factor which promotes the transcription of phage DNA but which has no polymerase activity on its own account. This material is not apparent in the first few minutes of infection, but turns up between about five and fifteen minutes afterwards. Whether this factor is actually an analogue of the sigma factor remains finally to be demonstrated—its lability has so far frustrated attempts outside the cell to show that it does actually enable RNA polymerase to transcribe the appropriate parts of the T4 genome. Indirectly, however, there is reason to think that Travers may have found a second potentiating factor of RNA polymerase.

What will come next? Most probably, there are further controlling factors to be identified. The genes transcribed by those which have been discovered so far are both on the same strand of the helical double molecule of DNA from T4, but it is known that RNA molecules that have been transcribed from the complementary strand of the DNA molecule make their appearance after about ten minutes of infection. So are there also special factors responsible for bringing these to light?

There also remains the problem of what happens to the RNA polymerase in cells of *E. coli* infected with bacteriophage. It is known that the normal enzyme is modified by the infective process. Although both forms respond in the same way to the sigma factor, Travers claims that the modified enzyme binds less tightly to the sigma factor than does normal RNA, which in turn implies that it can exchange one protein factor for another comparatively easily. The modification of RNA polymerase which seems to follow from T4 infection may thus be an adaptation to the need of the T4 bacteriophage to switch from one pattern of transcription to another as the infective cycle proceeds.

As always—or nearly always—in molecular biology, the bearing of these developments on the processes which occur in cells other than those of *E. coli* is largely a matter of conjecture. With promoting agents such as those now identified and repressor molecules which serve to inhibit the expression of certain genes, it seems permissible to consider a hierarchy of controlling factors, some positive and some negative. This fills out the picture of DNA transcription in an especially pleasing way. It also provides a further incentive for the study of the kinetics of DNA transcription, much neglected since the recognition that histone chemistry is not the answer to every prayer.

BACKGROUND RADIATION

Isotropic Microwaves

from our Astronomy Correspondent

THE current issue of *Monthly Notices of the Royal Astronomical Society* contains two papers which refer to the isotropy of the microwave background radiation discovered by Penzias and Wilson in 1965 (**144**, 255 and **144**, 279; 1969). The first adds gravitational waves to the list of factors which could conceivably produce anisotropy in the background, while the second considers how the isotropy is relevant to the helium problem—the question of how much helium there is in the universe and its significance in cosmology. Both take as their starting point the familiar notion that the microwave background is a byproduct of the fireball in the big bang cosmology. The hope has been that the anisotropy of the background would throw some light on the irregularities in the fireball which might have given rise to the clumping of matter in the universe into galactic clusters. So far, however, only upper limits have been placed on any anisotropy which may be present, and low upper limits at that. The Stanford group, for example, find that fluctuations on a scale of a degree must be less than 0·2 per cent, at least in the region of the sky which they covered (Conklin and Bracewell, *Phys. Rev. Lett.*, **18**, 614; 1967). But the theoretical evidence is that the anisotropy is in any case likely to be finer than this.

In the first paper, G. Dautcourt of the Babelsberg Observatory in East Germany considers how the deflexion of photons by gravitational fields (the well known bending of light beams by the Sun) and the scattering of photons by gravitational waves might produce anisotropy. Dautcourt agrees with others who have trodden the path before that the deflexion of photons by gravitational fields is unlikely to be important—except perhaps for a supercluster of galaxies. But Dautcourt shows that scattering by a background of gravitational radiation could be significant if the gravitational background results from turbulent motions in the original fireball. According to this, the Stanford measurements of the microwave isotropy can place upper limits on the energy density of such a gravitational background.

The second paper is by R. F. Carswell of the University of Sussex, who looks at the isotropy in terms of the helium problem. According to Carswell, there is good reason to choose an anisotropic model universe in the calculations, especially one which is axially symmetric. Using such a model and combining it with the upper limits for the microwave anisotropy, some information on the production of helium during the early stages of the universe can be gained.

Helium is important chiefly because the amount of it in the universe at present often seems larger than can be accounted for by the normal hydrogen-burning processes in stars. What is left over could be helium formed at the time of the big bang, and one possibility is that the precise amount of extra helium in stars might be used as a test to distinguish between different variations of the big bang cosmology. Carswell says that the amount of helium produced by some of his models can be less than five per cent by mass—appreciably less than the twenty per cent or so which is usually deduced from big bang models to account for the extra helium. But recent observation of helium abundances appreciably lower than the initial helium production in conventional big bang models has aroused interest in models producing low amounts of helium. Carswell agrees in the paper that the low abundance of helium which he has derived does not follow easily from the model—in particular, if new measurements reduce even further the degree of anisotropy which could be present, then it becomes impossible to account for the low helium abundances.