Rotation Curve Modelling to constrain Dynamical Mass Distribution in Spirals: Update

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Abstract

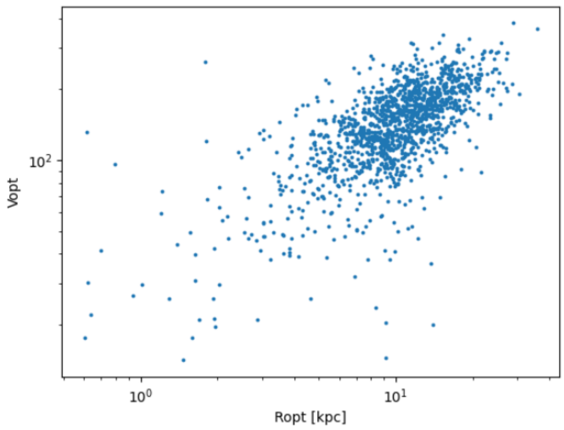
We now use a corrected sample for the analysis, also increasing the sample size to 1357 and tweaking the binning. This time we exclude NFW Analysis and are able to get largely closed contours for a Burkert Modelling.

Contents

Chapter 1

Data

The new data consists of 1462 galaxies with newly computed R_{opt} from surface brightness data to get rid of a few spurious values which arose of unsatisfactory fitting. We also exclude 188 rotation curves which still demonstrate nonphysical behaviour, ending up with a final sample of 1357. This tremendously reduces the scatter in the R_{opt} vs V_{opt} plot.



Chapter 2

Data Analysis

The following table conveys the change in binning:

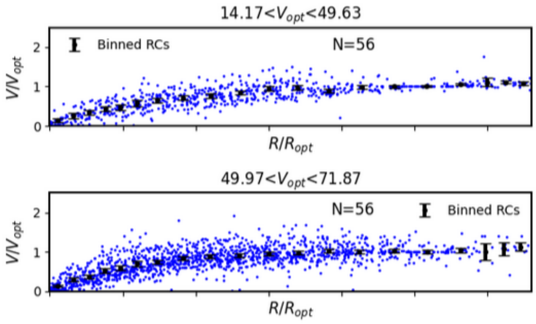
V_{opt} bin	$V_{opt}(km/s)$ range	N Galaxies	$\langle V_{opt} \rangle$	$< R_{opt} >$
1	14.17 - 49.63	56	36.26	4.23
2	49.97 - 71.87	56	61.58	6.27
3	72.5 - 85.17	57	79.74	6.31
4	85.37 - 109.36	169	98.09	8.19
5	109.95 - 127.87	169	119.46	9.08
6	127.91 - 145.68	169	136.05	9.94
7	145.77 - 164.99	169	155.66	10.95
8	165.19 - 184.52	169	174.6	12.27
9	184.56 - 212.21	169	197.46	13.97
10	212.43 - 237.2	85	223.63	15.43
11	238.11 - 382.21	86	268.37	16.5

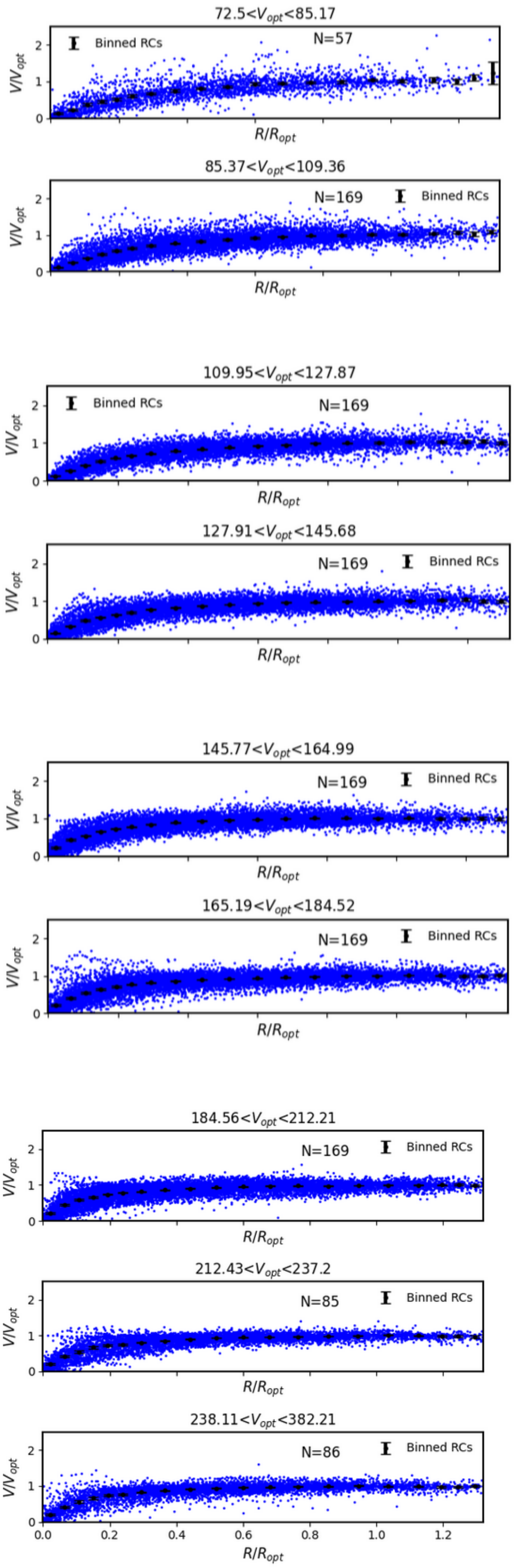
Everything else remains unchanged. The synthetic RCs are shown below.

