century. His work had involved detailed statistical research into the histories of seventy-two countries.

Tchijevsky found not only that his index was characterized by 11.11-year cycles but that the highs of these cycles tended to correspond with highs in sunspot activity.

In 1960 I made a thorough investigation of Tchijevsky's work, using sunspot data that were not available to Tchijevsky forty years earlier. I discovered that when the years of maximum sunspot activity were compared with the values of Tchijevsky's Index of Mass Human Excitability, the highs of the sunspot cycles *followed* the highs of his Index by an average of about one year.

This time lag often occurs when earthly cycles are compared with sunspots. In general, regardless of period, the sunspot cycles turn *after* the corresponding earthly cycles they are supposed to create. And you cannot have the cause follow the effect!

Can it be that something is causing both the cycles on the sun and the cycles here on earth—but that the sun takes longer to respond?

Could our friends Garcia-Mata and Shaffner be right in that it is the rate of change of sunspot numbers rather than the actual number of spots that is the trigger to our earthly behaviors?

Could it be that since cycles of the same length here on earth tend to have their highs later and later as they occur closer to the equator, and since sunspots normally occur in the lower latitudes, we must take these facts into consideration when trying to relate the two? Most events recorded here on earth with eleven-year cycles occur between 40 degrees and 55 degrees north latitude, while sunspots lie, on the average, at about 14 degrees north and south latitude on the sun, so there would normally be a time lag if the two phenomena were the result of a common cause, and if cycles on the sun behave like cycles on earth.

The evidence in favor of a relationship between solar activity and behavior here on earth is provocative but not yet conclusive. Yet new discoveries seem to be leading us closer and closer to a solution to the great sunspot mystery. One of these new clues, uncovered by C. N. Anderson, of the Bell Telephone Laboratories, followed this logical line of reasoning:

Sunspots increase and decrease in waves that range from seven to seventeen years in length, but which have an average wavelength of 11.11 years. Sunspots normally occur in pairs. Sunspots are magnetized. In one wave of the sunspot cycle positive spots will lead in the sun's northern hemisphere, negative spots will lead in the sun's southern hemisphere.

In the next wave this situation is reversed: Negative spots will lead in the northern hemisphere; positive spots will lead in the southern hemisphere. Thus it takes two sunspot waves—or "cycles," as they are called—for the behavior to come around again to the place of beginning. The period of the double sunspot cycle is thus 22.22 years (see Figure 55).

The wavelengths of certain average cycles in sunspot numbers with alternate cycles reversed correspond closely with the average times when several of our planets line up with each other as seen from the sun in what is called a "heliocentric planetary conjunction." If further investigation proves this association to be a real one, we will have added importantly to our knowledge of solar-system mechanics and to our ability to forecast ordinary sunspot numbers, an ability of increasing importance as we enter the age of space travel with its impending dangers from solar eruptions of all sorts.

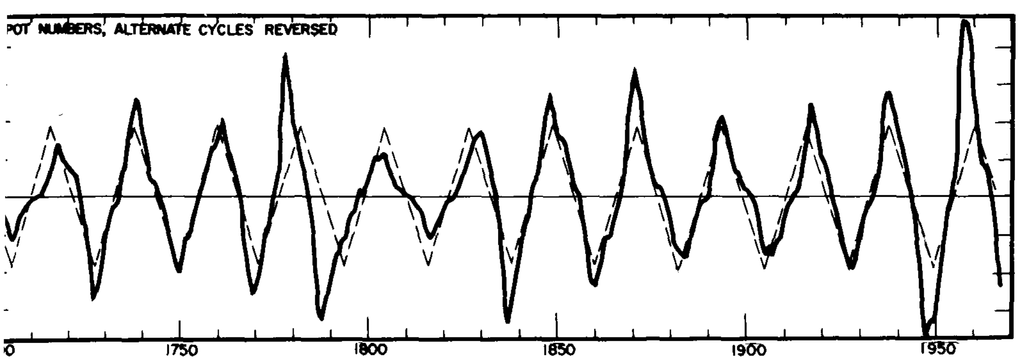


**Fig. 55. The Double Sunspot Cycle, 1700–1968**

Sunspot numbers with alternate 11.11-year cycles reversed.

