experiments using human blood are under way. He says unpublished work by the Philadelphia group also suggests that a different phospholipid from another cellular structure works in the same way. Studying ethanol's effects at the membrane level should increase the understanding of alcoholism in general, as well as suggest new approaches to treatment. Last month, a report from the National Institute of Mental Health described a new drug that may prove useful in stopping the intoxicating effects of alcohol by affecting the movement of chloride across membranes (SN: 12/6/86, p.358).

—D.D. Edwards

A more complex solar cycle

The sun is astrophysicists' exemplary star. It is the only one they can study at close range, and what they know of its behavior they extrapolate to other stars. The sun's activity also determines many things that happen on earth, from atmospheric physics and geophysics through paleontology to ecology. Solar physicists used to believe that the sun's physical activities varied over a cycle that takes approximately 11 years. Now it seems that the solar cycle is not so simple as scientists had believed.

According to results reported at last week's meeting in Pasadena, Calif., of the American Astronomical Society, the 11-year sunspot cycle seems rather to be part of a larger 19- or 22-year cycle that involves other aspects of the sun's behavior. Furthermore, the beginning of each new cycle overlaps the last phases of the previous one.

It is this overlapping feature, particularly, that will make serious problems for solar theorists as they try to explain the sun's behavior, according to the three astronomers involved in the observations now reported. Those astronomers are Herschel B. Snodgrass of Lewis and Clark College in Portland, Ore., Richard C. Altrock of the National Solar Observatory in Sunspot, N.M., and Peter Wilson of Caltech in Pasadena and the University of Sydney in Australia.

The classic sunspot cycle begins with the appearance of spots in the middle latitudes of the sun. Individual sunspots last only a short while, but as the cycle continues, the range of latitudes where new spots appear gradually narrows and at the same time approaches closer to the equator. When the latitudes at which new spots appear are graphed over time as the cycle proceeds, the graph shows a "butterfly pattern," that is, the appearance of a butterfly's wings, starting out fairly broad and away from the equator and narrowing and moving closer to the equator as time goes on.

The new evidence has been found from studies of small variations in the sun's rotation, along with other evidence from changes in the brightness of the solar corona and yet other evidence from variations in the magnetic polarity of sunspots. These data indicate that this sunspot cycle is part of a larger one that takes between 19 and 22 years to run and begins not in the middle latitudes but near the poles. Thus every 11 years or so, a new cycle begins near the poles, while the previous one still has 11 years to run near the equator.

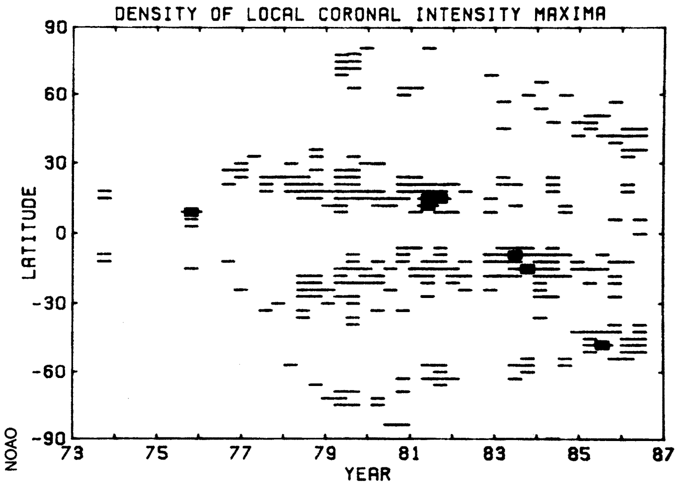
The sun's surface does not rotate rigidly, uniformly at the same speed; latitudes nearer the equator rotate faster than the polar ones. However, observations a few years ago showed that, contrary to expectations, the rotation rate does not increase smoothly from poles to equator. Instead, there is a small wiggle superimposed on the smooth change, so that alternately a slice of the surface will be going slightly faster and the slice next to it slightly slower than they might if the change in rotation speed were smooth.

Work done by Snodgrass at the Mt. Wilson Observatory in Pasadena shows that these zonal variations in rotation speed are cyclic. The zones appear near the poles and gradually migrate toward the equator on a cycle that is at least 18 or 19 years and may be 22. (The numbers are not sharply established; in any case, the sun's variations have never been very precisely timed. The classic sunspot cycle of 11 years has to be qualified with the words "more or less.")

Between the zones of fast and slow rotation is a great deal of torsional shear, producing an effect that some scientists describe as analogous to winds in the atmosphere of the sun. The material that undergoes the shear is an electrically conducting fluid, an ionized gas, and so it drags the sun's magnetic field, concentrating it in the zones where the torsion is greatest. As these torsional zones drift down to the middle latitudes, they begin to produce sunspots, which are magnetic phenomena. The spots are dark because they are cooler than their surroundings, and they are cooler because they represent local concentrations of magnetic field.

The magnetic polarity of the spots also varies cyclically. Spots come in pairs, and if the leader of a pair (as they are carried along with the sun's rotation) has a magnetic field polarized one way, the trailer's field will have the opposite polarity. Wilson reports that to come back to a given polarity relation between the leaders and trailers takes two 11-year cycles, providing further evidence for an overall 22-year cycle.

Finally, the cycle appears in variations in the brightness of the corona, the sun's hot, tenuous outer atmosphere, as Altrock reports. He used the classic technique of studying coronal variations, observing the green radiation from iron that has been ionized 14 times (that is, iron that has lost 14 electrons). He found that these variations, too, come in a cycle of 22 years that begins near the poles and drifts toward the equator.



Horizontal bars indicate solar latitudes having numerous coronal active regions. One cycle starts at ±30° latitude in 1977 and approaches the sun's equator. The newly discovered, overlapping solar cycle begins in 1979 at ±70° to 80° latitude and proceeds toward ±40° latitude.

As Wilson expresses it, the zones of variation in the rotation rate, which seem to drive the other phenomena in the cycle, seem to be caused by convective rolls in the sun's convection zone. Below the sun's outermost surface layers is the convection zone, where heat generated deep in the interior rises to the surface by convection. The matter carrying the heat rises to the surface, cools and then rolls over and descends to be heated again. These rolls maintain their shape in the manner of hair that has been rolled on curlers.

Under this hypothesis, the convective rolls would first appear near the poles and drift toward the equator. The zones where rotation speed differs would be the surface manifestations of the convection rolls, but why the rolls should migrate from poles to equator, the present observers cannot say. They opine that theorists will have a complicated time trying to explain these findings.

—D.E. Thomsen

News of the week continued on p. 46