II. On the Orientation of the Orbital Planes in Multiple Systems[1].

By Jacob Gabovitš.

Our knowledge of the relative inclinations of the orbits in multiple systems is rather scanty. The question is, whether the plane of revolution of a close pair coincides, at least approximately, with the plane of revolution of the farther component, or whether the two planes are independent of each other. Only in one case do we know with certainty that the two planes of revolution practically coincide, namely in the triple system 44 ι Bootis. The inclination of the visual pair AB is 83° (W. Finsen, *Union Obs. Circ.* No. 91); the fainter component is an eclipsing variable, and thus its inclination must also be near 90°. In order to get more information on the relative inclinations, we propose to treat the problem statistically; for the inclinations we use the catalogue compiled by Finsen (*loc. cit.*).

We consider separately the visual binary stars with two known components only, and the visual systems, where at least one component is a spectroscopic binary. If there exists no correlation between the two planes of revolution in complex systems, the distribution of the visual inclinations must be the same in both classes of systems. If, however, the planes in question coincide, the average visual inclination in complex systems must be greater than the average inclination in simple systems, on account of the well-known fact that, owing to observational selection, the average inclination of spectroscopic binaries is greater than the expected statistical average. The actual averages from our material are as follows:

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[1] Seminar in Astrophysics, 1936/37, conducted by E. Öpik.

Table I.

	$\overline{\sin i}$	Number
Triple (or multiple) systems	0.850 ± 0.022	20
Double systems	0.735 ± 0.020	122
All	0.750 ± 0.017	142

The difference between the two values of $\overline{\sin i}$ seems to be real, which speaks in favour of the coincidence of the orbital planes in multiple systems. The effect is still more pronounced, if we consider the distribution of sin i in both cases (Table II). Whereas in the simple systems all values of sin i from 0.0 to 1.0 are present, the values of sin i in complex systems occur exclusively in the interval from 0.6 to 1.0.

Table II.

Distribution of Sin i in Visual Binaries.

Sin i of the visual binary	.0—.1	.1—.2	.2—.3	.3—.4	.4—.5	.5—.6	.6—.7	.7—.8	.8—.9	.9—1.0
Multiple (spectroscopic) systems (visual binaries with spectroscopic components)	—	—	—	—	—	—	4	3	4	9
Double systems without known sp. components	2	1	2	4	8	9	20	24	20	32

If the law of distribution were the same in both cases, we should expect 5.4 multiple systems in the interval of sin i from 0.0 to 0.6, whereas the observed number is zero. By Poisson's formula the probability for such a result to be accidental is $e^{-5.4} = 0.005$, or small enough to be considered improbable. On the contrary, the hypothesis of a coincidence of the orbital planes in multiple systems explains our result, since the discovery of spectroscopic binaries is strongly favoured by high inclination.

Returning to Table I, we notice that the average value of $\sin i$ for all computed orbits is slightly smaller than the expected statistical average for a random distribution ($\frac{\pi}{4} = 0.785$). This may be the result of a slight selection in discovery and computation, because, contrary to what happens to spectroscopic binaries, greater inclination of the orbit makes the visual binary a more difficult object.

We might expect à priori some kind of influence of the galactic plane upon the orbital planes. If a galactic orientation exists, in the sense of the galactic plane being a preferential plane for binaries, the average value of $\sin i$ for systems in high galactic latitudes must be smaller, in low galactic latitudes larger than the average. A slight effect in this direction is shown by Table III, although its reality is not certain.

Table III.

Galactic latitude	Sin i
0^0 to $\pm 30^0$	0.764 ± 0.023
$\pm 30^0$ to $\pm 90^0$	0.736 ± 0.025