change in the number of "short" rows, but not in the side on which they clustered. Hotani's results are consistent with this argument.

What is intriguing is that the kind of structure described is also required by the basic "non-rotary" hypothesis for generation of helical waves, an idea with a lineage going back to 1883. On this hypothesis the packing pattern would be induced by some mechanism at the base to propagate round the rod, giving rise to apparent rotation. Although Hotani follows Kamiya and Asakura in eschewing speculation, their results taken together suggest that there could yet be some life in the old idea. □

The folded chain's last stand?

from Paul Calvert

IN the past two years low angle neutron scattering studies on amorphous polymers have shown that the chain dimensions in both the liquid and glassy states are equal to the random coil dimensions seen in ideal solution. This scotched the idea that there are ordered regions in amorphous polymers but has left the puzzle of how to pack chains to high density yet retain the random coil (Kirste *et al., Polymer*, **16**, 120, 1975; Cotton *et al., Macromolecules*, **7**, 763, 1974; Wignall *et al., Eur. Polymer J.*, **10**, 861, 1974).

Results of similar experiments on crystalline polymers are now being published and very surprisingly show that the chain is still in a random coil. This one fact contradicts much of our current understanding of polymer crystallisation.

The small angle neutron scattering experiment is similar to small angle X-ray scattering except that the contrast arises from the very different scattering powers of perdeuterated and protonated polymer rather than from density differences. Usually a few percent of normal polymer is mixed into a matrix of wholly deuterated chains. The strong incoherent scattering from the protonated chains is measured as a function of angle and allows their radius of gyration and molecular weight to be determined. For amorphous polymers the radius of gyration was found to be equal to the ideal solution value. The apparatus necessary is a nuclear reactor with a thermal neutron beam and a diffractometer. Experiments have been done at Harwell but the beam intensity there is low and much more can be done on the purpose-built research reactors at Grenoble and Jülich (see Schmatz *et al., J. appl. Cryst.*, **7**, 96, 1974; for a general description of small angle neutron scattering).

The first experiments on crystalline material showed that the scattering was dominated by scattering from the matrix attributed to submicron voids. This effect could be eliminated by using deuterated polymer in protonated matrix rather than *vice versa* as the scattering lengths of the protons and carbons almost cancel. It then became clear that segregation was taking place so that the deuterated polymer was clustering in the crystals as the measured molecular weights were many times the true value (Schelten *et al., Polymer*, **15**, 682, 1974; *Colloid and Polymer Sci.*, **252**, 749, 1974). This arises because deuterated polyethylene melts at about 6 °C below the protonated polymer.

The next set of results to be published were those of Sadler and Keller (*Polymer*, **17**, 37; 1976). They measured solution grown single crystals in the range of scattering angle appropriate to the interchain spacing in the crystal rather than the chain as a whole. They showed that their results can be explained in terms of an adjacent re-entry model but could not really eliminate alternative models. These experiments may have been affected by clustering which could invalidate the results.

During this summer results on melt crystallised polymers have been reported at several conferences by Ballard, Wignall and Longman from ICI at Runcorn using the Jülich diffractometer (to be published in *Polymer*). They tried to eliminate clustering by using a branched chain protonated polyethylene in conjunction with a linear deuterated polymer so that the crystallisation temperatures

Was the early Solar System windswept?

from David W. Hughes

IF the nebula that formed the Solar System had the same elemental composition as the Sun, the condensates, that is the planets, asteroids and comets which make up our present Solar System, represent only about 5% (by mass) of the original nebula. The remaining 95% has been lost in the intervening time between planetary formation and the present. Most modern cosmogonical theories use the solar wind to sweep the newborn Solar System free of this "left over" nebula which is made up mainly of volatile elements such as hydrogen and helium. This solar wind is a cloud of particles (mainly protons) which are streaming away from the Sun. At the present time the average cloud density near the Earth is 5 protons cm^{-3} and the particles stream past at a speed of about 450 km s^{-1}. In the T Tauri stage of the Sun's evolution this wind was blowing at about the same speed but was much denser, the Sun losing mass at a rate which could have been as high as 10^{19} g s^{-1}. This T Tauri stage lasted around 50 million years during which time the Sun's radius decreased from nearly that of the radius of Mercury's orbit to its present 7×10^5 km and the Sun lost a considerable percentage of its mass. The Sun was also a variable, surrounded by a thick, highly active chromosphere. Gravitational collapse was giving way to thermonuclear hydrogen burning as the main energy source

M. J. Handbury and I. P. Williams (Queen Mary College, University of London) question the wind-sweeping hypothesis in a recent paper in *The Observatory* (**96**, 140; 1976). Assuming that the solar gaseous nebula is in equilibrium about the Sun before the onset of the wind the authors then calculate the rate of momentum transfer between a continuous, spherically-symmetric wind and the nebula. Three forces are acting on the nebula, gravity, "centrifugal force" due to its rotation and the solar wind force due to its rotation and the solar wind force due to momentum transfer. As angular momentum is conserved a formula can be easily obtained for the new equilibrium distance between the nebula and the Sun. Handbury and Williams find that for all reasonable values of the parameters the nebula does not get pushed out to infinity by the T Tauri wind but simply increases in radius.

Now if energy transfer and not momentum transfer is the actual mechanism the total nebular energy could become positive and the nebula would disperse. But this would require the kinetic energy of the wind to be converted into thermal energy in the nebula and then back again into kinetic energy as the nebula moves away. Also loss due to radiation, evaporation or fast moving particles and other mechanisms has to be negligible.

So the authors conclude that the solar wind cannot be the broom which swept from the Solar System those elements that did not condense to form the planets and that cosmogonists must look for another process.