A determination of the galactic pole from stars at large distances from the galactic plane,

by *J. H. Oort*.

1. The galactic plane may be defined either by objects concentrated very near the galactic circle, such as *distant* O- and B-type stars, or, independently, by the distribution of faint stars in high galactic latitudes. In both ways the effects of the very inhomogeneous distribution of absorbing material are largely eliminated, for it is clear that these can have no effect on the determination of the plane from objects which from their nature are practically confined to this plane, while, on the other hand, it is well-known that the absorption is almost harmless for latitudes larger than 30°, so that star-counts above this latitude should not be much influenced[1]). What has been said of the absorption holds also for the effects of local conglomerations of stars. It is interesting to see how well these expectations are confirmed by the available data: the pole as derived in the present note from counts of stars more than 1000 ps distant from the galactic plane is found at $\alpha = 189^\circ\!\cdot 9$, $\delta = +27^\circ\!\cdot 4$ (1900) with a mean error of $\pm 1^\circ\!\cdot 0$ in each co-ordinate, while the pole derived in the preceding article from galactic objects was $\alpha = 191^\circ\!\cdot 0$, $\delta = +27^\circ\!\cdot 5$.

A third determination of the galactic plane, which is again entirely independent of the two others, is that from the motions of high-velocity objects, first suggested by MICZAIKA; the solution given by VAN TULDER yields $\alpha = 190^\circ\!\cdot 7$, $\delta = +26^\circ\!\cdot 3$ (1900) with a mean error of $\pm 1^\circ\!\cdot 0$, again agreeing well with the other determinations.

I believe we may thus adopt with considerable confidence the final position found in the preceding article by Mr VAN TULDER, viz. $\alpha = 191^\circ\!\cdot 0$, $\delta = +27^\circ\!\cdot 5 \pm {}^\circ\!\cdot 2$ (m.e.), as the pole of the plane of symmetry of the galactic system.

2. A preliminary estimate of the pole of the galaxy from star-counts in high latitudes has been given in *B.A.N.* No. 308, p. 235. A more complete determination has now been made from the values of $\Delta \log A(m)$ published in Table 8 of that article. These numbers are the logarithms of the ratios of the numbers of stars of magnitude m counted in a certain Selected Area to those computed on the supposition that the equidensity surfaces are planes parallel to that of the galaxy. Now it is clear that if the adopted galactic plane makes an angle with the true plane of symmetry the residuals $\Delta \log A(m)$ in the northern latitudes will have a tendency to be systematically positive in certain longitudes, while those in the southern galactic hemisphere will be systematically low in the same longitudes. The general density gradient in the direction of the galactic centre will cause an increase of $\Delta \log A(m)$ towards the longitude of the centre, but this is of the same sign in the northern and southern galactic hemisphere, and is thus eliminated when the results for the two hemispheres are averaged with reversed sign for the southern data. It will be easy to translate the gradients of $\Delta \log A(m)$ into angular measure. On p. 262 of *B.A.N.* No. 308 it was found that for the level corresponding to $m_{90} = 16{\cdot}0$ (logarithmic mean distance from the galactic plane, z_0, 1040 ps) a gradient of ·133 per 1000 ps in log $A(m)$ corresponds to an angle of $9^\circ\!\cdot 0$; for the level $m_{90} = 17{\cdot}0$ ($z_0 = 1410$) a gradient of ·150 corresponds to $12^\circ\!\cdot 1$.

Least-squares solutions were now made for the gradients δ_{325} and δ_{55} of $\log A(m)$ in the directions of 325° and 55° longitude, respectively, and for the levels corresponding to $m_{90} = 16{\cdot}0$ and to $m_{90} = 17{\cdot}0$, by means of the formula

$$x_0\, \delta_{325} + y_0\, \delta_{55} + k = \Delta \log A(m).$$

x_0 and y_0, which are the rectangular coordinates in the directions of 325° and 55° longitude, and $\Delta \log A(m)$ were taken or computed from Table 8, *B.A.N.* No. 308; x_0 and y_0 were expressed in 1000 ps as unit. On account of the increased uncertainty of the absorption Selected Areas below 30° latitude were given half weight; it should be noted that for the level at $z_0 = 1410$ only one out of the 54 areas used had a latitude below 30°, while for the level at $z_0 = 1040$ there were 14 out of the total of 85 below this limit, 10 of these 14, however, having latitudes between 25° and 29°.

The results, with their mean errors, are as follows.

		north	south	i_{north}	i_{south}	$\bar{i}$
$m_{90} = 16{\cdot}0$, $z_0 = 1040$	$\delta_{325} =$	$+{\cdot}128 \pm {\cdot}013$	$+{\cdot}134 \pm {\cdot}028$	$+8^\circ\!{\cdot}66 \pm {}^\circ\!{\cdot}91$	$+9^\circ\!{\cdot}07 \pm 1^\circ\!{\cdot}86$	$-{}^\circ\!{\cdot}20 \pm 1^\circ\!{\cdot}04$
	$\delta_{55} =$	$+{\cdot}018 \pm {\cdot}015$	$+{\cdot}007 \pm {\cdot}029$	$+1{\cdot}24 \pm 1{\cdot}02$	$+{\cdot}49 \pm 1{\cdot}98$	$+{\cdot}38 \pm 1{\cdot}11$
	$k =$	$+{\cdot}043 \pm {\cdot}011$	$+{\cdot}008 \pm {\cdot}028$			
$m_{90} = 17{\cdot}0$, $z_0 = 1410$	$\delta_{325} =$	$+{\cdot}152 \pm {\cdot}020$	$+{\cdot}094 \pm {\cdot}043$	$+12{\cdot}26 \pm 1{\cdot}60$	$+7{\cdot}58 \pm 3{\cdot}48$	$+2{\cdot}34 \pm 1{\cdot}92$
	$\delta_{55} =$	$+{\cdot}038 \pm {\cdot}026$	$+{\cdot}067 \pm {\cdot}071$	$+3{\cdot}08 \pm 2{\cdot}07$	$+5{\cdot}36 \pm 5{\cdot}70$	$-1{\cdot}14 \pm 3{\cdot}03$
	$k =$	$+{\cdot}014 \pm {\cdot}012$	$-{\cdot}046 \pm {\cdot}040$			

1) For regions of intermediate latitude, on the contrary, we should expect considerable influence of the absorption, particularly because, of the two great near-by areas of absorption, one, in Taurus, extends far to the south of the galactic plane, while the large nebulosities in the opposite region of the Milky Way (Ophiuchus) lie preponderantly on the north side. It is not surprising, therefore, to find that the pole derived by VAN RHIJN from star-counts in all latitudes (*Groningen Publ.* No. 43, 16, 1929) deviates considerably from the standard pole, and that the same holds for the pole derived by PANNEKOEK from the general distribution of light in the Milky Way (*Lembang Ann.* **2**, Pt 1, A69).