver coil, the signal in the presence of a field gradient represents a one-dimensional projection of the H₂O content of the object, integrated over planes perpendicular to the gradient direction, as a function of the gradient coordinate (Fig. 1). One method of constructing a two-dimensional image of the object, as represented by its H₂O content, is to combine several projections, obtained by rotating the object about an axis perpendicular to the gradient direction (or, as in Fig. 1, rotating the gradient about the object), using one of the available methods for reconstruction of objects from their projections. Fig. 2 was generated by an algorithm, similar to that of Gordon and Herman, applied to four projections, spaced as in Fig. 1, so as to construct a 20 × 20 image matrix. The representation shown was produced by shading within contours interpolated between the matrix points, and clearly reveals the locations and dimensions of the two columns of H₂O. In the second experiment, one capillary contained pure H₂O, and the other contained a 0.19 mM solution of MnSO₄ in H₂O. At low radio-frequency power (about 0.2 mWatt) the two capillaries gave nearly identical images in the

Fig. 1 Relationship between a three-dimensional object, its two-dimensional projection along the Y-axis, and four one-dimensional projections at 45° intervals in the XZ-plane. The arrows indicate the gradient directions.

Fig. 2 Proton nuclear magnetic resonance zeugmatogram of the object described in the text, using four relative orientations of object and gradients as diagrammed in Fig. 1.
line widths may be generated, NMR zeugmatography of solids, electron spin resonance zeugmatography, and analogous experiments in other regions of the spectrum should also be possible. Zeugmatographic techniques should find many useful applications in studies of the internal structures, states, and compositions of microscopic objects.

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BIOLOGICAL SCIENCES

Island Lizards: the Genetic-Phenetic Variation Correlation

Natural populations of many organisms are known to contain much more genetic variation than would have been predicted by all but a minority of geneticists two decades ago. Individuals of several species have up to 2% of their loci heterozygous, and from 0-5% or more of the loci in a population are polymorphic, although the higher estimates may result from sampling error. Vertebrates tend to be at the lower end of these ranges. Estimates such as these are based on electrophoretically detectable variation in proteins, so the true levels of genetic variation are probably higher. These generalizations are gaining wide acceptance, but there is still some unease about their accuracy. The fundamental question is whether the loci being sampled are representative of the genome as a whole. We here present evidence that the electrophoretic approach is relatively unbiased.

Two groups of lizards were used: eight species of Anolis from the West Indies and thirteen populations of the side-blotched lizards Uta stansburiana, sensu lata, from California and Mexico, caught in 1971 and 1972. Geographic variation is not a source of heterogeneity, as all specimens from a locality were collected within a few hundred metres of one another. After capture, they were transported alive or on dry ice to the laboratory and stored at -76°C until needed. After skimming, water-soluble proteins were routinely extracted and electrophoresed. Six of the eight Anolis species were from Puerto Rico, and two, A. extremus and A. roquet, were from Barbados and Martinique, respectively.

A single morphological character was used to estimate morphological variation in the Anolis species; the number of subdigital scales on the longest toe (second) on the hind foot, starting with the most distal lamella and counting proximally. Variability in this character is correlated with variability in other scale characters, but the other characters were not scored as accurately. Estimates of genetic variation in the Anolis species were derived from the starch-gel electrophoresis patterns of enzymes and nonenzymatic proteins, which together appear to represent the gene products of twenty-one or twenty-two loci. The proteins assayed were lactate dehydrogenase, malate dehydrogenase, alpha-glycerol-phosphate dehydrogenase, lactate dehydrogenase, indophenol oxidase, phosphoglucone isomerase, phosphoglucomutase, glutamic oxa...