intervals of azimuth, a constant error will either increase or decrease the size of the figure formed when the lines are plotted, but will have no effect on the center of the figure. Thus, four stars differing in azimuth by 90° should be observed, or five stars differing by 72°, etc. Theoretically, a four-star fix from bodies differing in azimuth by 90° (as N, S, E, and W) should produce only two lines of position, but in all probability a small rectangle will be the result.

The factor that has the greatest effect on a single observation is usually *random error*. The reliability of an individual line of position can be considerably improved by making several observations of the same body, and averaging the times and altitudes before solving for an LOP; this tends to average out the random errors. Alternately, if five or more observations of the same body are taken in quick succession, and its azimuth is noted by gyro, the accuracy of the individual observations may be determined by comparing the change of altitude between observation; the rate of change in altitude per second of time being equal to 0.25 × cos Latitude × sine of the angle between the body and the meridian. If the rate of change is steady for several sights one of these should be selected for reduction. This formula may be solved extremely rapidly with a slide rule.

An alternate method is to make three observations in quick succession and to solve and plot each one. If two LOPs are then in close agreement and a third differs considerably, it is usually safe to assume that the correct LOP lies midway between the two lines which are in agreement. The method is not as tedious as it may at first seem, particularly if solutions are made in parallel columns, as usually the only difference in the solutions are in minutes and seconds of time, and the resulting differences in GHA and $a\lambda$. Ordinarily, multiple observations are limited to sun lines, as the several bodies observed for a twilight fix serve as a check on each other.

In fixing or estimating the position of a ship, the navigator should not ignore the DR or EP, as these positions are based on other navigational information which may be more or less accurate than a given LOP. A DR or EP should be considered a *circle* with radius equal to the navigator's estimate of its accuracy, if knowledge of course and speed are considered to be equally good. If the navigator believes that one of these is known more accurately than the other, the DR or EP should be considered a small *ellipse*, with minor axis extending in the direction indicated by the more accurately known quantity and major axis extending in the direction indicated by the less accurately known quantity.

From the above, it can be seen that the interpretation of celestial lines of position can be a complex subject—one which calls for sound judgment on the part of an experienced navigator.

LOP bisectors.

3009. When a number of bodies, with azimuths all lying within a 180° sector of arc, are observed, a constant error may yield misleading results, if the fix is assumed to lie within the polygon formed by the LOPs. Such constant errors are frequently caused by unusual terrestrial refraction, which causes the value of the dip, as obtained from the *Nautical Almanac,* to be considerably in error. This may lead to the fix lying outside the polygon, resulting in an *exterior fix*, rather than the usual interior one. Where multiple LOPs well distributed in azimuth are obtained, this problem does not arise, as in this case the error may