Analytic Rotation Curves Without Dark Matter Fluid

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ABSTRACT

This paper investigates the astrophysical implications of incorporating Gravitational Friction (GF) into the dynamics of gravitational systems, particularly focusing on galaxy rotation curves without invoking dark matter. We analyze rotation curves from 175 late-type galaxies using data from the Spitzer Photometry & Accurate Rotation Curves (SPARC) database to determine the free parameter of the proposed model. Our results are compared with leading dark matter density profiles, including the Pseudoisothermal (pISO), Navarro-Frenk-White (NFW), and Burkert models, to evaluate the viability of GF as a competitive alternative to traditional dark matter explanations.

Key words: Gravitational friction – Stellar dynamics – Galaxy dynamics

1 PISO, NFW AND BURKERT ROTATION VELOCITIES

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Index	Name	GF	NFW	pISO	Einasto	Burkert
1	CamB	3.746	8.61	2.99	4.01	3.01
2	D631-7	2.362	6.05	0.85	0.72	0.95
3	DDO064	0.066	0.69	0.48	0.46	0.45
4	DDO154	1.745	13.70	3.23	0.83	1.63
5	DDO161	0.400	1.01	0.36	0.24	0.29
6	DDO168	4.072	14.40	6.03	4.76	6.06
7	DDO170	2.936	4.32	2.45	4.77	2.70
8	ESO079-G014	1.207	4.68	1.61	0.97	1.15
9	ESO116-G012	0.559	3.02	1.27	0.95	0.98
10	ESO444-G084	0.542	1.49	2.74	0.48	3.98
11	ESO563-G021	7.377	19.15	12.37	8.98	8.41
12	F563-1	0.563	1.34	0.70	0.93	0.70
13	F563-V2	0.055	1.91	0.47	0.14	0.28
14	F565-V2	0.032	0.94	0.16	0.32	0.14
15	F568-1	0.231	1.19	0.18	0.18	0.13
16	F568-3	1.024	3.89	1.18	1.23	1.17
17	F568-V1	0.092	0.28	0.19	0.12	0.07
18	F571-8	3.973	2.12	0.75	0.55	0.53
19	F571-V1	0.039	0.76	0.18	0.21	0.08
20	F574-1	0.215	2.19	0.35	0.23	0.12
21	F579-V1	0.443	0.25	0.06	0.22	0.18
22	F583-1	0.455	1.79	0.36	0.18	0.21
23	F583-4	0.254	0.21	0.42	0.23	0.64
24	IC2574	1.661	36.55	2.51	2.05	2.41
25	IC4202	8.698	20.17	8.67	5.43	2.95
26	KK98-251	0.119	1.57	0.35	0.34	0.37
27	NGC0024	1.727	0.93	0.37	0.84	0.86
28	NGC0055	0.093	2.85	0.55	0.17	0.41
29	NGC0100	0.049	0.89	0.10	0.13	0.10
30	NGC0247	2.854	2.03	2.38	1.77	2.06
31	NGC0289	1.222	1.95	1.97	2.03	2.06
32	NGC0300	0.423	0.74	0.47	0.50	0.62
33	NGC0801	3.574	6.77	7.07	7.70	7.10
34	NGC0891	1.203	3.46	4.24	1.35	2.01
35	NGC1003	3.009	2.48	2.67	2.47	3.01
36	NGC1090	1.905	2.73	1.54	1.79	1.41
37	NGC1705	0.255	0.15	0.08	0.07	0.84
38	NGC2366	0.181	3.49	1.09	0.24	0.86
39	NGC2683	0.497	1.50	1.89	1.71	1.25
40	NGC2841	2.014	1.48	1.58	1.36	1.81
41	NGC2903	5.694	6.34	6.67	6.19	7.20
42	NGC2915	0.536	0.97	0.71	0.71	0.56
43	NGC2955	4.565	4.03	4.21	2.89	3.71
44	NGC2976	0.242	0.85	0.33	0.34	0.34
45	NGC2998	2.022	3.05	1.47	1.09	3.52
46	NGC3109	0.295	9.92	0.23	0.22	0.20
47	NGC3198	1.416	1.46	1.31	1.08	1.47
48	NGC3521	0.399	0.25	0.20	0.12	0.20
49	NGC3741	0.177	0.41	0.90	0.44	0.93
50	NGC3769	0.344	0.93	0.88	1.00	0.77

