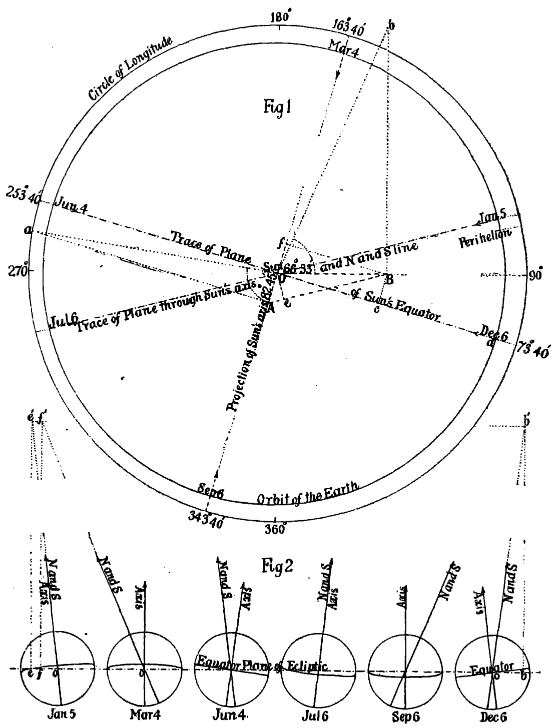
# THE POSITION OF THE SUN'S AXIS.

By FREDERICK R. HONEY.

The apparent rotation of the sun on its axis in 27-1/4 days—the synodic period—proved by the alternate appearance of spots on its surface at one limb and their subsequent disappearance at the opposite limb, enables the astronomer to determine the position of the sun's equator relative to the ecliptic, and the actual period of the sun's rotation in 25-1/3 days. The difficulty in the determination is due to the sun not being a solid body, and the consequent variation in the motion of the spots at different latitudes. The average of a large number of observations gives the longitude of the ascending node of the sun's equator, and the angle which its plane forms with that of the ecliptic. Since the sun's axis is perpendicular to this plane, its apparent position relative to the ecliptic, and to the north and south line of the celestial sphere at any assigned date is a simple problem of descriptive geometry.




Projections of the Sun referred to the Ecliptic

Fig. 1 is a plot of the earth's orbit. The longitude of the ascending node of the sun's equator is 73° 40′, which gives the position of the trace of the plane of the equator, and which, passing through the sun, intersects the earth's orbit at opposite points. The earth reaches these positions on December 6 and June 4; and if the sun be projected on a plane which is perpendicular to the line of sight in the direction of the arrow, the equator, at each of these dates, takes the positions shown in Fig. 2. The eye of the observer in each case is in the plane of the equator, and it is therefore represented by a straight line which forms with the ecliptic an angle which is shown in its true value (—7° 15′). At these dates the spots appear to cross the sun's disc in straight lines parallel to the equator. At other dates the apparent paths are elliptical.

In Fig. 1 the projection of the axis on the plane of the ecliptic is perpendicular to the trace of the plane of the equator; and in Fig. 2 in each position it is perpendicular to the equator. In order to find the apparent position of the north and south line, construct the right angled triangle ObB (Fig. 1) making the angle bOB = 66° 33′ which is the inclination of the axis of the celestial sphere to the plane of the ecliptic, and which is directed to the pole of the heavens. OB is its projection on the plane of the ecliptic (long.=90°). Draw Bc perpendicular to Od, and in Fig. 2 lay off (Dec. 6) ob = cB (Fig. 1), and make bb′ perpendicular to the ecliptic equal to Bb; ob′ gives the apparent direction of the north and south line. The projections (June 4) are obtained by similar constructions. The equator, axis, and N and S line on June 4 and December 6 are symmetrical with respect to an axis which is perpendicular to the ecliptic and midway between these figures.

If a plane be passed through the axis and the north and south line, its trace, drawn through the sun, will intersect the orbit at opposite points which the earth reaches on January 5 and July 6. The trace of this plane is found by assuming points on the axis and on the N and S line at equal distances from the ecliptic. In Fig. 1 construct the right angled triangle OaA, making the angle AOa=82° 45′(=comp. 7° 15′); and make the perpendicular Aa = Bb. A and B are the projections of points in the plane equidistant from the ecliptic, and AB is therefore parallel to the ecliptic and to the trace of the required plane. Since the observer's eye is in this plane at each date, the axis and N and S line apparently coincide as shown in Fig. 2. To determine its inclination to the ecliptic draw Oe (Fig. 1) perpendicular to AB, and in Fig. 2 lay off (Jan. 5) oe = Oe. Draw ee′ perpendicular to the ecliptic = Bb (Fig. 1), and draw e′o which is the apparent position of both axis and N and S line. The construction is similar for July 6; and the projections of the equator, the axis, and the N and S line are symmetrical. It should be noted, however, that only that part of the equator which is visible is represented.

If a line be drawn through the sun perpendicular to the trace of the plane of the equator, it will intersect the orbit at opposite points which the earth reaches on March 4 and September 6. At these dates in Fig. 2 the sun's axis and the minor axis of the ellipse which represents the equator are projected in the same line perpendicular to the ecliptic. To determine the N and S line, draw (Fig. 1) Bf perpendicular to the line of sight, and lay off (Fig. 2) March 4 o f = Bf (Fig. 1). Make ff′ perpendicular to the ecliptic equal to Bb; f′o is the apparent direction of the N and S line. As in the other projections the two figures March 4 and September 6 are symmetrical.

In order to realize the meaning of the constructions for each date, the reader should rotate Fig. 1 into a position where the earth is between him and the sun, and he is looking in the direction of the arrow. It should be noted that the sun's axis produced will pierce the celestial sphere at a point which is about midway between Vega ($\alpha$ Lyræ) and Polaris.

On account of the change of the earth's longitude each year, by a fraction of a degree, which is adjusted during leap year, there may be a change of one or more of the dates here given. For example, January 5 may read January 4.

## THE PARALLACTIC MOTION OF THE STARS IN ZONES

By R. H. TUCKER.

The parallactic motion of a star may be defined as its apparent motion projected upon that radius of the celestial sphere which terminates at the point towards which the sun is moving—the apex of the solar motion. If the radial velocity of a star has been measured, the velocity along the radius directed to the star is transformed into the equivalent projection upon the radius directed to the apex. The determination of the direction and angular motion of the sun, as well as its velocity, all depend upon the assumption, thoroughly justified by the theory of probability, that the motions of the stars in space have all possible directions and a wide range of velocities, and that if a very large number of stars are included the mean of all their individual motions will be so close to zero that any residual of motion will be negligible. If a definite residual of motion be found in a discussion of observed motions, this residual represents then the change of position of the whole mass of stars with respect to the solar system. The motion of the sun in space would be of the amount indicated by this residual, and in the contrary direction.

The apparent motion of any star, as given by the measured changes in its position, or by the measure of its radial velocity, is thus made up of two effects. One is the actual motion of the star in space of three dimensions, and the other is due to the change in the position of the observer—the motion of the solar system. It is not possible to separate these two effects if neither one is known. The usual method of com-