Description

Below are some tables with measured and calculated data of gravitational lenses as they are listed on https://www.cfa.harvard.edu/castles/. This site did not include the *Horsehoe*, which I manually added to the list. Appendix I lists the script that was used, appendix II contains the input data to this script.

Threshold mass

The *mass* of the Andromeda galaxy is about $1.5 \times 10^{12} \odot$. As an arbitrary threshold for "very heavy" a factor of 5 × Andromeda was used, i.e. $7.5 \times 10^{12} \odot$. Just a mere 2 out of the 58 lenses listed below are above this threshold: SDSS1004+4112 and SDSS1029+2623. *Can the existance of dark matter throughout the universe be derived from this?*

Quasar mass

For galaxies, I assumed an *average absolute magnitude* of -18 in practically all my calculations, and of all quasars in the SDSS:DR14Q database, the *average absolute magnitude* is:

21.9 according to the conventional formula without taking any extinction into account;
-25.3 using 3-spherical geometry with an *attenuation coefficient* of -5.5;
-28.1 using Euclidean geometry and the same *attenuation coefficient*.

In my other documents and calculations I used an *average absolute quasar magnitude* of -24.3 (which I once found somewhere on the Internet, but I cannot really find it back). These values yield a *luminosity ratio* of $100^{(24.3-18)/5} = 331$, which means an average quasar has the same *luminosity* as several hundred average galaxies. Might their *mass ratio* then be alike? The Milky Way is estimated as circa 🌀 $\equiv 10^{12} \odot$, so an average quasar might be as heavy as a few hundred Milky Ways. The heaviest gravitational lensing object listed below is SDSS1029+2623, which would have a *mass* of 28.5🌀 in case of 3-spherical geometry of the universe, and 38.4🌀 for Euclidean geometry. Roughly speaking this is 30🌀, which, compared to a quasar, would not be heavy at all. *Can the existance of dark matter throughout the universe be derived from this?*

Point mass vs. disk

The *lens masses* below were calculated as if they were point masses, which is correct only if the actual object is spherical, but it definitely is incorrect if it is a disk, see http://henk-reints.nl/astro/HR-Keplerian-decline.pdf and http://henk-reints.nl/astro/HR-Galaxy-Rotation-and-Dark-Matter-20190206T0858Z.pdf, where I explain that a disk certainly does not gravitationally behave according to the shell theorem and that *Keplerian decline* is definitely not to be expected at all. It means that a light ray passing a massive disk feels its apparent barycentre far more nearby that the disk's geometric centre. Doesn't this then yield a far lower *total mass* of the lensing object? *Can the existance of dark matter throughout the universe be derived from this?*

The table below shows the difference between 3-spherical and Euclidean geometry.
Their *ratio* reveals the *apparent magnification* at great *distances* if Euclidean geometry is applied to a 3-sphere.

Absolute transverse size in light years corresponding to a viewing angle of 1 arc second,
as a function of the dimensionless distance, for 3-sperical and Euclidean geometry

