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THE IMPORTANCE OF GUIDING ON THE MOTION OF A COMET IN ASTROMETRIC OBSERVATIONS

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Abstract. In this paper we discuss the influence of guiding on the motion of a comet on the derived astrometric position.

Key words: comets – astrometry

1. THEORY

When doing astrometric observations of a comet, one is not interested in a beautiful picture, nor in showing the tail of the comet. Often it may seem unnecessary to guide on the motion of the comet. A plate guided on the motion of the stars and with a trailed image of the comet can look very acceptable to be measured for an astrometric position. However, positions obtained in this way show a systematic error.

When observing for an astrometric position, one is interested in the nucleus of the comet. The nucleus itself can never be observed directly, but the central condensation will give a very good approximation of the position of the nucleus. One tries to find the maximum of the light distribution of the cometary image and to take that as the position of the comet. In reality the eye will not point the maximum itself, but the centre of some isophote surrounding this maximum closely.

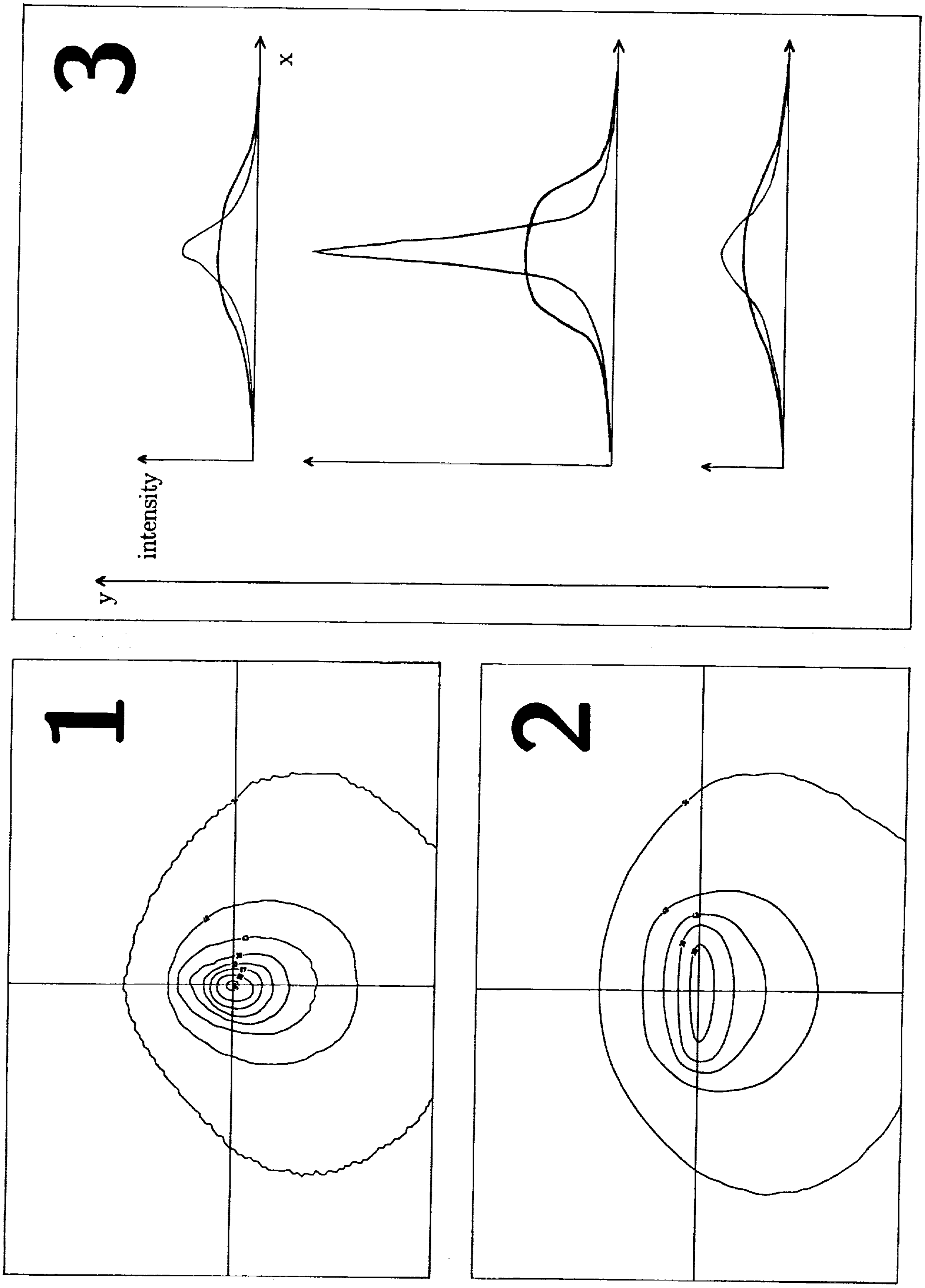
If the comet has moved (say, perpendicularly to the direction of the tail) during the exposure, then it may look as if there is a trailed central condensation, which can be measured quite well. However, this line of maximum intensity on the plate is not just the trail of the point of maximum intensity of the comet. At each point on the plate, the intensity is the integral of the intensity of the comet, integrated along the path of the comet on the plate. If we simplify by considering an infinitely long motion (say, parallel to the x-axis), then the intensity on the plate for the moving comet will be a function of one coordinate only (the y-coordinate). The intensity distribution on the plate will be the marginal distribution of the original light distribution of the comet. The maximum of this marginal distribution does not correspond to the y-coordinate of the maximum light intensity of the comet itself.

