ESTIMATION OF GALACTIC MODEL PARAMETERS BY INTERVAL METHOD

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The interval method of estimating *model parameters* (*MPs*) for the Galaxy was suggested earlier (Kutuzov 1988). *Intervals* are proposed to be used both for observational estimates of *galactic parameters* (*GPs*) and for the values of *MPs*. In this work we consider a model as a tool for studying mutual interaction of *GPs*. Two-component model is considered (Kutuzov, Ossipkov 1989). We have to estimate the array **P** of eight *MPs*.

We use the following array of seven *GPs*: $\mathbf{Y} = (R_{\odot}, V, U, A, C, m, M)$. Here $R_{\odot}$ is the distance of the Sun from the centre of the Galaxy, V is the circular velocity, U is the velocity of escape, A is the Oort parameter, C is the Kuzmin parameter, m is the mass of the central parsec, M is the mass of the Galaxy. *GPs* V, U, A, C refer to vicinity of the Sun. The model allows to obtain expressions for each *GP* as a function of *MPs*: $y_i = g_i(\mathbf{P}), \quad i = 1, \dots, k = 7$. In addition two descriptive functions are used. Data on the rotation curve of the Galaxy give us estimates just of the rotation function defined as $\Omega(x) = V(x)/x - V, \quad x = R/R_{\odot}$, $V(x)$ is the circular velocity function. Data on the peculiar velocity dispersion as a function of z allows to estimate the vertical acceleration $K_z(z)$. *GP* C is a slope of this curve at $z = 0$. R, z are cylindrical coordinates. Two model functions $g_8(\mathbf{P},\ x)$ and $g_9(\mathbf{P},\ z)$ correspond to $\Omega(x)$ and $K_z(z)$ respectively.

Observational estimates of *GPs* lie within *initial intervals* with assumed limits. We ascribe the weight w_i to the *i-th* interval which is inversely proportional to the square of its width. Now we can describe the agreement of the model with observational data by the value of the functional

$$F(\mathbf{P}, \mathbf{Y}, \Omega, K_z) = W_1 \sum_{i=1}^{k} w_i [1 - g_i(\mathbf{P})/y_i]^2 +$$

L. Blitz and P. Teuben (eds.), Unsolved Problems of the Milky Way, 713–714.

$$+\frac{W_2}{d_2 - c_2}\int_{c_2}^{d_2} w_2(x)[1 - g_{k+1}(\mathbf{P}, x)/\Omega(x)]^2 dx +$$

$$+\frac{W_3}{d_3 - c_3}\int_{c_3}^{d_3} w_3(z)[1 - g_{k+2}(\mathbf{P}, z)/K_z(z)]^2 dz.$$

W_l are group weights given arbitrarily, $[c_l,\ d_l]$ are the ranges of corresponding functions. Weight functions $w_2(x)$, $w_3(z)$ are calculated similar to w_i. The best agreement is obtained by minimizing F with respect to $\mathbf{P}$ taking into account the constraints on *MPs*. Such a problem refers to the constrained nonlinear programming. The solution depends on assumed values of $\mathbf{Y}, \Omega, K_z$. Taking the centres of the intervals we obtain *the central solution*. Let us vary the selected *GP* or all the values of one function at once taking in turn the values of left and right limits. It gives *separate intervals*. On their basis we construct *united intervals* which include all separate ones.

We take the initial intervals of *GPs* so that they would include most of the known observational estimates of *GPs* being narrow enough. The separate intervals of *GPs* have been calculated for three variants: 1 – equipartition of *GPs* and two functions, 2 and 3 – without data on vertical acceleration and on rotation respectively. We conclude that the own variation of *GPs* have the greatest effect on the separate intervals. The separate intervals do not extend very much beyond the initial ones. The exception occurs for *GP* m in the case of variants 1 and 2 only. It means that the rotation data do not allow high value of the central parsec mass.

United intervals of the function $V(x)$ are caused most frequently by variation of *GP* M for the central part, but they are caused exclusively by variation of *GP* V for $x > 0.2$. The model circular velocity has two maxima and is flat enough outside the solar circle. United intervals of the function $K_z(z)$ are caused by variations of the acceleration itself. They coincide with the initial intervals quite satisfactorily.

So, after all the *MPs* have been estimated, and the model can be used for calculation of galactic orbits as the potential has relatively simple analytical expression.

References

Kutuzov, S.A. (1988) *Kin. i fiz. neb. tel*, 4, p. 39.
Kutuzov, S.A. and Ossipkov, L.P. (1989) *Astron. Zhurn.*, 66, p. 965.