*The Solar Constant*

Dr. C. G. Abbot, of the Smithsonian Institution, has spent the greater part of his lifetime trying to convince meteorologists and scientists in general that the "solar constant" is not constant but fluctuates in cycles instead.

The "solar constant" is a measurement, in calories per square centimeter per minute, of the amount of the sun's energy received. As the name implies, it has little variation, but Dr. Abbot, involved for many years with the measurement of this "constant," noticed what he termed "dent-like depressions," that is, small ups and downs in the measurements.

These tiny ups and downs seemed to fluctuate in a cycle of 273 months—or almost twenty-three years. However, the small variation in the solar constant—only 1 or 2 percent—was a serious stumbling block for the meteorologists, who did not believe that the variations were large enough to account for such changes in the weather as were claimed by Dr. Abbot.

Dr. Abbot proceeded to project his cycles in the solar constant backward and discovered that these cycles corresponded with past weather conditions (Figure 56). Then he began to prepare charts of calculated precipitation or temperature based on his 273-month cycle (Figure 57) and followed this with long-range calculations for fifty-four weather stations. He published numerous papers covering over fifty years of study, and the amount of evidence he marshaled to support his case is impressive.

H. H. Clayton, chief forecaster of the meteorological service of Argentina, discovered similar correspondences between variations in solar radiation and barometric pressure (Figure 58) after learning of Abbot's work on solar variation. He applied his findings in extensive long-range weather forecasting.

Except in Argentina no weather-forecasting service attached to any government has ever taken solar variation into account, but I suspect that Dr. Abbot's work will one day have its moment in court.

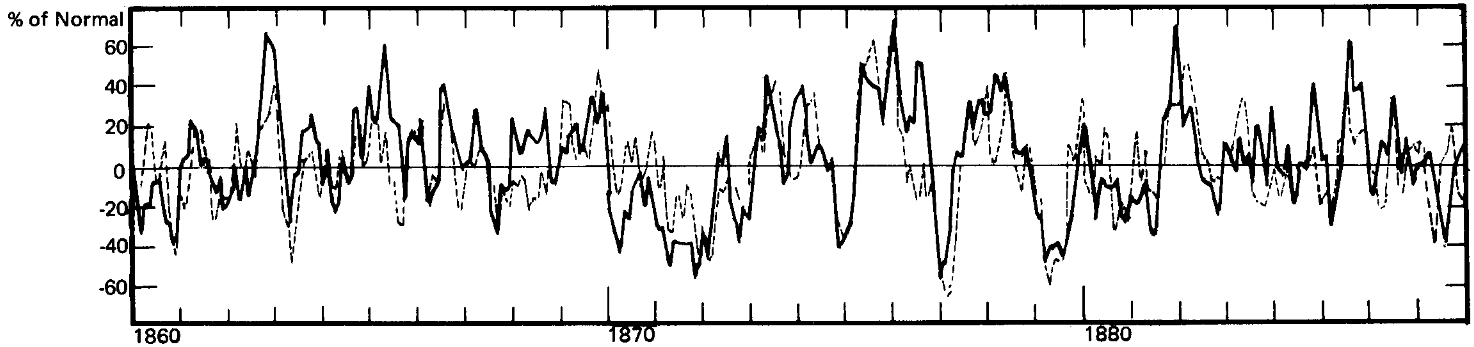


**Fig. 56. Abbot's Cycle of St. Louis Precipitation, 1860–1887**

The solid line indicates departures from normal in St. Louis precipitation. The broken line indicates Abbot's combination of various cycles over the same period.