2.1 Mass Modelling

2.1.1 Fitting

For our analysis we use informative flat priors for $\log M_D$ from 8 to 12.5, $\log R_C$ from 0 to 100, $\log \rho_0$ from -18 to -26 and an additional intrinsic scatter parameter $\log \sigma_{int}$

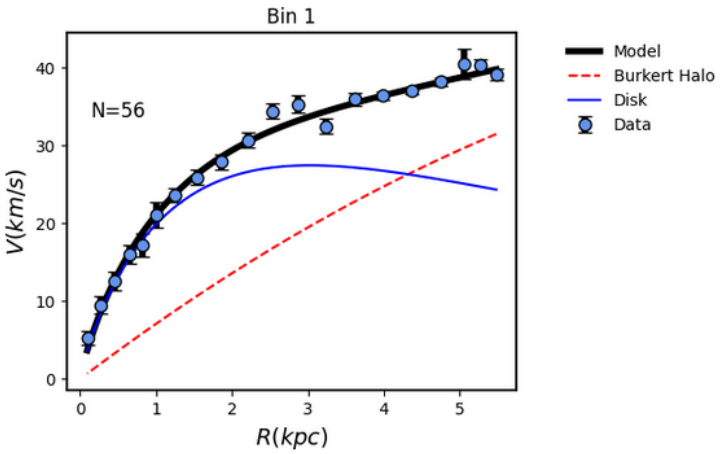


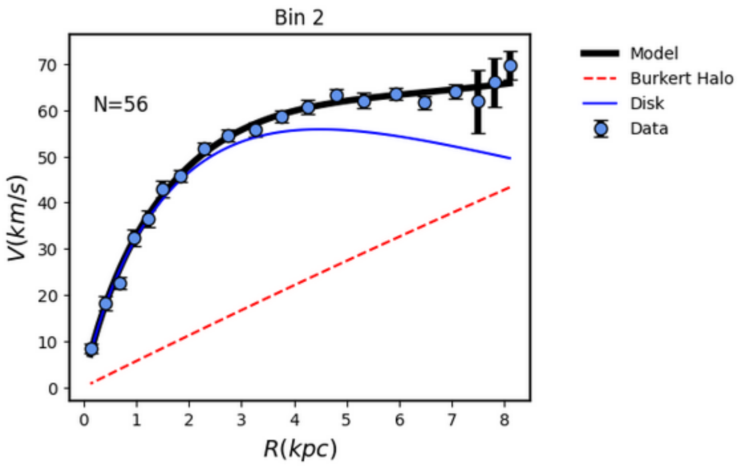

72.5<Vopt<85.17
N=57
Binned RCs
85.37<Vopt<109.36
N=169
109.95<Vopt<127.87
127.91<Vopt<145.68
145.77<Vopt<164.99
165.19<Vopt<184.52
184.56<Vopt<212.21
212.43<Vopt<237.2
N=85
238.11<Vopt<382.21
N=86
V/Vopt
R/Ropt
0.0
0.2
0.4
0.6
0.8
1.0
1.2

