height shifts up to 1500 km. According to these results gradients measured close together over regions 1500 km wide are found to reproduce all current $H\alpha$ results measured during eclipse. Somewhat steeper and flatter gradients are also observed.

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Eichhorn, Heinrich K. Systematic errors in the Helsingfors zone of the Carte du Ciel.

An ideal optical system should produce a point-for-point correspondence of star and its image by a strictly gnomonic projection with the central point on the optical axis of the lens system. In practice, the relative positions of the star images from any optical system may show, besides purely geometrical distortions, a dependence on the colors and magnitudes of the stars, as well as on seeing and atmospheric dispersion. A complete investigation of all these factors is very involved.

A dependence of the relative positions on the magnitudes of the stars in the Helsingfors zone of the Carte du Ciel has been shown to exist by Furuhielm (1906). This was later confirmed by Grönstrand (1937). Neither of them attempted to find an analytical formula for the removal of these errors, although their material was perfectly suited for this purpose.

Grönstrand's paper provides for four magnitude groups 4056 comparisons of stars in the Helsingfors zone with meridian positions observed at Pulkovo some 20 years after the plates were taken. Tables of systematic differences are also given for three magnitude groups in overlapping regions of plates with their centers at the same declinations (1610 comparisons) and at the same right ascensions (656 comparisons), and three magnitude groups (266 comparisons) for the systematic differences at the centres of overlapping quarter-regions of the plates. Furuhielm gives tables for the systematic differences of three magnitude groups for overlapping quarter-areas of plates, based on a total of 4045 comparisons. Weights of $\frac{1}{3}$ for one of Grönstrand's meridian comparisons; of $\frac{1}{2}$ for one of his edge comparisons and of one for Furuhielm's quarter-plate comparisons were found appropriate by making separate solutions for each of these sets.

A combined solution with all three sets, using a total of 19,000 comparisons was made with the

above weights, so that the weight of the combined solution is 12,193. The results with their mean errors are:

SYSTEMATIC CORRECTIONS TO THE HELSINGFORS ZONE
WITH THEIR MEAN ERRORS

	Δx	Δy
Coefficient of m'		
x^2	$+1.9 \pm 1.9$	$+2.8 \pm 1.7$
y^2	$-0.0030 \pm .0008$	$+0.0018 \pm .0007$
xy	$+0.0035 \pm .0008$	$+0.0021 \pm .0007$
rx	$+0.0012 \pm .0004$	$-0.0020 \pm .0003$
ry	$-0.0016 \pm .0009$	$+0.0005 \pm .0008$
x	$-0.07 \pm .05$	$-0.06 \pm .04$
y	$-0.0021 \pm .0009$	$-0.0028 \pm .0008$
Additional terms		
x^2	$-2".7 \pm 2".0$	$+3".2 \pm 1".8$
y^2	$-0.0001 \pm .0007$	$+0.0009 \pm .0006$
xy	$-0.0005 \pm .0006$	$+0.0021 \pm .0005$
x	$+0.0018 \pm .0003$	$-0.0006 \pm .0003$
y	$+0.14 \pm .01$	$+0.09 \pm .01$
	$+0.06 \pm .02$	$+0.13 \pm .01$

The unit for Δx and Δy is $0".01$, x and y are in millimeters, $m' = m - 8.5$, $r = (x^2 + y^2)^{\frac{1}{2}}$. The terms $-0.0016 rxm' - 0.07 x m'$ in x and $-0.0028 rym' + 0.01 y m'$ in y are easily explained by coma. This effect is much better established than it would seem from the errors of these terms, because there is a 97 per cent correlation between the terms in rxm' and xm' and also between rym' and ym' . However the terms in xm' , ym' and xym' in Δx and xym' in Δy cannot be easily explained by any known effect. Application of these terms reduces the sum of the squares of the residuals to about one-third of its original value. Diagrams for easy application of these corrections are being prepared for publication.

It can be seen that the systematic errors removed by this formula will in extreme cases be larger than one second of arc. The relative accuracy of this catalogue may well then be comparable to the Yale catalogues or the AGK2. This is based on the fact that the relative accuracy of a position on a single plate has a mean error about $0".23$.

A preliminary investigation of the Hyderabad zone of the Carte du Ciel shows a coma effect several times larger than that in the Helsingfors zone. The Algiers zone appears practically free from coma.

Furuhielm, R. 1906, Thesis, Helsingfors.
Grönstrand, H. O. 1937, *Acta Soc. Sci. Fenn.* New Ser. A 2, No. 7.

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