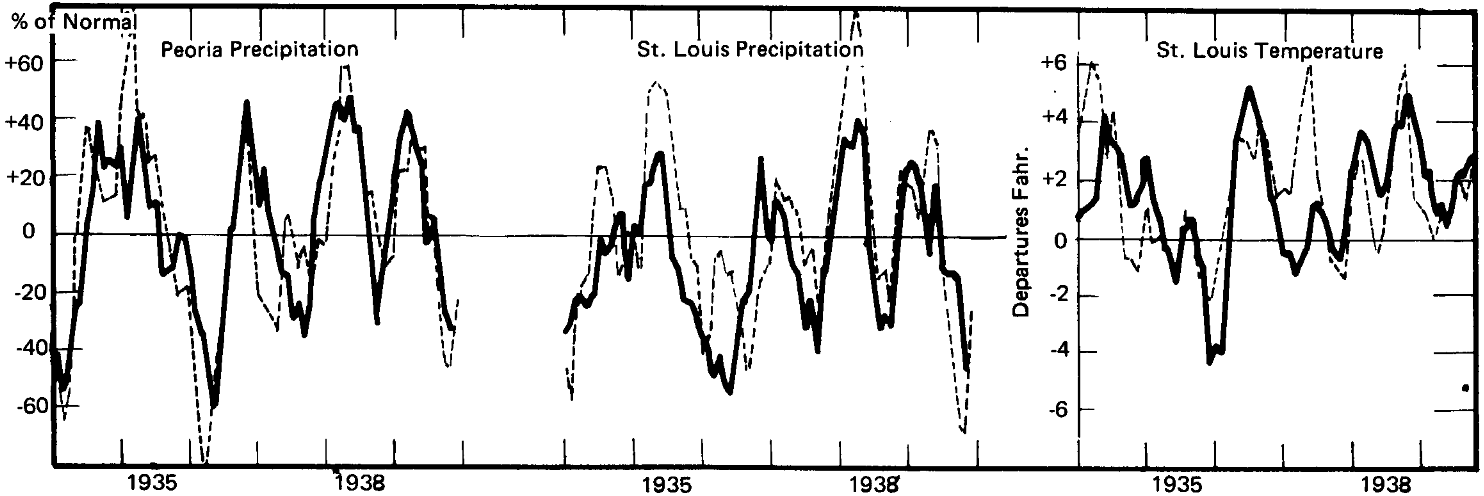


**Fig. 57. Various Other Weather Cycles, 1934–1939**

The solid lines indicate departures from normal precipitation at Peoria and St. Louis and temperature at St. Louis. The broken lines indicate Abbot's combination of various cycles over the same period.