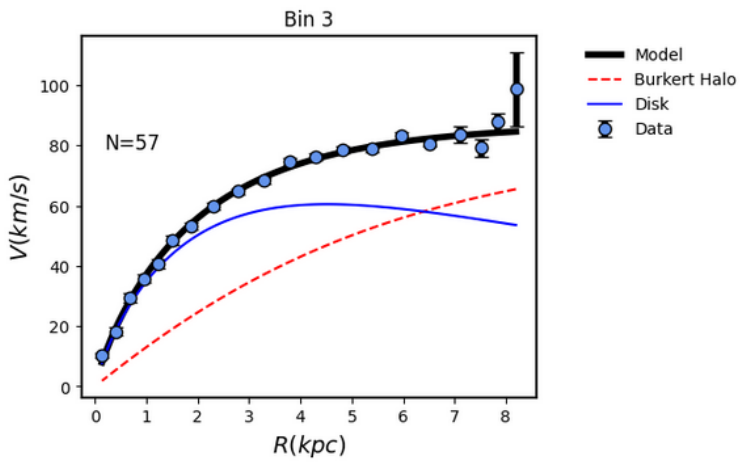
from -3 to 3. We allow 25 walkers to evolve over 10000 steps and discard the first 1000 steps for burn-in. The results follow in the next section

