THE MASS OF THE BINARY GALAXIES NGC 4038/39 (THE "ANTENNAE")

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The binary galaxies NGC 4038/39 have extended filamentary arms generated by tidal interactions (Toomre and Toomre, Ap. J. 178; 623, (1972)(TT)). The velocity field was determined by HI observations taken with the VLA (a facility operated by the NRAO under contract with the NSF), and the combined velocity and morphological information was used to constrain the allowed orbital parameters, halo characteristics, and dynamical friction. TT-type calculations were carried out with central masses and rings of test particles, and the calculated results compared with the data. Using disk orientations derived from optical data (Rubin et al., (1970) Ap. J. 160 81), and solving for the six remaining orbital parameters, central potential softening constant (representing the halo), and frictional relaxation time, a good fit between the model and the radio data was found. The best model is shown in Figure 1, and is superimposed on an HI column density map in Figure 2. The orbit is well-determined, and must be nearly parabolic; the pair are interacting for the first time, and if the galaxies have extensive massive halos much larger than their discs, then their tidal arms would be shorter and stubbier than observed. More limited halos are allowed; each galaxy could have up to 80% of its total mass in a halo, but the halos cannot be much larger than the discs. A halo several times larger than the disc, with 10 to 20 times the disc mass, is not permitted by the data.

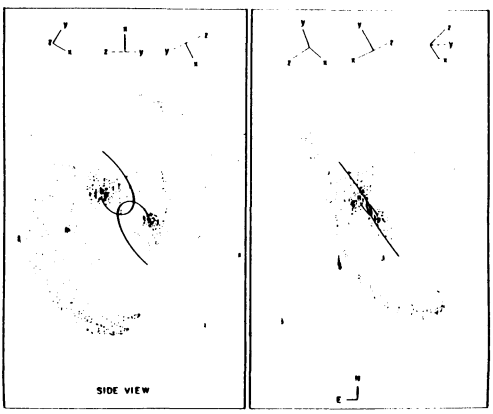

Figure 1: Best-fit model calculation for NGC 4038/39

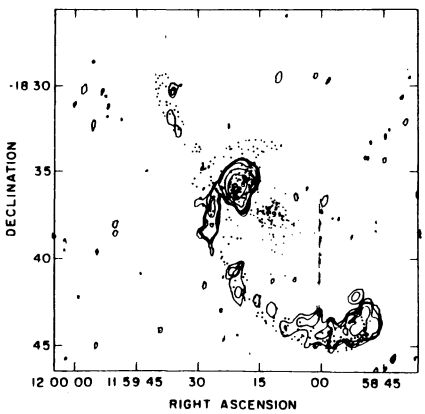

Figure 2: Hydrogen density contonrs compared to model

J. Kormendy and G. R. Knapp (eds.), Dark Matter in the Universe, 94.