UNBIASED MULTI-PARAMETRIC ESTIMATIONS OF DISTANCES AND PECULIAR VELOCITIES OF THE GALAXIES

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Accurate estimates of distances and peculiar velocities for galaxies may be derived with the help of multi-dimensional regression analysis using two or more distance indicators p_k (corrected apparent sizes, luminosities, other distance-dependent quantities) and some calibrators q_l (velocity dispersions of the ellipticals or HI-line widths of the spirals, mean surface brightness, colours, other distance-independent quantities) together, cf. Georgiev (1992). Here an example is given for 349 spiral galaxies with axial ratio $D/d > 1.4$ from the sample of Fisher & Tully (1981). The p–values are the major axis and the blue magnitude and the q-values are the HI line width, type and axial ratio.

The deceleration laws in the nearby universe are $\log p_k = -\log V + const_k$, where using the Hubble law $\log V$ changes $\log R$ (Fig. 1). The deviations $\Delta\log V_{ik} = \Delta\log p_{ik} = \log V_i + \log p_{ik} - const_k$ are **unbiased** raw estimations of the peculiar velocities. The regressions $\Delta\log p_k = f_k(q_l)$ (Figs. 2 - 4) give better estimations $<\log V_{ik}> = -\log p_{ik} + const_k - f_k(q_{il})$. Figure 2 presents the shifted Tully-Fisher (TF) diagram and Fig. 5 shows the deceleration diagram after TF-corrections of the major axes.

The regressions $\Delta\log p_k = F_k(q_1,q_2,...)$ are the multi-parametric generalizations of the TF (or Faber-Jackson) relations. The initial velocity estimations in the multi-dimensional method are $<\log V_{ik}> = -\log p_{ik} + const_k - F_k(q_{i1},q_{i2},...)$ and the final estimations $<\log V_i>$ are obtained by the linear regression $\log V = G(<\log V_1>, <\log V_2>,...)$. The mean-square value of the final peculiar velocity estimations $\delta\log V_i = \log V_i - <\log V_i>$ occurs about 1.2 times lower than that obtained by the pure TF-method (Fig. 6).

The general multi-dimensional method is performed by one C-program of the author including the graphics library of Dr. L. Georgiev (1991).

References

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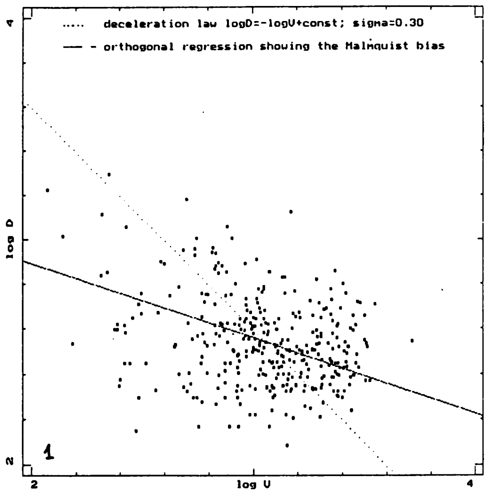


Figure 1. The observed deceleration diagram where V is the corrected Hubble velocity and D is the corrected apparent major axis: 1 - the deceleration law logD = -logV + const; sigma = 0.30; 2 - the orthogonal regression showing the Malmquist bias.

