are absorbed by the filter and which impinge on the retina when it is removed.

Colour Filters of Tropæolin.—Three filters were prepared with this dye-stuff which by transmitted light exhibited respectively a golden yellow colour, a deep yellow and an orange-yellow hue respectively. The first of the three filters showed a cut-off of the shorter wavelengths in the spectrum up to 450 mμ and a noticeable absorption up to 500 mμ. With the second filter, the cut-off has shifted to 490 mμ with a perceptible absorption up to 510 mμ. The third filter exhibits a cut-off at 500 mμ and an appreciable absorption up to 520 mμ.

Observations with these three filters showed the effects already noticed with the auramine-yellow filters and described in the preceding chapter. Following the removal of the filter from before the eye of the observer, he notices a coloured glow over the screen, this however being definitely absent at the centre of the field in a circular area corresponding to the projection of the fovea of his retina on the screen. The colour of the glow is violet for the first, blue for the second filter and bluish-white for the third, the brilliancy of the glow increasing in that order. A dark spot at the centre of the foveal disk is very clearly seen. There are also indications of a radial structure in the foveal area.

Colour Filters of Acridene Orange.—Four filters were prepared with this dye-stuff. By transmitted light they exhibit a light orange hue in the case of the first filter, and progressively deeper orange hues for the others in the series. Spectroscopic examination showed that the first filter extinguishes all the shorter wavelengths in the visible spectrum up to 525 mμ. The wavelength of cut-off shifts to 535 mμ for the second filter, to 545 mμ for the third filter and to 550 mμ for the fourth.

The effects observed with the first of the acridene orange filters are very similar to those exhibited by the third of the series of tropæolin filters. In particular, the darker region at the centre of the field corresponding to the fovea was quite clearly seen. With the more heavily dyed filters of the series, this central region is less well-defined and less clearly observable. The appearance of the screen following the removal of the filter does not indeed differ very much from its appearance in the absence of the filter. A short-lived bright glow with a hint of blue in it is all that is actually observed.

THE SOLAR RED SHIFT

ONE of the predictions (the third prediction) of the General Theory of Relativity is the solar red shift, *i.e.*, spectral lines emitted by an atom in the sun, because of the higher gravitational potential of the sun, would be shifted to longer wavelengths as compared to corresponding terrestrial lines observed in the laboratory (*cf.* Recent attempts to test this prediction by Mossbauer effect). That there is such a solar red shift has been readily observed, but accurate measurements have proved the existence of a definite variation in the numerical value of the shift across the disk of the sun. The shift, instead of being constant as Einstein's prediction would require, is less than half the predicted value at the centre of the disk, and increases nearly to the predicted value near the limb. No satisfactory explanation could be given to this observational curve of variation of red shift across the solar disk.

In a paper to the *Canadian Journal of Physics* (1965, 43, 57) A. H. Gillieson explains the observed solar red shift curve of variation as the resultant of *two* gravitational effects: first the Einstein effect on the atom emitting the photon, and second, an effect on the emitted photon during its travel from the sun to the earth. To calculate the gravitational effect on the emitted photon, Gillieson postulates a dumbbell-shaped quantum mechanical model of the photon, having two "effective masses" each $m/2$ at the ends of an "effective diameter" $2r$, and rotating with a frequency v, and moving in the direction of the axis of rotation with a velocity c. Calculations have shown that the resultant of the two effects produces a curve similar to the observed one.

A theoretical consequence of the gravitational photon effect is that in addition to the bending of a light ray in passing close to the limb of the sun (the second prediction of Einstein), there should also be a slight reddening.

Based on this photon model the extra-galactic red shifts are interpreted as caused not by the Doppler effect caused by the recession of the galaxies (postulating an expanding universe) but by interaction and consequent loss of energy of the photon in passing through the inhomogeneities of the gravitational field in space.

From consideration of the ultimate fate of energy-degraded photons, the continuous creation of matter from such degraded radiation is suggested.—(*Canad. Jour. Phys.*, 1965, 43, 57.)