NGC 3992 - A GALAXY WITHOUT A MASSIVE HALO

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As a continuation of our earlier work (Gottesman and Hunter, 1982), we have reobserved the HI emission from the galaxy NGC 3992. We have combined all the data and produced new maps, at a significantly improved signal-to-noise ratio, of the gas density and velocity distribution with resolutions of $\sim$ 22" and 25 km $s^{-1}$. The resultant, angle averaged, HI rotational velocity is shown in Figure 1 for the symmetric and nearly circular flows for $r \leq 3.35'$ from the center ($r \leq 14.0$ kpc, assuming de Vaucouleurs' (1979) distance of 14.2 mpc for NGC 3992). Shown, also, in Figure 1 is a fit to the observations provided by a Toomre disk of index n = o. No attempt was made to fit the observational data within 1', in view of the low signal to noise.

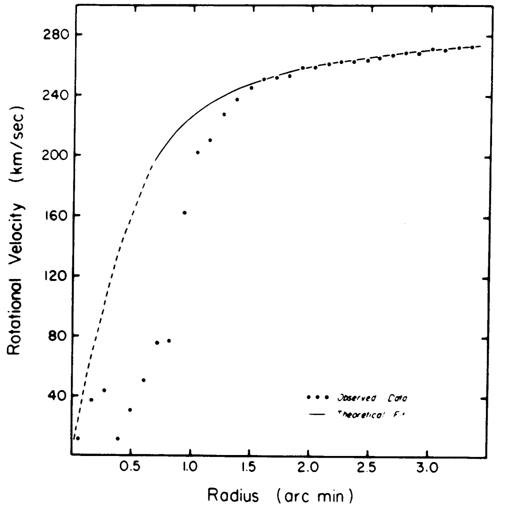


Figure 1. Angle Averaged Rotation Curve for the HI in NGC 3992

The surface density and gravitational potential of the n = o disk are obtained by <u>integrating</u> the density and potential for the n = 1 disk



*E. Athanassoula (ed.), Internal Kinematics and Dynamics of Galaxies, 93–94.*

(Toomre, 1963), Viz. $\sigma_0(a, r) = -\int \sigma_1(a, r)ada = [C_1{}^2/(2\pi G)](a^2 + r^2)^{-\frac{1}{2}}$, and $\phi_0(a, r) = -\int \phi_1(a, r)ada = -C_1{}^2 \ln[a + (a^2 + r^2)^{\frac{1}{2}}]$. The rotational velocity as a function of r and disk mass interior to r are given by $v(r) = C_1 [1 + a^2/r^2 + (a/r)(1 + a^2/r^2)^{\frac{1}{2}}]^{-\frac{1}{2}}$ and $M(r) = (C_1{}^2 r/G) [(1 + a^2/r^2)^{\frac{1}{2}} - a/r]$ respectively. With our fit, $C_1 = 293$ kms$^{-1}$, a = 1.76 Kpc, and M(14.0 Kpc) = 3.0 x $10^{11}$ $M_\odot$. (The mass has been augmented by 20% to allow for finite disk thickness.) By way of comparison our published Brandt model, which was based on half the present data, resulted in disk masses interior to r = 19.7 Kpc in the range (1.6 - 4.3) x $10^{11}$ $M_\odot$, with the uncertainty reflecting the allowable range in the Brandt function parameters. Serendiptiously, we observed HI emission from three nearby dwarf systems, UGC 6923, 6940, and 6969, which appear to be Magellanic cloud-like satellites of NGC 3992. The global line profiles of the objects are well resolved, and in Table 1 we list the velocity differences $\delta V_i$ and projected separations $S_i$ between the satellites and NGC 3992. Listed, also, are indicative masses for the primary galaxy, $q_i = 2.325 \times 10^5 (SV_i)^2 S_i M_\odot$.

Table 1

| Object | $\delta V_i$(km/sec) | $S_i$(Kpc) | $q_i$($10^{10}$ $M_\odot$) |
|---|---|---|---|
| UGC 6969 | 64 | 44.2 | 4.2 |
| UGC 6940 | 50 | 34.7 | 2.7 |
| UGC 6923 | 16 | 59.5 | 0.55 |

Using the mass indicator of Bahcall and Tremaine (1981), $M = (24/\pi)\, 1/3 \sum_{i=1}^{3} q_i = 1.9 \times 10^{11} M_\odot \pm 1.5 \times 10^{11} M_\odot$. After allowing for observational errors, particularly uncertainties in the $\delta V_i$ values, we conclude that the mass interior to 60 Kpc from the center of NGC 3992 cannot exceed about 4 x $10^{11}$ $M_\odot$.

Therefore, we conclude that NGC 3992 is unlikely to possess a massive halo. This confirms our earlier analysis, and is based on twice as much data and an alternative model for the mass distribution in NGC 3992. Indeed, if we invert the argument and suppose that the galaxy does possess a massive isothermal halo, then, at large radii, $V(r) \to C_1/\sqrt{2} = 175$ km s$^{-1}$. A $\chi^2$ test for three degrees of freedom yields only a 3% probability that satellites moving in such a halo would exhibit velocity differences as small as those observed.

REFERENCES

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