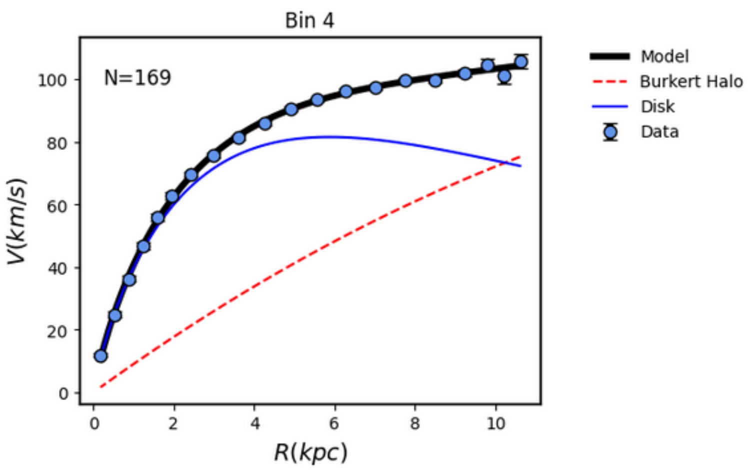
Chapter 3

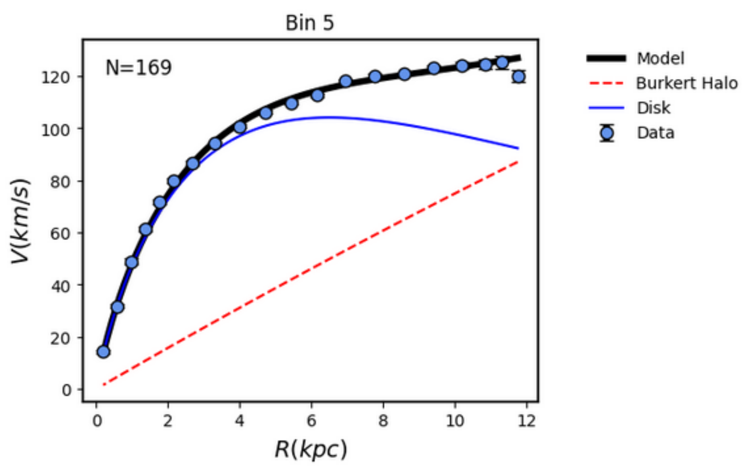
Results

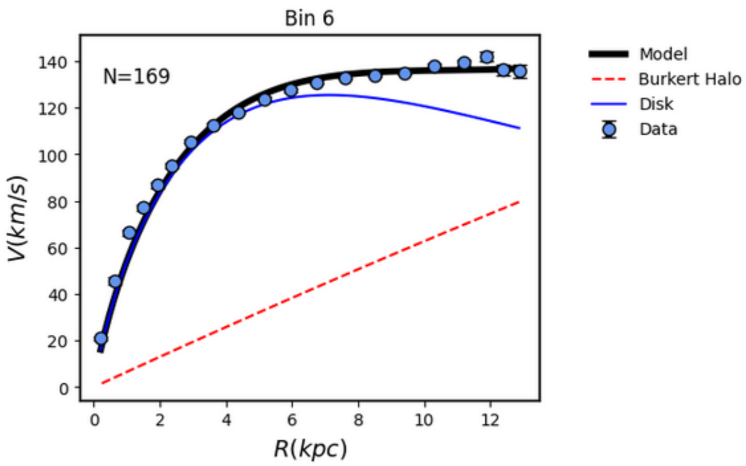


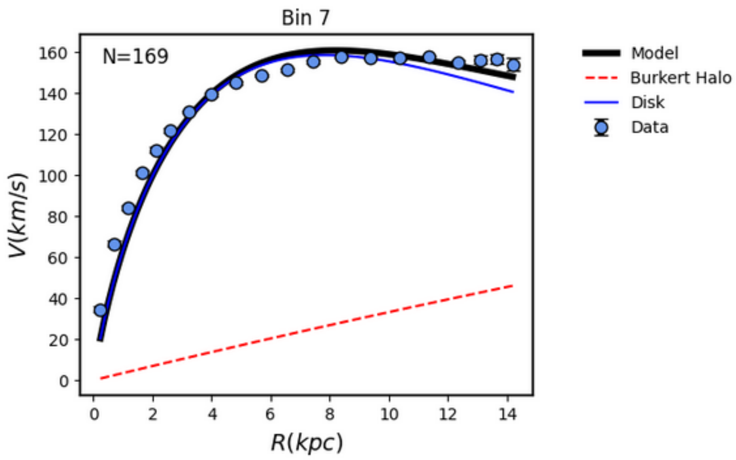


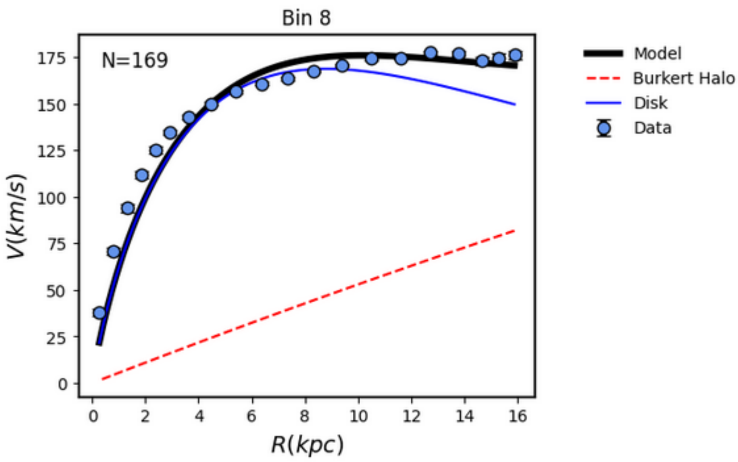

Bin 3
N=57
V(km/s)
R(kpc)
Model
Burkert Halo
Disk
Data

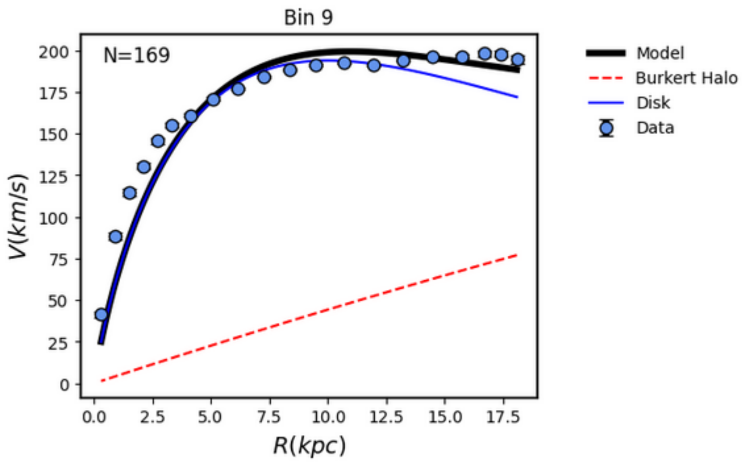

Bin 4
N=169
V(km/s)
R(kpc)
Model
Burkert Halo
Disk
Data

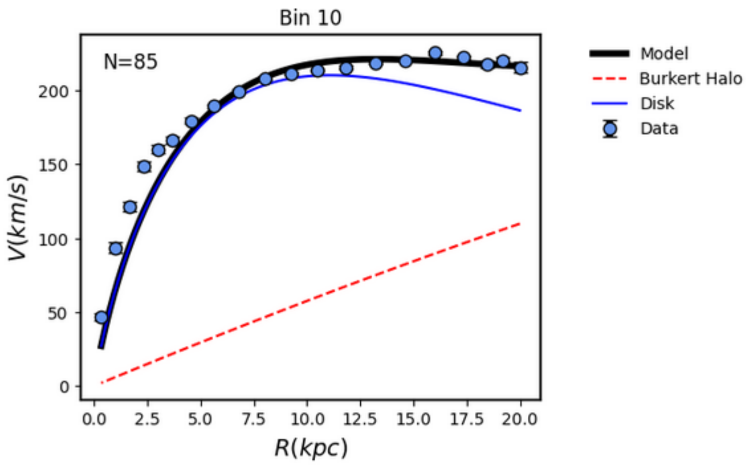