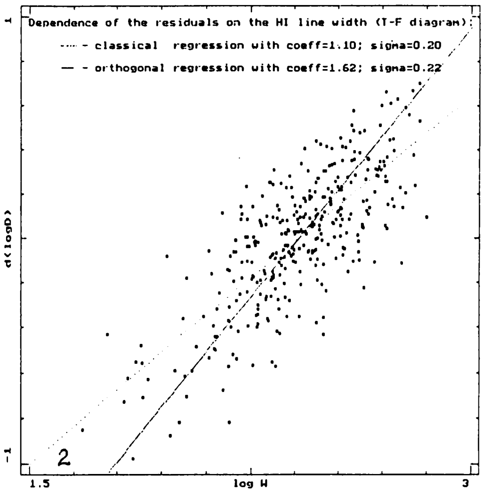
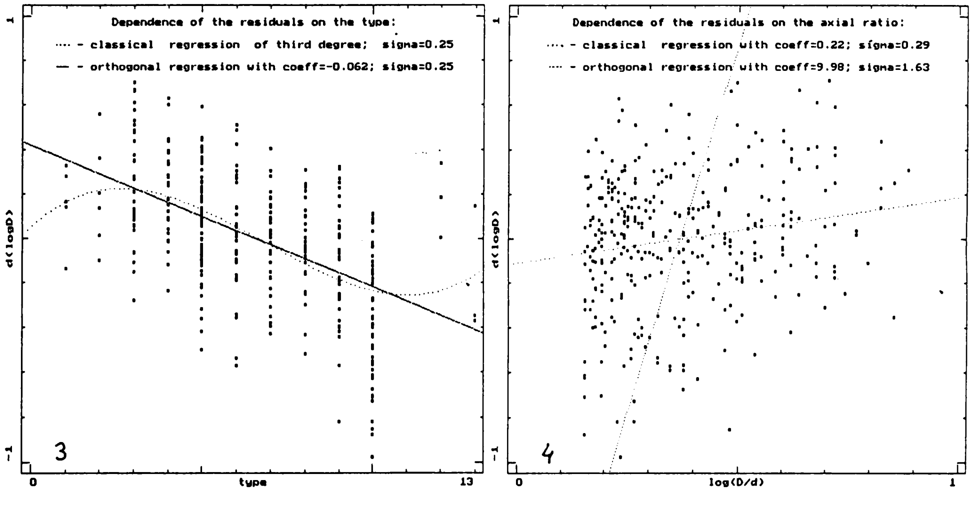


Figure 2. Shifted TF-diagram where d(logD) is the deviation from the deceleration law given in Fig. 1: 1 - classical regression; coef. = 1.10; sigma = 0.20; 2 - orthogonal regression; coef. = 1.62; sigma = 0.22.



Figures 3 and 4. Dependence of the deviations from the deceleration law on the type and the axial ratio of the galaxy.

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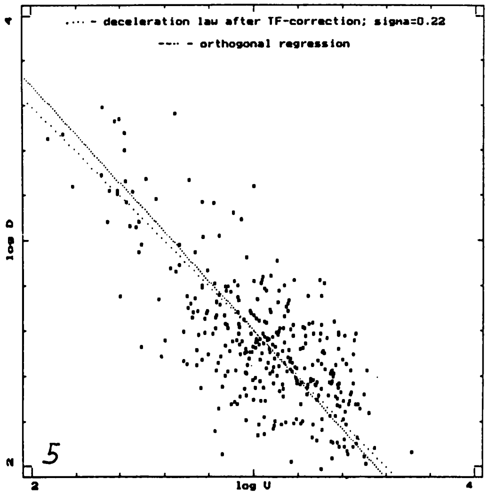

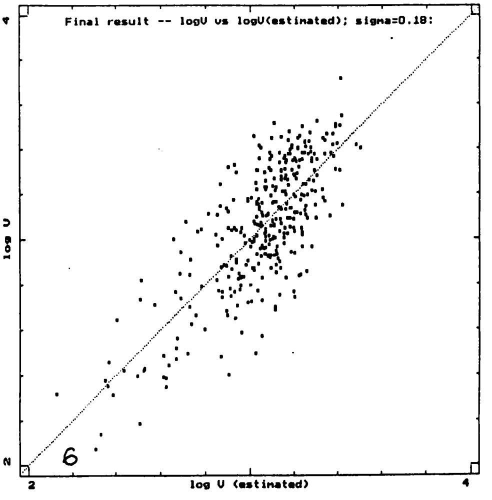

Figure 5. The deceleration diagram after TF-correction which illustrates our unbiased performance of the TF-method; sigma = 0.22.

Figure 6. Comparison between the observed velocities and the velocities obtained by the full multi-parametric method; sigma = 0.18.

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