This evidence, although strong, is circumstantial; but more direct support comes from comparisons of physical and chemical characteristics. The Australasian and Ivory Coast bottle green microtektites are very similar in appearance; they are transparent pale green and vary in shape from spherical to irregular. But by contrast with the range of smooth to grooved and pitted surfaces of the normal microtektites, the bottle green ones have deeply corroded surfaces. Thus the normal and bottle green microtektites are quite distinguishable from each other on the basis of surface texture and colour (although more easily in the case of the Australasian bodies). On the other hand, in both areas the normal and bottle green microtektites are similar in that they do not contain crystalline inclusions—and this distinguishes them from igneous glasses. Moreover, although the bottle green microtektites differ from the normal variety in having no vesicles, they also differ in this respect from igneous glasses. Finally on the physical side, bottle green microtektites are found to have higher densities and refractive indices than most normal microtektites; but the similarities are maintained in so far as the group of high-magnesium Australasian tektites reported by Chapman and Scheiber (*J. Geophys. Res.*, **74**, 6737; 1969) also have the higher densities. In short, the density ranges for normal and bottle green microtektites overlap.

As far as chemistry is concerned, the Australasian bottle green microtektites have significantly different compositions and trends from those of the normal microtektites. The two Ivory Coast types have different compositions—the bottle green ones have lower SiO_2, Na_2O and K_2O, but higher MgO, FeO and CaO—but the same oxide trends. Moreover, the bottle green microtektites from the two areas have similar compositions. The normal Ivory Coast microtektites are, however, in many ways similar in composition to high silica Australasian bottle green microtektites, the chief difference being the lower FeO and the higher CaO and TiO_2 of the latter. And the bottle green Australasian microtektites overlap in composition with the high magnesium tektites of Chapman and Scheiber.

All this is very confusing; but what it amounts to is that the normal and bottle green microtektites have both chemical differences and similarities. The fact is, however, that whatever the differences are, they are distinct from the differences between microtektites and igneous glasses. This is particularly apparent when compositions are plotted on an MgO–K_2O–Na_2O ternary diagram. Both tektites and microtektites have higher MgO and lower Na_2O contents than igneous glasses for similar SiO_2 contents, and the bottle green microtektites lie on a trend which continues smoothly into the normal microtektites and tektites. The trend for igneous glasses is conspicuously different. Glass thus concludes that the bottle green microtektites are properly named.

But does this conclusion have any bearing on the origin of tektites and microtektites, a matter of long dispute? Glass believes it does. Whatever the precise origin of tektites, most workers seem to agree that they are produced in some sort of impact process—and if this is the case, tektite compositions should give some clue to the nature of the originating material. The most abundant bottle green microtektites have SiO_2 contents of 48 to 54 per cent and on average comprise 61 per cent pyroxene and 22 per cent plagioclase. They also contain normative corundum and quartz and small quantities of orthoclase and ilmenite. These data suggest that if the originating material were igneous it would have been gabbroic. It would seem, however, that the Al_2O_3 and MgO contents of the bottle green microtektites are much higher than in gabbroic rocks. Furthermore, the bottle green microtektite compositions are not similar to that of any important meteorite group nor to any produced by the mixing of normal meteoritic material with normal tektite material. Nor (*pace* certain theorists who would place the origin of tektites on the Moon) do they correspond to any important group of lunar material returned to Earth. The obvious conclusion is that if the originating material is on the Earth it must be extremely rare—so rare, in fact, that none has yet been found. The constraint in the origin of tektites and microtektites is thus severe.

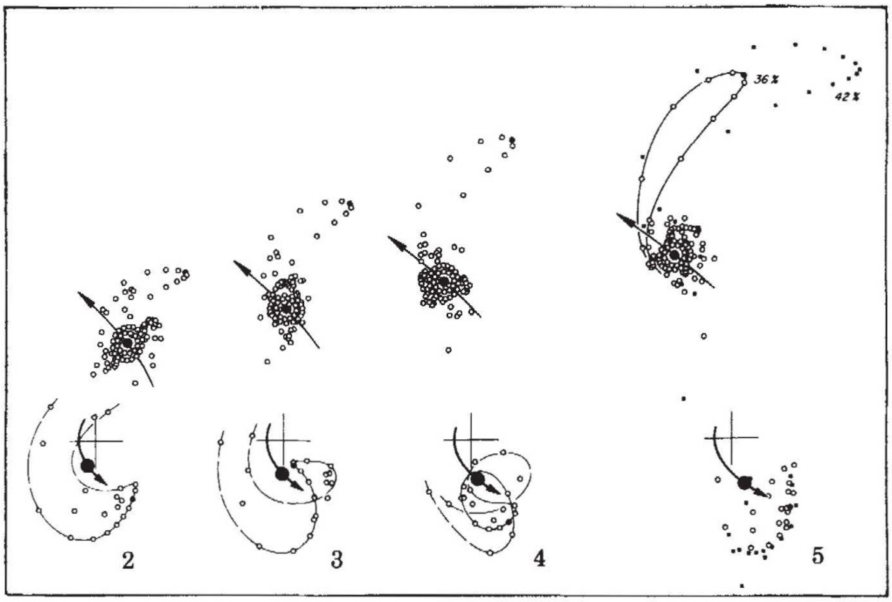
COSMOGENY

Origin of Bridges and Tails in Galaxies

by our Cosmology Correspondent

THE bridges and tails seen in some galaxies may simply be tidal relics of close encounters, according to Toomre and Toomre (*Astrophys. J.*, **178**, 623; 1972). They have studied such events in a "deliberately simple minded" computer simulation in which each encounter involves only two galaxies and is roughly parabolic, and in which each galaxy is idealized as a disk of non-interacting test particles initially orbiting a central mass point.

Two particularly interesting features emerge from the analysis. After a small companion passes such a galaxy, the primary disk may deform into an arm or a bridge extending towards the secondary, together with a counter arm on the opposite side. After a similar encounter with an equal or more massive partner there is a tail on the far side of the primary; on the near side there is an "avalanche" of particles which are mostly captured by the satellite galaxy (see diagram). Toomre and Toomre also offer specific models to account for the shapes of the interacting pairs Arp 295, M51+NGC 5195, NGC 4676 and NGC 4038/9.



The later stages of a "flat" parabolic passage of "companion" four times as massive as the "victim" galaxy. The companion carries off many particles from the victim, which grows a tail on the opposite side.