rho	z	3sph	Eucl	ratio
0.01	0.010	668	668	1.00
0.02	0.020	1334	1335	1.00
0.03	0.030	2000	2003	1.00
0.04	0.041	2664	2671	1.00
0.05	0.051	3325	3338	1.00
0.06	0.062	3982	4006	1.01
0.07	0.073	4636	4674	1.01
0.08	0.083	5285	5341	1.01
0.09	0.094	5929	6009	1.01
0.10	0.106	6567	6677	1.02
0.11	0.117	7199	7344	1.02
0.12	0.128	7824	8012	1.02
0.13	0.140	8440	8680	1.03
0.14	0.151	9049	9347	1.03
0.15	0.163	9649	10015	1.04
0.16	0.175	10239	10683	1.04
0.17	0.187	10818	11350	1.05
0.18	0.200	11388	12018	1.06
0.19	0.212	11946	12686	1.06
0.20	0.225	12492	13353	1.07
0.21	0.238	13026	14021	1.08
0.22	0.251	13547	14689	1.08
0.23	0.264	14055	15356	1.09
0.24	0.277	14548	16024	1.10
0.25	0.291	15028	16692	1.11
0.26	0.305	15493	17359	1.12
0.27	0.319	15942	18027	1.13
0.28	0.333	16375	18695	1.14
0.29	0.348	16793	19362	1.15
0.30	0.363	17194	20030	1.16
0.31	0.378	17578	20698	1.18
0.32	0.393	17944	21366	1.19
0.33	0.409	18293	22033	1.20
0.34	0.425	18624	22701	1.22
0.35	0.441	18936	23369	1.23
0.36	0.458	19230	24036	1.25
0.37	0.475	19505	24704	1.27
0.38	0.492	19760	25372	1.28
0.39	0.510	19996	26039	1.30
0.40	0.528	20212	26707	1.32
0.41	0.546	20409	27375	1.34
0.42	0.565	20585	28042	1.36
0.43	0.584	20741	28710	1.38
0.44	0.604	20876	29378	1.41
0.45	0.624	20991	30045	1.43
0.46	0.644	21085	30713	1.46
0.47	0.665	21158	31381	1.48
0.48	0.687	21211	32048	1.51
0.49	0.709	21242	32716	1.54
0.50	0.732	21253	33384	1.57
0.51	0.755	21242	34051	1.60
0.52	0.780	21211	34719	1.64
0.53	0.804	21158	35387	1.67
0.54	0.830	21085	36054	1.71
0.55	0.856	20991	36722	1.75
0.56	0.883	20876	37390	1.79
0.57	0.911	20741	38057	1.83
0.58	0.940	20585	38725	1.88
0.59	0.969	20409	39393	1.93
0.60	1.000	20212	40060	1.98
0.61	1.032	19996	40728	2.04
0.62	1.065	19760	41396	2.09
0.63	1.099	19505	42063	2.16
0.64	1.134	19230	42731	2.22
0.65	1.171	18936	43399	2.29
0.66	1.210	18624	44066	2.37
0.67	1.250	18293	44734	2.45
0.68	1.291	17944	45402	2.53
0.69	1.335	17578	46069	2.62
0.70	1.380	17194	46737	2.72
0.71	1.428	16793	47405	2.82
0.72	1.478	16375	48072	2.94
0.73	1.531	15942	48740	3.06
0.74	1.587	15493	49408	3.19
0.75	1.646	15028	50075	3.33
0.76	1.708	14548	50743	3.49
0.77	1.774	14055	51411	3.66
0.78	1.844	13547	52078	3.84
0.79	1.920	13026	52746	4.05
0.80	2.000	12492	53414	4.28
0.81	2.086	11946	54081	4.53
0.82	2.180	11388	54749	4.81
0.83	2.281	10818	55417	5.12
0.84	2.391	10239	56084	5.48
0.85	2.512	9649	56752	5.88
0.86	2.645	9049	57420	6.35
0.87	2.793	8440	58087	6.88
0.88	2.958	7824	58755	7.51
0.89	3.145	7199	59423	8.25
0.90	3.359	6567	60090	9.15
0.91	3.607	5929	60758	10.2
0.92	3.899	5285	61426	11.6
0.93	4.251	4636	62093	13.4
0.94	4.686	3982	62761	15.8
0.95	5.245	3325	63429	19.1
0.96	6.000	2664	64097	24.1
0.97	7.103	2000	64764	32.4
0.98	8.950	1334	65432	49.0
0.99	13.11	668	66100	99.0

Below , the lists of gravitational lenses are all the same, but in various sorting orders.

