(C) A third important perturbation is the *oscillation of the ecliptic*. This oscillation is induced by the oscillation of the plane of the earth's orbit. We let $\varepsilon(t)$ denote the angle between the ecliptic plane and the equatorial plane (Fig. 113). The function $\varepsilon(t)$ describes the ecliptic oscillations as a time function.

Here we take into consideration the precession of the longitude and the ecliptic oscillation but not the smaller oscillations such as nutations. The exact astronomical and mathematical theory of ecliptic motion was formulated by S. Newcomb. This theory is well known and has been generally accepted up to the present time; it is the basis of all modern calculations concerning the evolution of ecliptic and other parameters of the earth's motion. We have used Newcomb's theory and modern specifying equations (from the work of H. Kinoshita [322]) in calculating the functions $\alpha(t)$ and $\varepsilon(t)$, using a computer. Various other astronomers (including C. H. F. Peters, E. B. Knobel, and R. R. Newton) have used Newcomb's theory as a basis for calculating the positions of the stars in ancient times from modern exact data.

The considerable proper motions of some stars is also taken into account—actually we consider all stars as moving stars. All data about the directions and velocities of proper motions are contained in [323] and [326]. Most stars which are visible (to the naked eye) move very slowly, but there do exist stars (the bright ones) whose position on the celestial sphere has changed by several degrees over two thousand years. We can consider all proper motions of the stars during the time interval from 500 B.C. to the present as rectilinear motions.

Finally, we also consider the refraction effect, which is important for the stars close to the horizon.

We measure time t, using centuries as units. The value $t = 0$ corresponds to 1900 A.D. The coordinates of "modern" stars are reduced to this year. The value $t = 1$ corresponds to 1800 A.D. and so on. But the parameter t must not be an integer. For example, the value $t = 3.75$ corresponds to 1525 A.D. The parameter t will change inside some time interval fixed a priori. For the Almagest, we choose this interval to be $0 \leqslant t \leqslant 25$, i.e., from 600 B.C. to 1900 A.D.

3. Some Characteristics of the Ancient Star Catalogues

We study the star catalogues of Ptolemy (the Almagest), Tycho Brahe, and Hevelius. All these catalogues were worked out without telescopes. Each catalogue contains about 1000 stars, whereas modern catalogues contain about 5000 stars visible to the eye.

The modern catalogues use equatorial coordinates which can be measured more simply and accurately than ecliptical ones. The medieval and ancient catalogues mentioned above use the ecliptical coordinates. The ancient astronomer did not know about the small ecliptic oscillations and hence supposed the ecliptical coordinates to be "eternal" coordinates. In other words, they supposed that ecliptical latitudes did not change over time and that ecliptical longitudes changed with constant velocity induced by precession. The equatorial coordinates even of fixed stars (those without proper motions) change in a more complicated way. After the dis-