ing behaviour is involved, but it cannot account for my strain differences in the latter maze in CL and CR (the changes between the first and second choice points in the probabilities of turning left or right) and it is necessary to introduce another variable, namely genetic differences in associative learning.

All Bicker and Spatz have done is to confirm Murphey's[3] demonstration that *Drosophila* show spontaneous alternation. This would explain why they obtained similar results in the dark and need not refute my suggestion that the flies associate passage through the maze with visual cues. In any case, one would expect very little learning in their maze, where there is only one forced turn between the two choice points, whereas my maze had a sequence of six forced right–left or left–right turns.

Finally, I should like to stress the need to consider both genetic variation and apparatus differences in maze learning work with *Drosophila*. First, I found large strain differences in learning, and other workers should similarly use a wide variety of strains, rather than just one, if they wish to demonstrate learning. Second, Hay and Crossley (submitted for publication) showed with a maze rather like the one used by Bicker and Spatz but with an extra forced turn, that such apparently minor apparatus variations as the length of the connection between the start-tube and the first choice point can have very large effects on the probabilities of turning left or right. For example, the values of CL for males of the LM 20 strain varied from a mean ± s.e. of -0.069 ± 0.058 to $+0.491 \pm 0.102$ depending on the apparatus. Thus apparatus specifications need to be considered carefully in replicating the maze-learning work but in turn offer a means of studying in more detail some of the factors that determine turning preferences in *Drosophila*.

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Comments on a closed galaxy model for cosmic-ray propagation

Rasmussen and Peters[1] have presented a model of cosmic-ray propagation in which the particles do not escape from the galactic confinement region, but are eventually absorbed by meson-producing interactions with the interstellar gas. This contrasts with the generally accepted 'leaky-box' model in which cosmic rays escape from the Galaxy after traversing ~ 4 g cm^{-2} of interstellar gas. We consider here the intensities of positrons and γ rays implied by the two models.

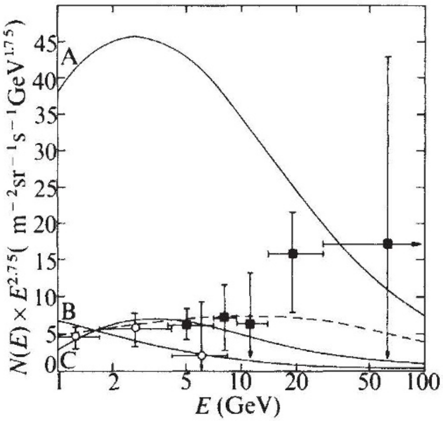

Fig. 1 Positron intensities above 1 GeV. – – –, Leaky-box model with average matter traversal of 4 g cm^{-2} and $E_{\mathrm{mod}} = 0.4$ GeV; ———, closed galaxy model with various values of E_{mod} and n_H (see text). ○, From ref. 3; ■, from ref. 4.

In Fig. 1, which is adapted from a figure of Orth and Buffington[2], the dashed line shows the positron intensity calculated by them for the leaky-box model. For the case of no escape of positrons, appropriate to the closed galaxy model, the solution of the diffusion equation for the positron intensity is

$$N(E) = q_0 E^{-\Gamma}(\Gamma - 1)^{-1}(Eb + a)^{-1}$$

where $q_0 E^{-\Gamma}$ is the rate of production of positrons by the observed equilibrium nuclear flux. Their rate of energy loss is $bE^2 + aE$, the first term corresponding to synchrotron and inverse Compton losses and the second to bremsstrahlung. Both q_0 and a are proportional to n_H, the effective mean density of interstellar gas traversed by the cosmic rays (nucleons cm^{-3}). Taking the rate of production of positrons given by Orth and Buffington; and $b = 10^{-16}$ GeV^{-1} s^{-1} the interstellar positron intensity is

$$N(E) = \frac{514E^{-2.65}n_H}{(E+8.0n_H)}\,\mathrm{m}^{-2}\,\mathrm{sr}^{-1}\,\mathrm{s}^{-1}\,\mathrm{GeV}^{-1}$$

To compare this with observations, the modulation of the intensity by the interplanetary magnetic field has to be included. The modulation factor is expected to have the form

$$\exp(-E_{\mathrm{mod}}/E) \text{ for } E > 1 \text{ GeV}$$

The leaky-box spectrum in Fig. 1 was obtained using $E_{\mathrm{mod}} = 0.4$ GeV and $n_H = 1$ cm^{-3}. Curve A is our calculated closed galaxy positron spectrum for the same values of these parameters. The observations show that either a lower n_H or a higher E_{mod} is required. It is not unreasonable to reduce n_H as a larger confinement volume is natural for the closed galaxy model. Curve B is obtained by fixing $E_{\mathrm{mod}} = 0.4$ GeV and varying n_H to give a weighted best fit to the observations. The optimum value is $n_H = 0.027$ cm^{-3} implying that the lifetime of cosmic rays in the Galaxy is $\sim 5 \times 10^9$ yr. If we regard E_{mod} as a free parameter we obtain the joint optimum values for n_H and E_{mod} of 0.1 cm^{-3} and 2.3 GeV respectively (curve C). It is not possible to rule out a modulation as large as this, at least down to 1 GeV, although the non-thermal radio background would favour the smaller value.

Independent evidence is provided, however, by the galactic γ-ray emission above 100 MeV from around the anticentre direction. Dodds *et al.*[5] have shown that if nuclear cosmic rays at their local interstellar density filled the disk out to the edge of the Galaxy, their interactions with the observed neutral hydrogen would produce twice as many γ rays as observed. Agreement with observation is obtained if, for instance, the cosmic-ray intensity decreases with galactic radius, R, in proportion to the mass density or if the intensity remains constant out to $R = 12$ kpc and is zero beyond. This type of behaviour is unlikely for the closed galaxy model, which favours a large confinement volume with a uniform cosmic-ray intensity. The γ rays are produced by cosmic-ray nuclei in the 1–10 GeV range. $E_{\mathrm{mod}} = 0.4$ GeV was assumed in deriving the local interstellar intensities of nuclei used by Dodds *et al.* from those observed at the Earth. For $E_{\mathrm{mod}} = 2.3$ GeV the intensity could be greater and the discrepancy in the γ-ray flux would be increased by a further factor of two. Thus we conclude that, although the closed galaxy model can be reconciled, as its authors state, with the observed positron flux, there are difficulties in making it agree at the same time with the observed γ-ray flux from the anticentre direction.

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