Table 1. with Burkert and surface tension rotation velocities. From left to right, the columns read: name of the galaxy; central density in units of $M_\odot/\mathrm{pc}^3$; central radius in kpc and the χ^2_{red} value for the Burkert and our model cases.

Index	Name	GF	NFW	pISO	Einasto	Burkert
51	NGC3877	1.888	5.95	3.47	2.75	2.44
52	NGC3893	0.709	0.99	0.69	0.54	0.31
53	NGC3917	0.996	3.33	1.64	1.38	1.31
54	NGC3949	0.284	0.80	0.84	1.62	0.84
55	NGC3953	0.430	0.52	0.56	0.64	0.28
56	NGC3972	0.777	1.81	0.80	1.24	1.13
57	NGC3992	1.085	0.72	0.71	0.92	1.00
58	NGC4010	0.702	3.09	2.16	1.56	1.98
59	NGC4013	0.781	0.81	0.84	0.85	0.84
60	NGC4051	0.806	1.72	1.73	1.67	1.26
61	NGC4085	0.868	9.76	5.28	7.84	5.20
62	NGC4088	0.469	0.59	0.64	0.74	0.63
63	NGC4100	1.269	0.99	1.21	0.44	0.59
64	NGC4157	0.257	0.49	0.45	0.47	0.45
65	NGC4183	1.071	0.20	0.14	0.20	0.44
66	NGC4214	0.710	0.64	0.77	0.19	1.07
67	NGC4217	1.208	3.74	2.23	1.39	1.49
68	NGC4559	0.254	0.24	0.35	0.11	0.26
69	NGC5005	0.122	0.09	0.10	0.12	0.10
70	NGC5033	1.111	3.53	7.15	2.21	2.54
71	NGC5055	1.626	2.58	6.19	2.70	2.10
72	NGC5585	4.320	6.65	5.18	4.24	4.98
73	NGC5907	4.980	5.24	3.30	3.57	6.05
74	NGC5985	4.652	1.91	2.54	2.14	2.95
75	NGC6195	1.241	2.08	1.81	1.84	1.79
76	NGC6503	2.204	1.55	1.29	1.41	2.53
77	NGC6674	5.128	2.78	1.47	1.63	1.44
78	NGC6946	1.288	1.69	1.55	1.57	1.53
79	NGC7331	0.704	0.81	0.95	0.74	1.29
80	NGC7793	0.594	0.90	0.79	0.66	0.76
81	NGC7814	0.336	0.56	0.46	0.59	0.87
82	UGC00191	4.650	5.96	1.97	5.15	6.73
83	UGC00731	0.393	0.45	0.22	0.13	0.56
84	UGC01230	0.356	1.61	1.18	0.74	0.37
85	UGC01281	0.216	1.08	0.14	0.03	0.14
86	UGC02259	2.989	1.39	0.96	1.97	4.53
87	UGC02455	1.960	3.50	1.07	1.58	1.06
88	UGC02487	3.241	5.24	4.86	5.76	4.84
89	UGC02885	0.588	0.99	0.84	1.04	1.10
90	UGC02916	9.689	11.37	11.58	9.18	10.55
91	UGC02953	5.836	5.64	4.97	5.70	6.07
92	UGC03205	3.501	3.08	3.82	2.94	3.84
93	UGC03546	0.606	0.96	0.99	0.75	0.72
94	UGC03580	2.658	2.34	2.40	2.35	2.69
95	UGC04278	1.099	1.37	0.58	0.57	0.58
96	UGC04305	1.366	1.81	1.45	0.71	1.08
97	UGC04325	0.530	5.31	2.89	1.44	0.80
98	UGC04483	0.130	1.19	0.54	0.92	0.50
99	UGC04499	0.335	1.78	0.46	0.61	0.39
100	UGC05005	9.250	0.33	0.05	0.01	0.02

Table 2. Table with the index starting from 51 and ending at 100.