Bin 5
N=169
V(km/s)
R(kpc)
Model
Burkert Halo
Disk
Data

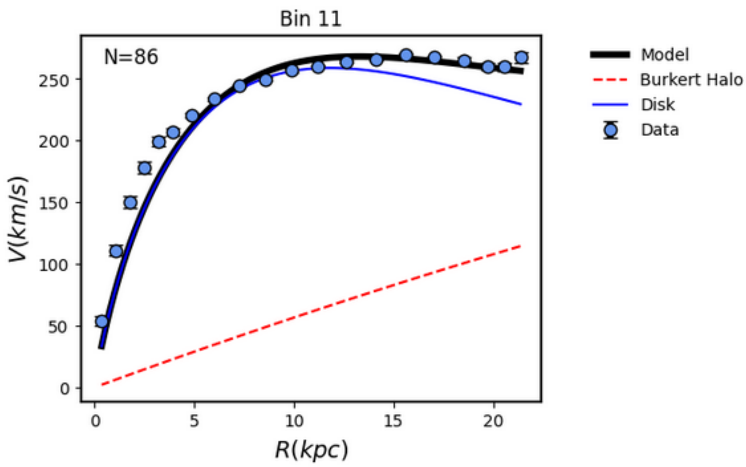

Bin 6
N=169
Model
Burkert Halo
Disk
Data
V(km/s)
R(kpc)


Bin 7
N=169
Model
Burkert Halo
Disk
Data
V(km/s)
R(kpc)


Bin 8
N=169
Model
Burkert Halo
Disk
Data
V(km/s)
R(kpc)


Bin 9
N=169
Model
Burkert Halo
Disk
Data
V(km/s)
R(kpc)

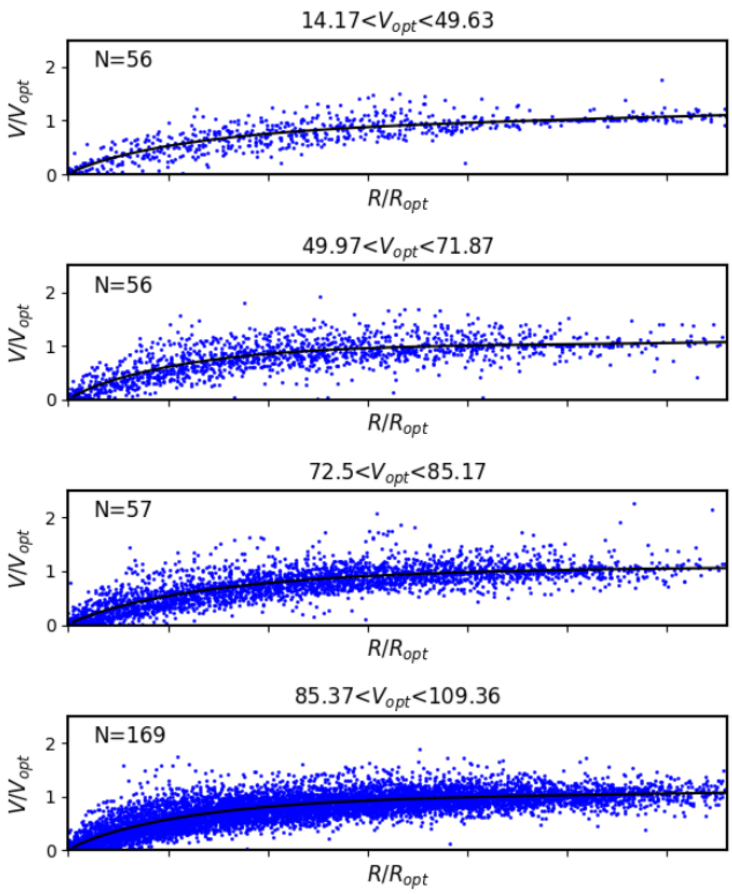

Bin 10
N=85
Model
Burkert Halo
Disk
Data
V(km/s)
R(kpc)

