of plate tectonics, the theory provides an opportunity to run the clock back so many million years, stop, change directions and start the clock again. Thus oceanic mosaics may be gradually taken apart.

Continents are doubtless also mosaics, though longer time scales are involved. Ocean basins of respectable dimensions can be created in 100 million years by sea floor spreading, but it is imagined that continents are permanent features. This does not preclude both a continent and part of an ocean from occupying the same plate at some time in history. It does suggest that large continents have been formed by smaller pieces of continental material being driven together. These mosaics will take much more unravelling, but the question is high on the list of geophysical priorities. With the possibility of tens of previous cycles, there is ample scope for the enquiring mind.

COSMOLOGY

Universe Still Expands

from a Correspondent

How do galaxies form in an expanding universe? Ever since 1946, when calculations of the rate of growth of perturbations in a homogeneous expanding universe were carried out by E. M. Lifshitz, cosmologists have found great difficulty in reconciling the existence in the universe of irregularities as large as galaxies, with the expansion of the universe from a uniform primaeval fireball. Many astronomers have tried by different arguments to account for the growth of galaxies within the framework of an Einsteinian big bang universe, but with such conspicuous failure as to have provided an important source of ammunition for the supporters of less conventional theories of the universe, notably the steady state theory. But in 1967 there was a glimmering of hope for the conventional cosmologists when the Japanese mathematician, T. Kihara, showed that previously neglected non-linear effects could become locally important enough to dominate the processes of galaxy formation, and suggested that this could indeed occur in a time comparable with the accepted age of the universe. Now Masa-aki Kondo, working at the Department of Astronomy of Tokyo University, has carried this approach further, and confirms that with arbitrary initial conditions it is possible to form dense local concentrations of matter in an expanding universe.

Kondo has found two general families of solutions, one corresponding to local free expansion and the other to freely falling contraction of an irregularity resulting ultimately in infinite density (*Pub. Astro. Soc. Japan*, **21**, 54; 1969). Either situation could arise as a result of the small initial disturbances of temperature and density in the primaeval fireball but, naturally, only the contracting irregularities will be visible, their collapse presumably being stopped short of infinite density by angular momentum, which Kondo neglects. Although these results will be taken as encouragement for general relativity theory, it is also interesting that like most Einsteinian cosmology they can be exactly reproduced by a Newtonian analysis of the kind used recently by Bonnor and McCrea. From either viewpoint, they must represent another blow to the surviving advocates of steady state cosmologies.

GRAVITATION

Too Much Torque

THE slightly quaint experimental techniques which for decades have been the arbiters of the third decimal place in the gravitational constant, known as "big G ", seem at last to be nearing retirement. A new device, which seems capable of bypassing the problem of how to isolate a system of masses from the outside world, has been tested by a team of physicists at the University of Virginia (R. D. Rose *et al.*, *Phys. Rev. Lett.*, **23**, 655; 1969), which claims to have achieved a precision better than that of all previous measurements, notably that of Heyl, whose value is widely thought to be the most reliable so far.

The experiment of Rose *et al.* is quite cunning. In order to eliminate the gravitational effects of static objects, they set up a rotating system in which the angular acceleration of a turntable would be the key quantity. Two spheres of high density tungsten were fixed at opposite sides of a turntable, which was free to rotate in the horizontal plane. A metal cylinder, suspended by a quartz fibre, was placed between the

Schematic drawing of experimental apparatus for measuring G .

spheres with its axis making an acute angle with the diameter joining the two spheres. The asymmetry of the system then assured a net gravitational force on the cylinder. A servomotor system triggered by an optical level was also attached to the turntable, and was designed to keep a constant angle between the cylinder and the spheres. In this way the force on the cylinder remained constant.

The time for the first revolution was found to be about 30 minutes, and it took two hours for the rate to reach 0.5 revolutions per minute. Constancy of