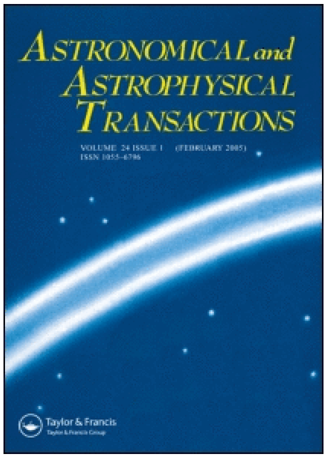

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THE ROTATION CURVE FROM THE NEUTRAL HYDROGEN 21 CM LINE PROFILES, THE SPIRAL STRUCTURE AND THE MASS OF THE GALAXY

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For the determination of the mass of the Galaxy we must know the rotation law of the galactic disc. Our method of the determination of the galactic rotation curve utilizes the whole 21-cm neutral hydrogen line profile not only in the outer region of the Solar circle ($R > R_0$) but also for the inner region ($R < R_0$). The rotation curve was obtained in our earlier works for the ring-like distribution of the neutral hydrogen density (Petrovskaya, 1987a,b), but this condition is valid only if $R < 0.66\ R_0$ (Petrovskaya, 1986, 1987c). The result of the last paper was the 4-arm spiral structure of the neutral hydrogen subsystem in the region $0.66R_0 < R < R_0$. A redetermination of the rotation curve, accounting for the spiral structure was done by Malahova & Petrovskaya (1992). In the region $R > R_0$ the rotation curve was corrected for the warp of the hydrogen layer (Gerasimov & Petrovskaya, 1990). We found for the rotation curve the behavior $\sim R^{0.3}$ when $1.2 < R/R_0 < 2$. This result does not contradict the data of Rubin *et al.* (1982) for the spiral galaxies, R^{α}, where the mean value of $\alpha = 0.1$ has a large scatter.

The rotation curves of the other spiral galaxies have a "signature" at the distance R_1 from the centre, and the warp of the neutral hydrogen layer begins at this distance. The signature is supposed to be the consequence of the disc truncation, taking place at R_1. The method of mass determination for such galaxies used the representation of the rotation curve as a result of the superposition of two subsystems: the exponential truncated disc and the spherical halo. For the first the following form of the density distribution is usually used (Casertano, 1983)

$$\rho(R, z) = \rho_0(R)[ch(z/z_0)]^{-2},$$

$$\rho_0(R) = \begin{cases} \rho_0 \exp(-R/h), & \text{if } R \leq R_1 \\ \rho_0(R_1)[1 - (R - R_1)/\delta], & \text{if } R_1 \leq R \leq R_1 + \delta \\ 0 & \text{if } R \geq R_1 + \delta \end{cases} \quad (1)$$

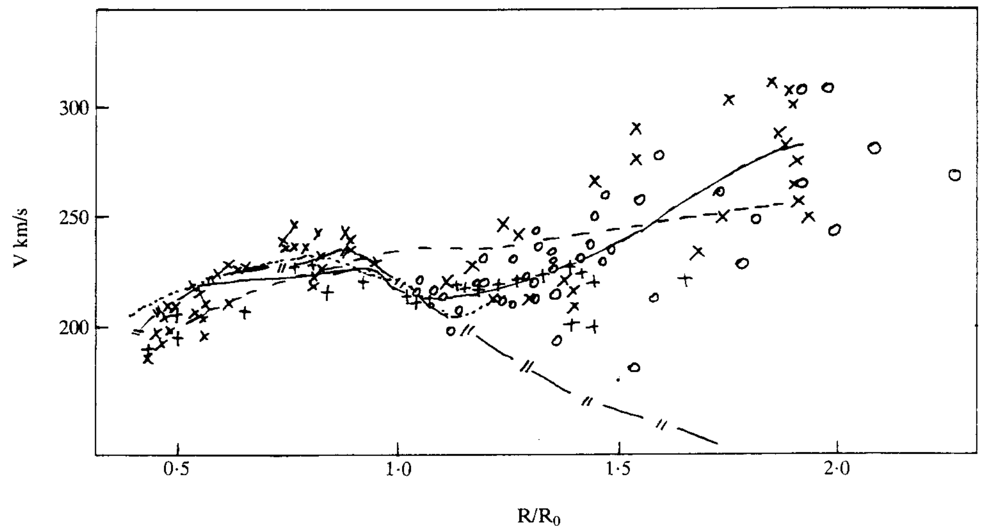

Figure 1 The data of the Galaxy rotation: from the 21 cm line by Malahova, Petrovskaya, 1992 ($R < R_0$), *by Gerasimov, Petrovskaya,* 1990 ($R > R_0$) (×); by Teerikorpi, 1989, and by Petrovskaya, Teerikorpi, 1986 (+); from the HII regions by Blitz, 1979, and by Chini, 1985 (○). The smoothed rotation data: from HI and CO data by Burton, Gordon, 1978, and from HII regions by Georgelin, Georgelin, 1976 (⋯⋯). Modeled rotation curves: for the truncated disc (–//–); for the disc + halo models with $V_h = V_{oh}(R/h)^{0.3}$ (––––) and $V_h = V_{oh}[1 + A(R/h - 3.5)^\gamma]$(—).

We apply (1) and the expression for the radial force by Casertano (1983) to the disc of our Galaxy.

The signature of the rotation curve of the Galaxy can be seen in the Figure 1 near the Sun's position. We supposed the disc truncated just at this radius and took the following parameter values: $h = 2.69$ kpc, $R_1 = 8.08$ kpc, $R_1/h = 3$, $z_0/h = 0.2$, $\delta/h = 0.2$. It should be noticed that the hydrogen layer warp begins at ~9 kpc from the galactic centre, and this fact supports our supposition of disc truncation near the Sun.

For the halo we took two variants of density distribution.

(i) In order to obtain the rotation curve $R^{0.3}$ for the large R halo density must be $\sim R^{-1.4}$. Then we find $V_{oh} = 143$ km/s, $M_h/M_d = 2.67$ and $M_h + M_d = 0.990 \times 10^{11}$ $M_\odot$ (up to the distance $R_1 = 3h$), $M_d = 2.7 \times 10^{10}$ $M_\odot$. Where the halo velocity is $V_h(R) = V_{oh}(R/R_1)^{0.3}$, M_d—the disc mass, M_h—the halo mass.

(ii) For a more accurate description of the linear velocity behavior we took $V_h(R) = V_{oh}$ for $R/h \leq 3.5$ and $V_h(R) = V_{oh}[1 + A(R/h - 3.5)^\gamma]$ for $R/h > 3.5$. In that case the halo mass in the spherical layer between $R_2 = 3.5h$ and $R > R_2$ will be $M = RV_{oh}{}^2G^{-1}A(R/h - 3.5)^\gamma$ where $V_{oh} = 165$ km/s, $A = 0.228$, $\gamma = 1.12$, and we find $M_h/M_d = 1.46$ and $M_h + M_d = 0.960 \times 10^{11} M_\odot$ up to $R = R_1$, $M_d = 0.39 \times 10^{11} M_\odot$.

The data on Galactic rotation and the results of their approximations by two models are presented in Figure 1. In both cases the whole mass of the Galaxy up to a distance of 20 kpc of the galactic center is equal to $3 \times 10^{11} M_\odot$. If the corona extends up to 390 kpc of the galactic center, and its mass is equal to $2 \times 10^{12} M_\odot$ as Haud *et al.* suppose, then the density must decrease faster than $R^{-1.4}$ for $R > 20$ kpc.

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