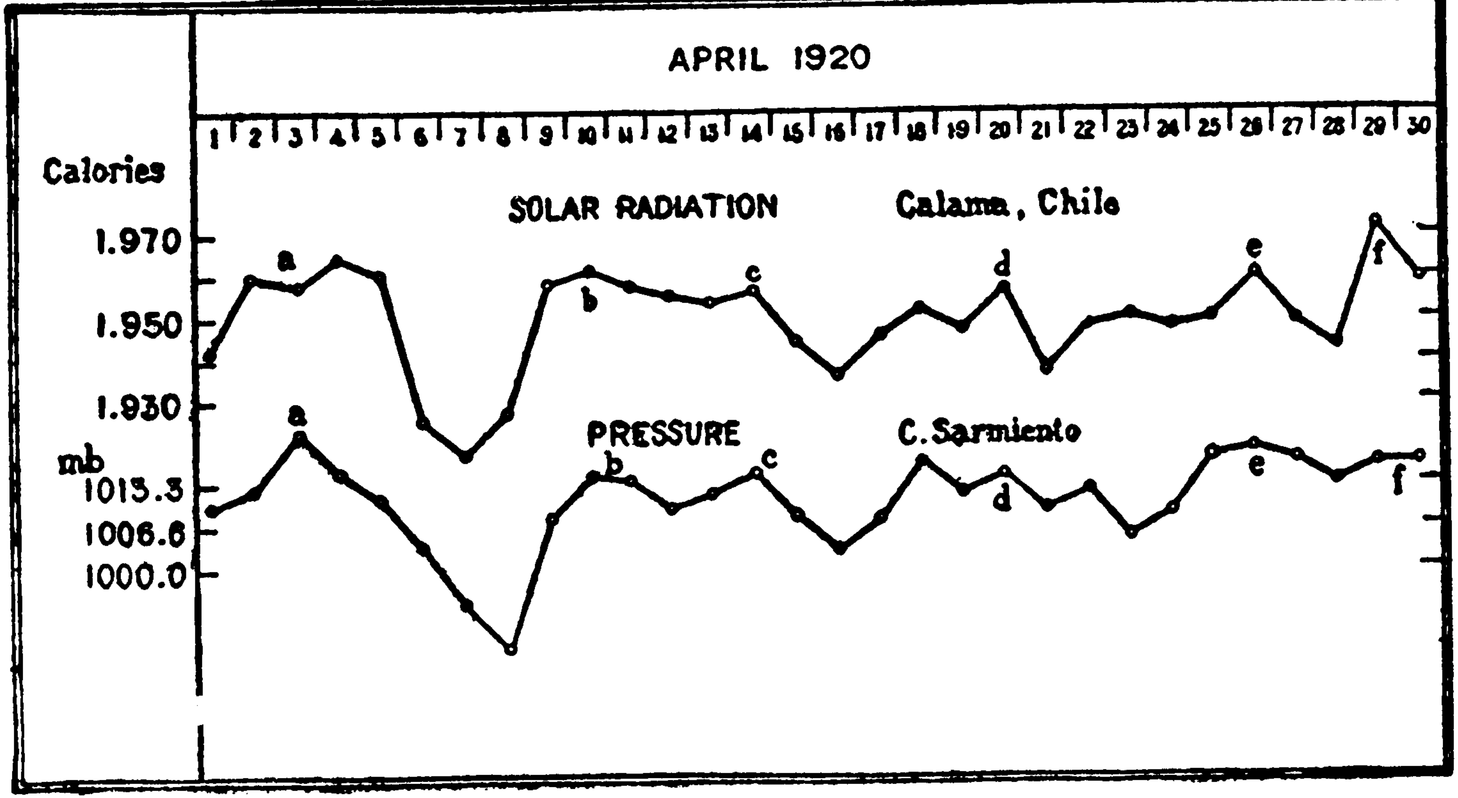


**Fig. 58. Solar Radiation at Calama, Chile, April 1920**

Note the close correspondence between solar radiation and barometric pressure over the same period of time (after Clayton).

## *The Moon Cycles*

Even before Neil Armstrong and Edward Aldrin stepped courageously onto the surface of the moon, we "earthlings" had begun to refer to it as the "seventh continent." However, none of the six continents floating placidly on the face of our earth can begin to approach the effects that the moon and its cycles have on our life.

Although the sun is 26 million times larger in mass than the moon, it is 389 times farther away and so the moon exerts a force on us which is 2½ times greater than that of the sun. This tremendous force is most evident in the behavior of our tides. As the moon circles our planet in a cycle of 24 hours, 50½ minutes, high tides and low tides follow each other in most parts of the world every 12 hours, 25 minutes. This gravitational pull is strong enough to lift millions of gallons of water as high as fifty feet in places such as New Brunswick's Bay of Fundy. Since so much of you is water, is it unreasonable to conjecture that the moon's cycles might somehow also "lift" you?

There are three main moon cycles besides the daily one just mentioned. The first is the monthly lunar cycle caused by the revolution of the moon around the earth. The length of this monthly cycle, relative to the sun (from full moon to full moon), is 29.53039 days.

The moon travels around the earth in an ellipse—a flattened circle—with the earth near the center of this ellipse. This ellipse wobbles like a poorly thrown football in a cycle that takes thirty-one years and two or three days (depending on leap years) to return to the point where it started. The axis of this orbit not only wobbles but turns in a counterclockwise direction, making one complete cycle relative to the stars every 3,232.6 days, or 8.85 years.

As you know from watching and reading about our astronauts, the orbit of the moon is not exactly in the same plane as the orbit of the earth. Looking at the two, from the side, for half the lunar month the moon is a little above the line connecting earth and sun and for the other half a little below it. The line where the planes of the two orbits connect is called the line of nodes; this intersection line, relative to the stars, is the same every 18.6 years.

Although man has made great advances in applying his knowledge of the moon to the predicting of tides and their levels, he is only beginning to explore other possible moon-earth relationships, for now it is known that there are tides in the atmosphere that are influenced by the force of the moon. Changes in geomagnetism and radio-field strength appear to follow the changing phase of the moon, and movements of the earth's crust seem to relate to the position of the moon. It has been estimated that the city of Moscow rises and falls nearly twenty inches, twice a day, in response to the moon's gravitational beckoning.

The effect of the moon on our physical environment is now under intensive study, although complete and definite answers are still to come. We have even begun to explore the realm of lunar folklore. The Department of Agriculture has investigated the question of whether planting crops during certain phases of the moon will affect the ensuing growth and yield of the crop. They found that the phase of the moon in which a crop is planted has no relation to its outcome, although folklore may still have its basis in fact. It is said that timber in the tropics must be felled at the correct phase of the moon. If the trees are cut when the moon is waxing, the sap runs heavy and draws beetles that eat the wood. Contracts to cut timber in South America and the South Sea Islands sometimes specify that the wood is to be cut only during the waning phase of the moon.

