SUN TIME AND CLOCK TIME

As we put behind us each twenty-four hours of time, we little think of the natural phenomena that are concerned in the making of the day.

When we speak of the day only, especially if we be versed in the sciences and have a pedantic regard for the exact use of terms, we may mean either of two quite different things. The day that we all know and ordinarily have in mind is familiar to science as the *solar day*.

The phenomena of the solar day are plainly apparent to observation. No calculation is necessary to determine its features. We first see the sun in the east. We then observe its apparent movement from the eastern horizon to the western, although the movement is only apparent. The phenomenon is really caused by the constant turning of the earth from the west toward the east on its axis. It then remains hidden from sight, while night is upon us, until we again see it in the east. We have thus been witness to the passing of one solar day.

The other thing we may have in mind when we speak generally of the day is what we may term, for want of a better name, the *stellar day*, the word we now employ being derived from the Latin *stella*, a star. This day is measured by the rotation of the earth upon its axis, with relation to the fixed stars, just as if no sun were in the heavens and just as if the earth were not, during its continuous rotation, racing along its orbit around the sun.

In speaking of our observed solar day, we have had the twenty-four hours begin at sunrise. Astronomers measure the day from noon. Accordingly, they have defined the solar day as being the interval of time that elapses between two consecutive returns of the same terrestrial meridian to the sun. Speaking with less exactness, it may be said to be the time expended in one complete turn of the earth upon its axis, for it is this turning, or rotation, which, on an average of every twenty-four hours, presents a given terrestrial meridian to the sun. Let us now understand why it is not strictly correct to say that the solar day is marked by one complete turn of our globe on its gigantic axle. The day that is so marked is really what we have termed the stellar day. It must be remembered that, as it rotates, our sphere travels rapidly along a path or orbit around the sun. Again, we must note that the rate at which the earth moves along its orbit is far from uniform throughout the year. The orbit is not a circle, but an ellipse, and the globe is nearer the sun at some stages of its movement than at others. When we are at our nearest to the sun, the earth is said to be in *perihelion*; when we are farthest away, it is said to be in *aphelion*. The change in distance from the sun, operating through the law of gravitation, successively accelerates and retards the speed at which we move about the great luminary that is the center of the solar system. We may now see what effect the orbital movement has upon the length of the solar day. Our advance along the orbit at varying rates of speed, the advance being considerable during each rotation of our sphere upon its axis, makes uncertain the length of the intervals between the successive returns of meridians to the sun, however uniform we may concede the periods actually occupied by the rotation to be, as measured by the fixed stars. Therefore, while we invariably consider the solar day as twenty-four hours long, the truth is that we can seldom actually describe that period to its duration, although, as we have indicated above, twenty-four hours is its average length.

As a result of the variations in the length of the solar day, watches and clocks, which show the time according to the stellar day, cannot often agree with the sundial, which registers true solar time. Flammarion gives us the following table of "times" which a well-regulated watch would show at solar noon on certain days of the year at a given place:

Date	**H.M.**
January 1	12:04 P.M.
January 15	12:10 "
February 1	12:14 "
February 11	12:14 "
March 15	12:09 "
April 1	12:04 "
April 15	12:00 Noon
May	11:57 A.M.
May 15	11:55 "
June 1	11:57 "
June 15	12:00 Noon
July 1	12:03 P.M.
July 26	12:06 "
August 15	12:04 "
August 31	12:00 Noon
September 15	11:55 A.M.
October 1	11:49 "
October 15	11:46 "
November 3	11:43 "
November 16	11:44 "
December 1	11:49 "
December 15	11:55 "
December 25	12:00 Noon

It will be understood from what we have said that it is only from the standpoint of our relation to the sun that the length of the day is variable. The actual time consumed in a rotation of the earth upon its axis, that time being what we have termed the stellar day, is practically exact and it is less than twenty-four hours. If, then, we regard the day as being coincident with the period actually occupied by one turn of the globe upon its axis, and look not to the sun as our mentor, an inspection of the fixed stars teaches that the duration of the day is twenty-three hours, fifty-six minutes and four seconds. The conditions we have stated are thus strikingly put by Prof. Poynting: "The sun is not a regular timekeeper. Our twenty-four hour day is only the average between successive noons, or times when the sun is due south. If compared with a good clock, the sun is in parts of the year too soon and in other parts too late, sometimes as much as a quarter of an hour. The variation in the solar day is due partly to the inclination of the earth's axis to the plane in which it moves around the sun, partly to variation of the earth's motion round the sun at different times of the year. The fixed stars keep good time, getting round in about four

minutes less than twenty-four hours. By them clocks are rated. Their day is the true time of our revolution of the earth."

The day has been divided into twenty-four hour parts from the earliest times, although, in different sections of the world and at different periods of history, its commencement has been placed at different points in the twenty-four hours. In present times and in most countries, the day is usually regarded as commencing at midnight, the twelve hours before noon being designated as A. M., or *ante meridiem*, those after noon as P. M., or *post meridiem*. The ancient Chaldeans and the modern Greeks have made the day commence at sunrise, while, at least until a few years ago, the Italians and the Bohemians begin it at sunset. The ancient Greeks, instead of dividing the entire day into twenty-four equal parts, cut the period of light into twelve equal portions and the period of darkness into the same number.