New Cosmological Data and the Values of the Fundamental Parameters
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A Robust Technique for Estimating Cosmological Parameters

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Abstract. We present a new ROBUST technique for extracting information from galaxy surveys which allows determination of cosmological parameters free of almost any model assumptions concerning the galaxy luminosity function and spatial clustering. We illustrate ROBUST by estimating H_0 and the linear bias parameter, β, from recent redshift-distance data.

1. The ROBUST Method

Rauzy & Hendry (2000; hereafter RH00) and Hendry et al. (2000; hereafter H00) describe a new statistical method for estimating cosmological parameters from magnitude-limited redshift-distance surveys. The method makes no assumptions about the spatial distribution of galaxies or the form of the galaxy luminosity function (LF), and no Malmquist corrections are required. The key idea of the method is the definition of a random variable, ζ, related to the cumulative LF, which is uniformly distributed on the interval [0,1] and is uncorrelated with galaxy distance. Of course the distance of each galaxy is inferred from its observed redshift via a (parametric) velocity field model. We can therefore use the fact that ζ is uncorrelated with distance to estimate the parameters of the velocity field model by computing the sample correlation coefficient of ζ and (inferred) distance as the model parameters are varied and identifying the range of parameter values consistent with null correlation.

2. Estimation of β

In RH00 we applied ROBUST to a subsample of 318 galaxies, complete to I-band magnitude $m_{\lim} = 11.25$, extracted from the Mark III MAT spirals (Willick et al. 1997). We divided the subsample into 6 classes according to Tully-Fisher (TF) rotation velocity – although ROBUST makes very conservative use of TF information, requiring to assume neither a linear TF relation nor a gaussian distribution for its residuals. We compared the TF-estimated peculiar velocity with the (β dependent) IRAS predicted peculiar velocity of each galaxy. We then carried out a null correlation analysis to estimate $\beta = 0.6 \pm 0.125$, in excellent

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agreement with recent VELMOD results obtained from similar data (Willick & Strauss 1998).

3. Estimation of H_0

Having applied the ROBUST method to reconstruct the LF of a sample of distant galaxies, we can obtain a robust estimate of H_0 by matching a sample of HST KP calibrating galaxies to e.g. the median of the reconstructed LF. In H00 we carried out such an analysis using a complete subset of KLUN spirals (Theureau et al. 1997). Again, we made robust use of TF information by selecting, for each calibrator, the subset of distant galaxies with similar TF velocity and morphological type, and reconstructed the LF of this subset. We obtained $H_0 = 65 \pm 6$ km s^{-1}Mpc^{-1}, in excellent agreement with recent HST KP results (Mould et al. 2000).

4. Discussion

The principal virtue of our method is its robustness: no assumptions are required about the spatial distribution of galaxies, the LF of galaxies (aside from its universality) and the form of the TF relation. For the estimation of β our results would seem to indicate that Malmquist corrections do not seriously undermine the VELMOD and ITF approaches, since we obtain excellent agreement with those methods without requiring the application of Malmquist corrections. For the estimation of H_0, again the assumption-free nature of our method suggests little or no systematic error, at the stage of linking primary and secondary indicators, due to e.g. Malmquist bias. ROBUST improves significantly upon previous attempts to bypass Malmquist bias by restricting attention to a nearby 'plateau' region.

Our ROBUST method also provides, as a by-product of cosmological parameter estimation, an objective, robust test of statistical completeness and some powerful statistical tools for investigating such issues as the large-scale homogeneity of the universe and galaxy luminosity evolution and morphological segregation. We are currently applying ROBUST to these topics.

References

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