This phenomenon is not surprising if you will recall the work of H. S. Burr with the electric voltage of trees. Burr drilled tiny holes several feet apart (vertically) on a tree trunk and connected the holes with wire. An electric current flows along such a wire, and Burr has recorded this flow, minute by minute, for many years. The current sometimes flows up and sometimes down. Neither the current nor the voltage is steady, but the same strength of current flows in the same direction at the same time in trees that are miles apart!

The variation in voltage goes in cycles, and one of the cycles observed appears to correlate with the phases of the moon. Of course, the effect of the moon may be direct, or it may be secondary.

Remember Professor Frank Brown and his pieces of potato hermetically sealed in rigid containers under constant conditions of pressure and temperature? They gave evidence, among other things, of a lunar monthly rhythm of oxygen consumption. The rate was lowest at the time of the new moon and went up to a high during the third quarter of the moon.

Thus there is solid evidence that does indicate that plants respond to some extent to the changing phases of the moon. Lunar cycles in plants exist, although research on this phase of the earth-moon system is also in its infancy. It is logical that work on the effect of the moon would start first with the tides, on which our facts are remarkably complete, then move to other physical aspects (air, geomagnetism, etc.), then move to plants and animals, and lastly, concentrate on man—for man hesitates to admit that he is influenced by any environmental forces!

The lunar cycles of life in the sea and on the seashore are obvious. One of the classic examples is the palolo worm of the South Seas. This small native delicacy has an elongated posterior filled with reproductive cells. These posteriors break away from the worm's body, which is lodged in burrows in the coral rock, and swarm to the surface of the sea—but only in early morning for two days during the last quarter of the moon during October and November. How does the palolo know when the moon is in its final quarter—and in just two out of thirteen lunar months?

During April and May, grunions, small edible fish native to the coast of California, throw themselves on the beaches until they nearly cover the white sand. But they do this only after the moon and the sun have cooperated to produce the fortnight's highest high tide. On the beach the female grunions scoop shallow depressions in the wet sand and deposit their eggs. The eggs remain, since later and lesser tides do not disturb them. When the next highest high tide arrives, some fifteen days later, the eggs will hatch and the fry will enter the sea.

What force guides the grunion to deposit its eggs in the sand after the highest tide and not before? And how does it know exactly which tide will be the highest? For if another and stronger tide immediately followed the deposit of eggs, they would be washed from the sand and have no chance to develop.

The effect of moon on man is buried deep in the consciousness of the race. The word *lunacy,* for example, came into use because of a general belief that the moon triggered certain forms of insanity that occurred in phase with the moon.

Sleepwalking is sometimes attributed to the influence of the full moon, and certainly the supposed romantic influence of the moon has been the source of much income to song writers. In addition to these and other traditional beliefs there is much scientific evidence of the moon's influence on human activity. In 1950 I published a summary of the number of births occurring in the waxing and waning period of the moon. The record covered the period from 1939 to 1944 and was supplied by Curtis Jackson, then Controller of the Methodist Hospital of Southern California. Of the babies born at the hospital during the time covered, 17 percent more were born during the waxing period of the moon than were born during the waning period. In some of the years births in the waxing period of the moon exceed by as much as 25 percent those in the waning period.

What could be the reason for this behavior? Does it imply a cause-and-effect relationship between the moon and amorousness or fertility? Or is there a rhythm in amorousness or fertility that just happens to correspond to the waxing and waning of the moon? The answers to these questions lie in the field of medicine and outside the study of cycles. We can do no more than pose the question. Physical and experimental science must provide the answers.

Dr. William F. Petersen was one of the truly great men I have known in my lifetime. Although primarily a medical doctor, he felt that in addition to acquiring greater knowledge about bacteriology and immunology, it was imperative that we do everything possible to relate man to his environment. He believed that however minor they might be, cosmic influences should be taken into account.

While studying the moon's effect on man, Petersen compared various kinds of vital statistics with various phases of the moon to see if there were any relationships. These statistics included conceptions compared to deaths, the incidence of scarlet fever, the incidence of epileptic attacks, deaths from tuberculosis, and others.