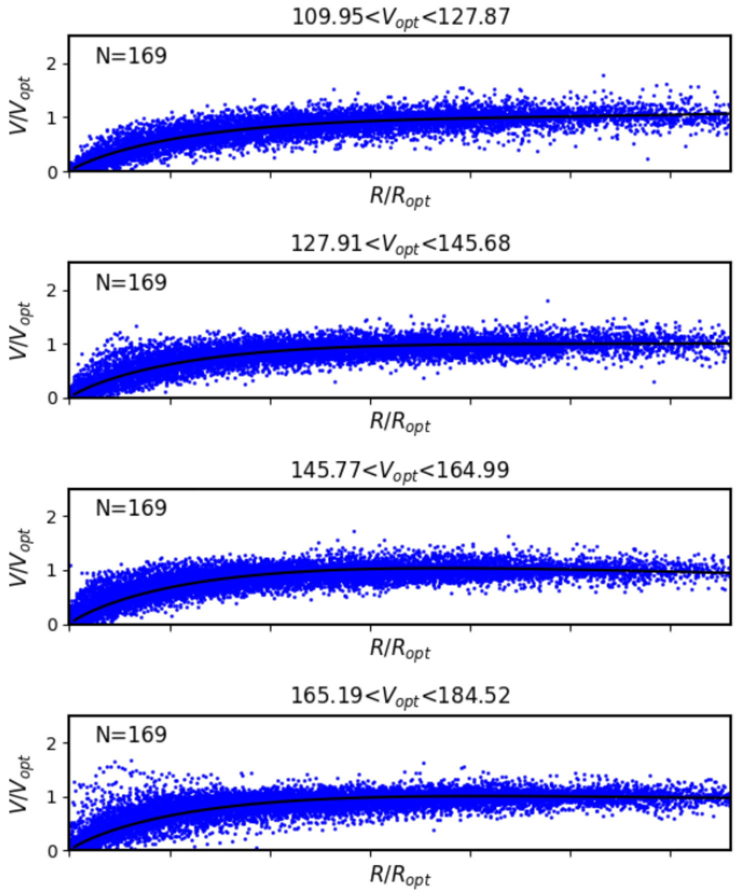

Bin 11
N=86
Model
Burkert Halo
Disk
Data
V(km/s)
R(kpc)

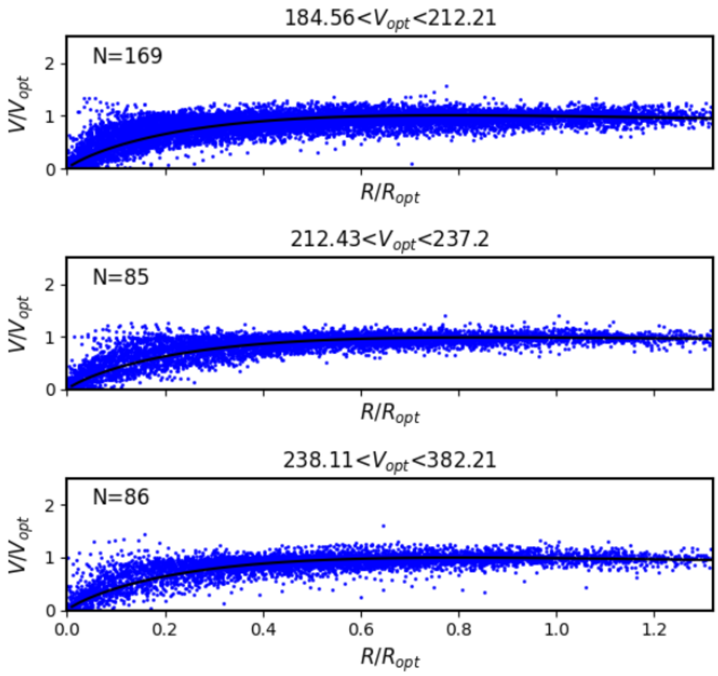
The optimal parameters are in the table below: Finally, the following figures show

	logMd	logp	Rc	logsigma_int
0	8.80	-24.69	9.93	-2.05
1	9.59	-24.92	53.18	-1.95
2	9.66	-24.15	7.30	-1.97
3	10.04	-24.49	18.10	-1.95
4	10.29	-24.62	64.38	-1.94
5	10.49	-24.79	85.91	-0.31
6	10.74	-25.34	76.35	0.09
7	10.84	-24.94	87.65	0.08
8	11.02	-25.09	87.58	0.16
9	11.13	-24.87	90.65	-0.61
10	11.34	-24.88	89.57	-1.89

the modelled Universal Rotation Curves(URCs) in various bins.