Figure 1 shows the light distribution of Comet Sorrells (1987 II) as measured on a plate taken with the Double Astrograph at Uccle. The comet is oriented with the tail down (parallel to the y-axis). The cross shows the position of maximum intensity (the derived position of the comet). Figure 2 shows the intensity distribution that would be obtained on a plate by letting the cometary image move horizontally at a constant speed, and with the same total exposure time. The minimum is slightly shifted down.

Figure 3 shows the two intensity distributions along the x-axis along cuts in different y-positions. The intensity for the moving comet is the convolution of the intensity for the non-moving comet with a block function. In the limit of infinitely long motion, it is just the area under the intensity distribution of the non-moving comet. For a cut through the maximum, the non-moving comet gives a sharp and high maximum; for a cut under (towards the tail) the maximum, due to the asymmetric light distribution of the original comet along the y-axis, the distribution along the x-as will have a lower, but also less sharp maximum, i.e. with more prominent wings. The total area under the function can be larger, and thus give more intensity on a plate with a moving comet. For a cut above the maximum, the maximum will be sharp and low, and consequently give a much smaller area. Thus the maximum of the light distribution along the y-axis will be shifted towards the tail if the comet has moved on the plate during the exposure.

Figure 4 shows the intensity distribution for the same comet, but now moving parallel to the direction of the tail, and Figure 5 the same for a diagonal motion. The results are even more striking.