There appeared to be a definite lunar phase to the chart of deaths from tuberculosis, with an increase in deaths after the full moon. Nevertheless, this is only one factor. Certainly, in any individual case, local weather conditions, the condition of the patient, and other related factors are much more important than the phase of the moon. Nevertheless, when put on a lunar axis and smoothed by a three-day moving average, the record of deaths from tuberculosis does show a high seven days after the full moon and a low eleven days before the full moon.

Researchers are constantly accumulating evidence that tends to show that the moon exerts an influence on earthly affairs, both in the physical environment and in plants and animals. As with nearly every other subject in this book, the material I have presented is the smallest of summaries of a subject that requires a complete book of its own.

## *The Variable Stars*

Our universe is replete with cycle activity. The planets are spinning in cycles; Jupiter completes one rotation every nine hours and fifty minutes while Pluto takes six days, nine hours, and twenty-one minutes to do the same thing. All planets are also revolving around the sun in cycles; Mercury requires only 2.89 months for a round trip while it takes Pluto 2,981 months to complete its tremendous ellipse around our sun. A third type of planetary cycle involves the length of time it takes for any two planets to line up in a straight line with the sun. Our earth is on a straight line with Mercury and the sun every 116 days, while we only manage to get in line with Mars and the sun every 780 days. These conjunctions, of course, offer a great area for finding possible effects on earthly things, but science has pretty much ignored this area of investigation and left it to the astrologers. However, there are enough hints of a possible relationship between periods of conjunction between our earth, the sun, and other planets so that I'm not sure this idea should be left to them.

Several thousand stars also have cycles. They are called variable stars, and their brightness fluctuates in periods that vary from a few hours to several years. Furthermore, the intensity of the light curves of some of these stars fluctuates in the typical zigzag pattern that characterizes many cycles in both solar and earthly phenomena.

For example, refer to Figure 59, reprinted from *Astronomy* by W. T. Skilling and R. S. Richardson, published and copyrighted by Henry Holt and Company. These curves show that the stars to which they refer get brighter and fainter in the sort of pattern that would result if some master hand pulled a reversing switch at more or less regular intervals.

Variable stars fluctuate in all sorts of wavelengths. The most usual lengths are ½ day, seven days, and 250 days.

What causes the change in brightness of the variable stars? No one really knows.

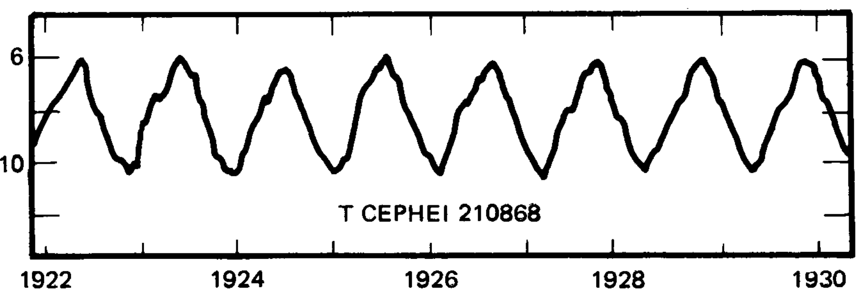


**Fig. 59. A Cycle in a Variable Star, 1922–1930**

The light curve of the star T Cephei. The wavelength is 387 days.

## *The Comet Cycles*

In 1704 the English astronomer Edmund Halley published a paper in which he predicted that a comet that had appeared in

1682 would *reappear* in 1759. It did, and its reappearance established the fact that comets, although they travel in extremely eccentric orbits, have cycles of revolution around the sun. Halley's Comet is scheduled to make its next appearance in 1985.

Hundreds of other lesser-known comets orbit the sun in cyclic trips that are as short as 2.3 years. No one knows how comets originated but astronomers can give you the orbiting cycle for every one so far discovered.

### *Quasars, Pulsars, and Cycles*

Since 1962 two new phenomena have generated tremendous excitement among the world's astronomers.