109.95<V_opt<127.87
N=169
127.91<V_opt<145.68
N=169
145.77<V_opt<164.99
N=169
165.19<V_opt<184.52
N=169
V/V_opt
R/R_opt


184.56<V_opt<212.21
N=169
212.43<V_opt<237.2
N=85
238.11<V_opt<382.21
N=86
V/V_opt
R/R_opt

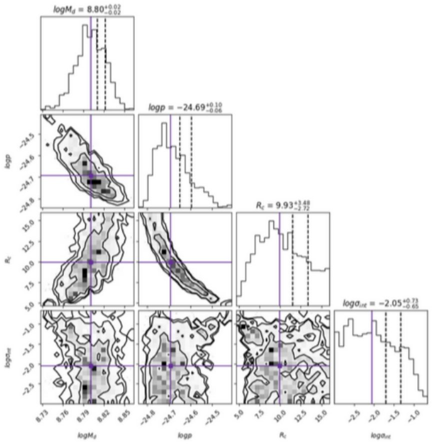
Chapter 4

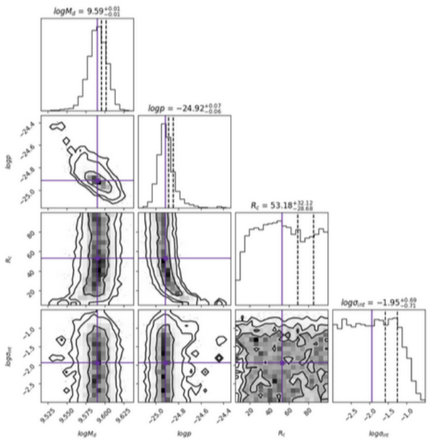
Summary

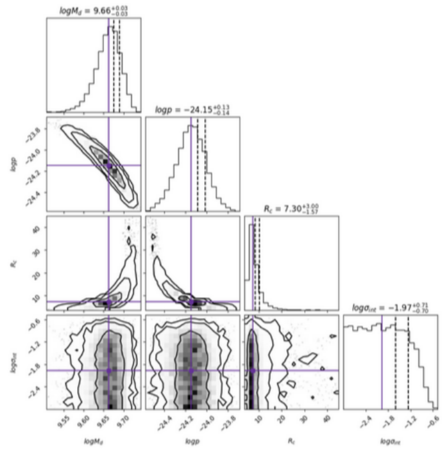
In this project we attempted to model the rotation curves of spiral galaxies in the recent PROBES Dataset by separating their profiles into dark matter and baryonic contributions. We started by binning the RCs into bins of optical velocity, then radially, normalising them w.r.t R_{opt} and V_{opt} and finally coadding them so that systematic effects are minimized. Then we prepared synthetic rotation curves by denormalising them.
Dark Matter Contribution was modelled using a Burkert(core) profile. Baryonic contribution was limited to the consideration of the dominant disk component.
We fit the model using an MCMC Code and obtained closed contours, hence successfully modelling the RCs.