Index	Name	GF	NFW	pISO	Einasto	Burkert
101	UGC05253	1.172	2.42	3.79	0.77	0.95
102	UGC05716	1.059	2.49	3.07	2.54	2.35
103	UGC05721	0.222	1.09	0.94	0.53	0.44
104	UGC05750	0.071	1.44	0.26	0.08	0.18
105	UGC05764	1.503	10.58	7.05	4.04	4.05
106	UGC05829	0.100	0.13	0.19	0.12	0.26
107	UGC05918	0.071	0.29	0.03	0.12	0.09
108	UGC05986	0.238	5.89	1.72	0.09	1.13
109	UGC06399	0.035	1.14	0.15	0.12	0.08
110	UGC06446	0.266	0.27	0.22	0.25	0.51
111	UGC06614	0.202	0.27	0.18	0.11	0.10
112	UGC06628	0.040	0.25	0.31	0.17	0.16
113	UGC06667	0.263	2.28	0.39	0.15	0.17
114	UGC06786	1.579	0.69	0.69	0.54	2.26
115	UGC06818	0.582	5.89	2.10	3.13	2.18
116	UGC06917	0.153	1.17	0.39	0.45	0.29
117	UGC06930	0.293	0.44	0.22	0.34	0.28
118	UGC06973	0.172	1.68	1.45	3.00	1.61
119	UGC06983	0.305	0.74	0.58	0.60	0.53
120	UGC07089	0.088	0.36	0.23	0.15	0.22
121	UGC07125	0.572	0.82	0.40	0.30	0.27
122	UGC07151	0.522	3.64	1.58	2.01	1.36
123	UGC07261	0.556	0.12	0.16	0.14	0.86
124	UGC07323	0.132	1.04	0.43	0.44	0.40
125	UGC07399	0.460	1.61	0.36	0.99	1.28
126	UGC07524	0.181	0.89	0.34	0.21	0.25
127	UGC07559	0.070	1.07	0.26	0.36	0.27
128	UGC07577	0.178	0.36	0.22	0.29	0.22
129	UGC07603	0.132	2.14	0.47	0.36	0.28
130	UGC07608	0.073	0.89	0.14	0.30	0.16
131	UGC07690	0.051	0.84	0.87	0.75	0.29
132	UGC07866	0.042	0.11	0.12	0.19	0.18
133	UGC08286	2.490	2.87	1.00	1.88	1.48
134	UGC08490	0.405	0.13	0.21	0.12	0.42
135	UGC08550	0.601	1.08	0.55	0.91	1.30
136	UGC08699	0.720	0.73	0.87	0.70	0.97
137	UGC08837	0.432	8.32	0.68	1.02	0.67
138	UGC09037	0.781	2.03	1.09	1.13	1.02
139	UGC09133	6.268	7.15	6.78	6.36	7.89
140	UGC10310	0.053	1.39	0.64	0.40	0.23
141	UGC11455	3.076	5.40	2.40	2.10	1.64
142	UGC11557	0.433	1.59	0.67	0.51	0.66
143	UGC11820	5.470	1.82	3.46	1.51	2.42
144	UGC11914	0.686	0.86	0.65	0.53	0.59
145	UGC12506	1.492	0.18	0.29	0.17	0.77
146	UGC12632	0.050	0.43	0.17	0.11	0.09
147	UGC12732	0.245	0.24	0.24	0.21	0.44
148	UGCA281	0.140	1.29	0.38	0.59	0.29
149	UGCA442	0.392	3.85	1.60	1.43	1.24
150	UGCA444	0.399	0.07	0.22	0.07	0.24
	TOTAL	205.3	426.56	243.33	208.68	225.93
	INF	7	10	10	19	10

Table 3. Your table caption here