

light, other things remaining the same. We have the blue and green sectors on one side and the red sector on the other side. What observation tells us is that the result is a purple sensation. We can therefore identify this sensation as the result of the superposition of the blue, green and red sectors, the yellow sector being absent. Observation likewise tells us that when the red is also weakened, even if it is not actually extinguished, the sensation perceived is blue. In other words, the observed sensation changes from purple to blue if the balance is tilted towards shorter wavelengths by lowering the intensity of greater wavelengths. If, further, the blue sector is much weakened, the sensation perceived is green, even though the red has not been totally extinguished. Thus, in every case, it would be seen that the perception of colour is determined by the domination or masking of the weaker by the stronger sensations. It is also evident from the facts that the blue and the green sectors are not antagonistic to each other, the perceived sensation arising from their co-operation being a blue or a green or an intermediate colour, according to the circumstances of the case. Other examples of transitional colours present themselves in the sequence of hues ranging from a pure yellow to a pure red through the intermediates of an orange-yellow, an orange and a scarlet.

*The Trichromatic Hypothesis.*—From the theoretical standpoint, each of the numerous

distinguishable colours we can perceive in the spectrum is an independent visual sensation. The trichromatic theory of colours bases itself on the idea that the perceived colours of polychromatic radiation can be described in terms of "three fundamental sensations" and that these may be summed up making use of a set of empirically determined coefficients (positive or negative as the case may be) which vary from point to point over the spectrum. That the procedure is highly artificial is obvious, and its claim to acceptance disappears when the basic idea and its consequences are found to be flatly contradicted by the facts of observation. As we have seen, the circumstances in which polychromatic radiation actually presents itself to our perceptions as exhibiting such readily recognisable colours as purple, blue, green and red are very different from those contemplated by the trichromatic hypothesis.

One of the reasons for this failure of the trichromatic hypothesis stands out clearly. That hypothesis regards red, green and blue as the major visual sensations and relegates the sensation of yellow to a minor and secondary or derivative position. Actually, it is yellow which is the major visual sensation, while the red, green and blue though more colourful are only its subsidiaries. They are perceived as full colours only when the yellow is put out of the way.

## CHEMICAL REACTIONS BY LASER LIGHT

WITH the advent of the laser the observation of 'two-photon' absorption processes at optical frequencies has become possible. Y. H. Pao and P. M. Rentzepis of the Bell Telephone Laboratories have reported experiments where this effect has been used for the first time to induce a specific chemical reaction. By irradiating a sample of distilled styrene monomer with light from a pulsed laser they succeeded in obtaining polystyrene. The sample was kept at the temperature of liquid nitrogen ( $-192^{\circ}\text{C}.$ ) to stabilize free radicals released during the process. Following irradiation by a succession of some 20 laser pulses, the sample was warmed to room temperature when the polymer was precipitated. An infra-red spectrum analysis showed the precipitate to be identical to the known polymer, polystyrene.

Monochromatic light from ruby laser has a wavelength  $6948\text{ \AA}$  which is equivalent to a quantum of energy  $1.8\text{ eV}$ . Ordinarily, photon

of this energy cannot be absorbed by styrene monomers to induce chemical reaction. However, when an intense laser beam interacts with the molecular system, pairs of photons are absorbed almost simultaneously to excite the monomer molecule by  $3.6\text{ eV}$ . This in turn causes the formation of free radicals and induces polymerization.

It is pointed out that the 'two-photon' absorption process proceeds in two stages by means of transient intermediate or 'virtual' states of molecules whose energies are about  $1.8\text{ eV}$  and whose lifetimes are of the order  $10^{-13}$  or  $10^{-14}$  seconds only. These short-lived states become significant only under very high photon flux when transitions from them to the final state (of about  $3.6\text{ eV}$ ) may be induced. The authors believe that the experiment demonstrates a general phenomenon and that other multiphoton reactions may be induced by laser light.—(*Applied Physics Letters*, March 1, 1965.)