Figure 6 shows the same as figures 1 and 2, but now for a fictitious cometary image showing more asymmetry in the light distribution in the coma and with a more pronounced and sharper central condensation, in order to visualize better what is happening. The moving comet now gives two intensity maxima on the plate. The lower one is obtained in the same way as the maxima in the previous cases, and is the result of the asymmetry in the light distribution in the coma; the upper one comes from the trail of the central condensation. Measuring the latter one would give good positions, but in real cases the central condensation is too faint to show this trail.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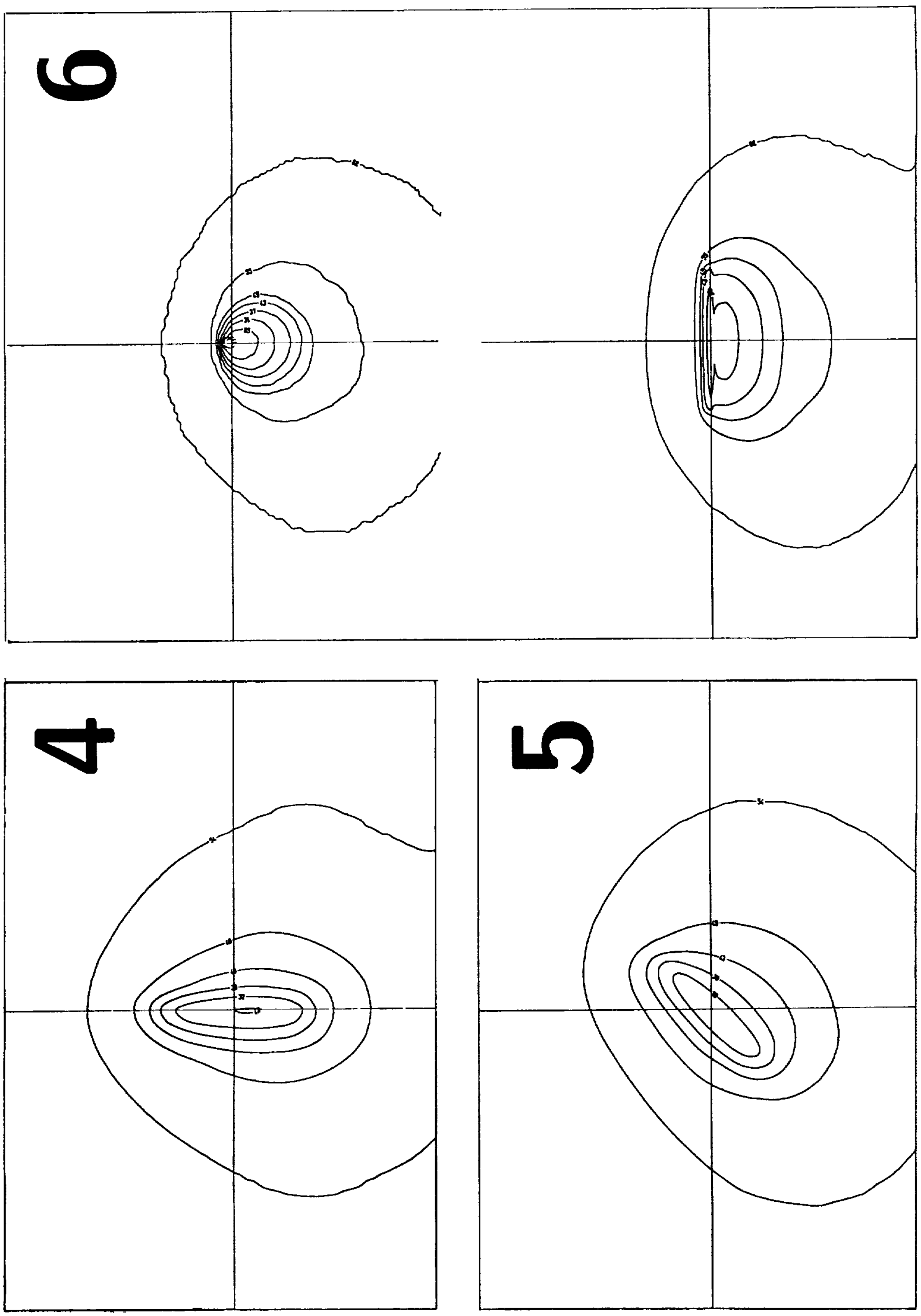
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2. COMPARISON WITH OBSERVATIONS

This effect was found by taking two simultaneous plates at the Double Astrograph (Ukkel, Belgium) of Comet Sorrells. Only one of them could be guided on the motion of the comet. Both plates were measured, and gave positions differing by 4 arcseconds. This difference was clearly larger than the error on the measurements. However, it seemed to be also larger than the theoretical difference, which should have been of the order of 1 arcsecond. The same measurements were performed for all other cases where we had two simultaneous plates of the same comet of which only one was guided on the motion of the comet. Although the differences in positions could be very large (40" for comet P/Giacobini-Zinner), there seemed to be no correlation between the position angle of the shift, and the position angle of the direction to the sun. But this might be due to very imprecise measurements because of the very diffuse cometrary images.

3. CONCLUSION

Although it was theoretically proved that the effect does exist, it could not be shown irrefutably from observations.