

## Fundamental Positions and Motions of Stars.

The oldest astronomical problem is the determination of the positions of the stars and planets. So many different motions are involved that the problem is still a little short of being fully solved, although the patient toil of the meridian circle observers, <sup>over more than a century</sup> has yielded a set of fundamental positions and constants, which are practically speaking as accurate as any of the standards found in the experimental sciences.

Instruments.

Fundamental positions are those strictly defined with reference to the two coordinates of the celestial sphere, declination and right ascension. The problem of obtaining declinations and right-ascensions which are absolute for any epoch involves instrumental and theoretical difficulties. No astronomical instrument is perfect. ~~There are corrections for~~ For example the meridian circle used for determining declinations and right-ascensions <sup>errors</sup> requires corrections for level, azimuth, ~~and collimation~~ <sup>and circle-scale.</sup> which early observers recognized and ~~was~~ eliminated by ~~simple formulae~~ comparatively simple measurements and formulae. One serious error remained, namely flexure of the instrument and this has never been fully reduced to <sup>certain</sup> ~~practical~~ method for its elimination. <sup>Besides</sup> even if a perfect meridian circle were available the earth's atmosphere would still be present to distort the line of sight between the star and telescope by an error, which follows no ~~really accurate~~ really consistently ~~and~~ accurate law. At best the positional astronomy still struggles with only an approximation for the ~~no~~ errors from atmospheric refraction. Besides the meridian circle

~~There is the time-keeper~~ there is the time-keeper which must keep strict account of the right ascension. Theoretically it should be ~~now~~ free from the periodic variations in the earth's rotation, so that it keeps absolutely regular time. We are well aware that no such clock exists, although the ~~modern~~ <sup>free</sup> ~~pendulum~~ <sup>pendulum</sup> types are ~~now~~ <sup>only long periods</sup> considerably more accurate than any in maintaining this rate <sup>than</sup> any time keeper yet devised.

But ~~granting that~~ granting the ideal situation of ~~a~~ a perfect set of instruments meridian circle and clock, with a fair approximation for refraction, ~~the observer~~ the observer is still present to leave his mark upon the observations. Until we know just how his prejudices or propensities have intruded, we cannot reduce our ~~observers~~ claim absolute objectivity for a single position. ~~no~~ Present day methods have done much toward reducing personal equations to a minimum. The eye and ear methods <sup>for rt. ascension</sup> were not constant and a great number of observations were required to