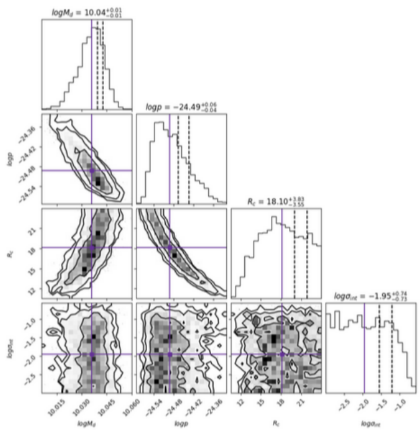
4.1 Appendix

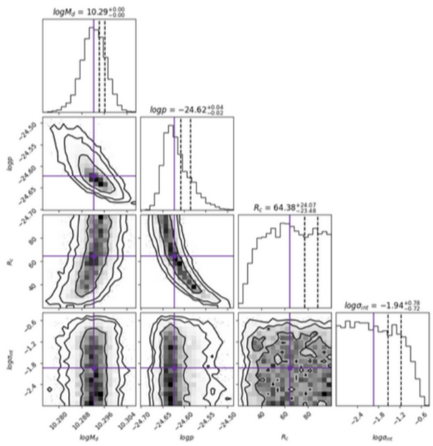
4.1.1 Posterior Distribution Plots

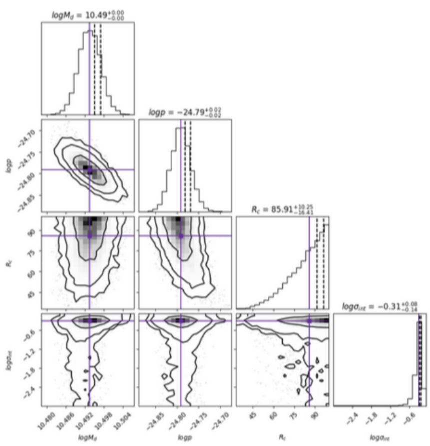


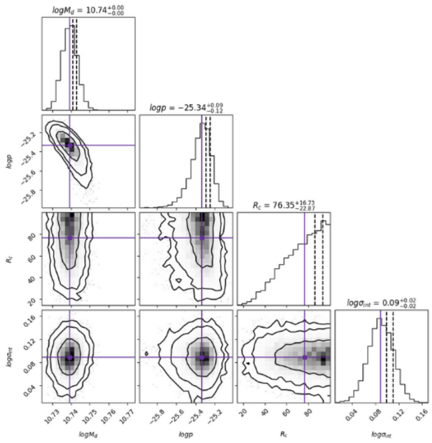


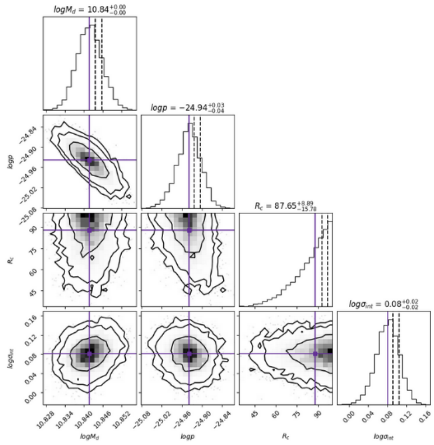


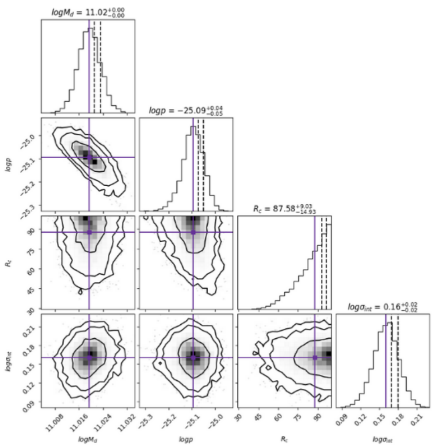


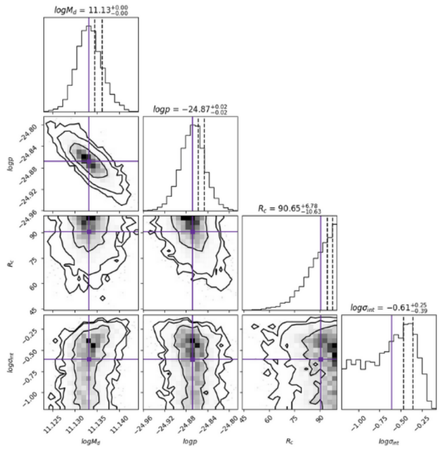


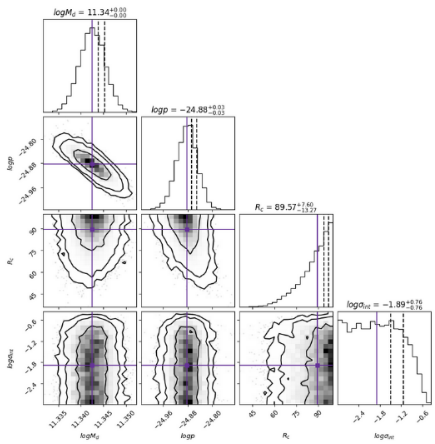












Data Availability

All codes and data used in this project can be found on this GitHub Repository: `https://github.com/ambicagovind31/RC-Modelling`.