Quasars (for quasi-stellar radio sources) appear to be closely packed groups of millions of stars, smaller than galaxies. They were first detected by radio telescopes. Apparently they are so distant that, traveling at the speed of light (186,000 miles per second), it has taken 6,000 million light-years for the energy and light from some of them to reach this planet. Radio waves charted at the Jodrell Bank radio telescope in England on June 7, 1966 (Figure 60), began their journey through space over 1,000 million years before the earth came into existence.

I need not point out to you the fairly regular wave or cycle. Quasars are also known to fluctuate in brightness, presenting us with another puzzle. This mysterious aspect is illustrated by Quasar 3c273. It is approximately seven light-years in diameter, which means that it would take seven years for electromagnetic waves to cross the entire quasar. If so, how could the different stars in the quasar all fluctuate in brightness *together*? How could the different stars *know* when to be bright and when to be dim so that separated by billions and billions of miles they still act like a string of bulbs on our Christmas tree, synchronized to blink in unison?

Pulsars are believed to be small balls of debris, only a few miles in diameter, left in space after the explosion of some stars. On these mini-planets, which are composed of densely packed atomic particles called neutrons, are small areas with gigantic magnetic fields firing extremely strong radio signals—and often light waves—

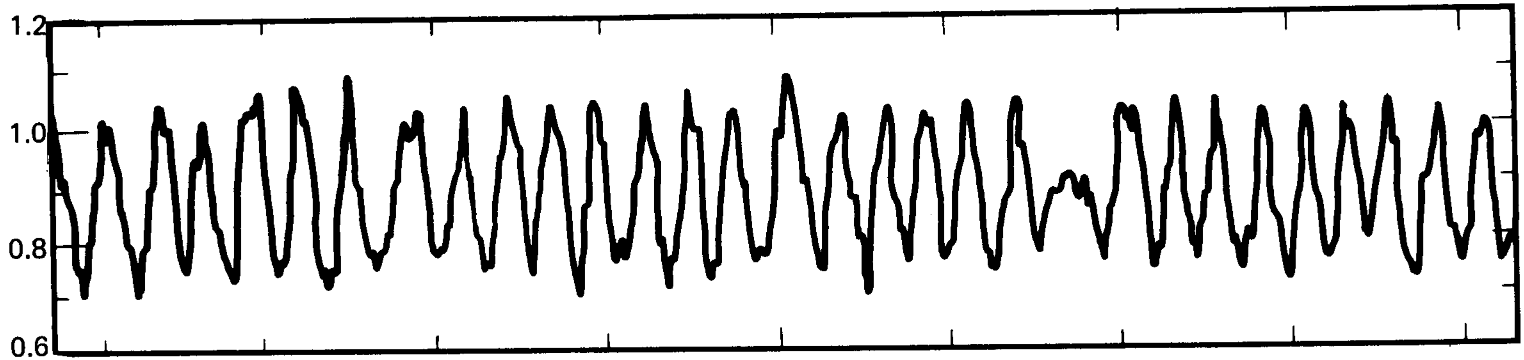


**Fig. 60. A Cycle in a Quasar**

Radio signals received from Quasar CTA 102 as recorded on June 7, 1966. Quasar CTA 102 is believed to be at least 6,000,000,000 light years away. If this is so, the radio waves causing the deflection of the pen on this record started on their journey through space over 1,000,000 years before the earth came into existence (after Sir Bernard Lovell).

into space. As they spin, they spray these waves across the face of our earth in cycles. Some pulsars sweep the earth every thirtieth of a second while others have cycles as long as 3.7 seconds.

### *Cycles in Radio Weather*

Before his recent retirement John H. Nelson held, for over two decades, the position of propagation analyst for RCA Communications. His responsibility was to forecast daily radio weather so that shortwave radio transmissions would not be interrupted by "poor radio weather."

Radio waves cannot travel in a circle around the earth. They must be bounced off the ionosphere, a layer of rarefied gas enveloping the earth 200 miles up. This ionosphere "ceiling" is created by radiation—particularly ultraviolet—from the sun. Whatever it is that affects radio communication is presumably something that affects the ionosphere.

We do not yet know what this "something" is, but Nelson discovered that it is associated with the angular relationship between the planets as viewed from the sun. Imagine yourself up in space looking down upon the solar system with the sun in the middle and the planets revolving at various distances around it. Draw imaginary lines from the sun to each of the planets. Each of these lines, of course, will be distant from each of the other lines by a certain number of degrees. If at any instant any three or more planets are so situated that the angular relationship between the lines connecting them and the sun is 15 degrees or some multiple of 15 degrees (Figure 61), the quality of radio propagation will be affected, provided one of the angles is 60 degrees, 90 degrees, 120 degrees, or 180 degrees.

For important disturbances there must also be at least two fast-moving planets and one or more slow-moving planets involved in the configuration. The fast-moving planets are Mercury, Venus, Earth, and Mars; the slow-moving planets are Jupiter, Saturn, Uranus, Neptune, and Pluto. The fastest moving planet is looked upon as the "trigger" planet. It is as simple as that—but it is still all very mysterious, and John Nelson is the first to admit that he

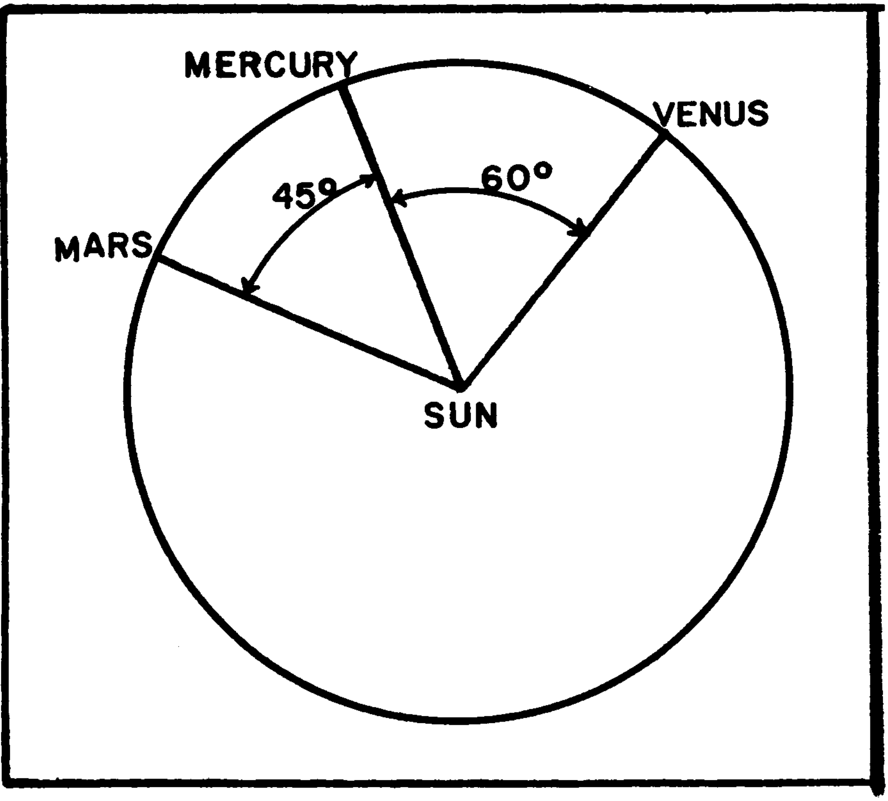


**Fig. 61. Planetary Relationships**

Diagram to show Mercury 60° (four times 15°) from Venus, Mars 45° (three times 15°) from Mercury, and 105° from Venus. This configuration will affect the quality of radio weather.

does not know why certain angular relationships of our planets are associated with disturbed weather. But indubitably they are.

John Nelson's work has illustrated another successful application of forecasting based upon a knowledge of cycles. With this knowledge, according to the last report I had received, he had made 1,460 forecasts during 1967. His accuracy rating was 93.2 percent! His discovery that there is a correspondence in timing and time span between the cycles of shortwave radio disturbances and planetary cycles also shows how a knowledge of cycles can suggest the possibility of a cause that might otherwise be unsuspected. We must learn if there are correspondences between these planetary cycles of his and other phenomena here on earth. Are there corresponding cycles in weather, for example, or corresponding cycles in plants, or animals, or man?

Now you are perhaps aware of the scope of our mystery. Its clues are everywhere, from a tiny microscopic one-celled creature fluctuating in abundance in the waters of our world to quasars, pulsating in cyclic brilliance and energy over 6,000 million light-years away.

Is all this rhythmic behavior here on earth and "out there" merely coincidence? Let us gather together some of these "clues" and see what we have.