Gravitational lenses as listed on https://www.cfa.harvard.edu/castles/ as of 2019-08-31

Calculated for 3-sperical and Euclidean geometry of the universe

- shown distance at which light rays pass the lensing object has been corrected for the (transverse) expansion of the universe during light travel time from lens to us
- lens and source are assumed collinear
- legend:
  - Lens : name of lens
  - zL : redshift of lensing object
  - zS : redshift of source object
  - size : apparent diameter of corresponding Einstein ring [arc seconds]
  - rhoL : dimensionless distance to lens (via rel. Doppler)
  - rhoS : dimension distance to source
  - rhoSL : dimensionless distance from source to lens
  - alpha : apparent radius (size/2) [arc seconds]
  - phi : angle from source to lens [arc seconds]
  - theta : total deflection angle (alpha + phi) [arc seconds]
  - r : distance at which ray passes lens [light years]
  - mass : calculated mass of lensing object [solar masses]
  - ratio : Euclidean/3-spherical mass ratio
- ORDERED BY: Lens name

								3-spherical				Euclidian				
Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	phi	theta	r	mass	phi	theta	r	mass	ratio
B0218+357	0.68	0.96	0.34	0.48	0.59	0.11	0.17	0.50	0.67	2440	12.7e9	0.74	0.91	3664	25.8e9	2.03
B0712+472	0.41	1.34	1.46	0.33	0.69	0.36	0.73	0.69	1.42	10048	111e9	0.67	1.40	12112	132e9	1.18
B1030+074	0.60	1.54	1.65	0.44	0.73	0.29	0.82	1.02	1.84	11962	171e9	1.23	2.06	16783	268e9	1.57
B1152+200	0.439	1.019	1.59	0.35	0.61	0.26	0.80	0.98	1.77	11139	153e9	1.08	1.87	13723	200e9	1.30
B1422+231	0.34	3.62	1.68	0.28	0.91	0.63	0.84	0.71	1.55	10835	130e9	0.38	1.22	12425	118e9	0.90
B1600+434	0.41	1.59	1.40	0.33	0.74	0.41	0.70	0.63	1.33	9635	99.4e9	0.56	1.26	11614	114e9	1.15
B1608+656	0.63	1.39	2.27	0.45	0.70	0.25	1.14	1.59	2.73	16420	348e9	2.07	3.20	23629	587e9	1.69
B1933+503	0.76	2.63	1.00	0.51	0.86	0.35	0.50	0.56	1.06	7023	58.0e9	0.74	1.24	11303	109e9	1.87
B1938+666	0.881	2.059	1.0	0.56	0.81	0.25	0.50	0.70	1.20	6697	62.4e9	1.13	1.63	11974	152e9	2.43
B2045+265	0.87	1.28	2.74	0.56	0.68	0.12	1.37	3.61	4.98	18440	713e9	6.23	7.60	32657	1.93e12	2.71
B2114+022	0.32	0.59	1.31	0.27	0.43	0.16	0.66	1.01	1.66	8234	106e9	1.09	1.75	9317	126e9	1.19
BRI0952-0115	0.632	4.50	1.00	0.45	0.94	0.48	0.50	0.50	1.00	7232	55.9e9	0.47	0.97	10425	78.6e9	1.41
CFRS03.1077	0.938	2.941	2.1	0.58	0.88	0.30	1.05	1.26	2.31	13690	245e9	2.03	3.08	25720	615e9	2.51
CY2201-3201	0.32	3.9	0.83	0.27	0.92	0.65	0.42	0.35	0.76	5217	31.0e9	0.17	0.59	5903	27.0e9	0.87
HE0047-1756	0.41	1.66	1.44	0.33	0.75	0.42	0.72	0.64	1.36	9910	105e9	0.56	1.28	11946	119e9	1.14
HE0230-2130	0.52	2.162	2.05	0.40	0.82	0.42	1.03	1.00	2.03	14778	232e9	0.96	1.99	19408	299e9	1.29
HE0435-1223	0.46	1.689	2.42	0.36	0.76	0.40	1.21	1.16	2.37	17126	315e9	1.11	2.32	21444	385e9	1.22
HE1104-1805	0.73	2.32	3.19	0.50	0.83	0.33	1.60	1.84	3.43	22612	603e9	2.38	3.97	35456	1.09e12	1.82
HE2149-2745	0.50	2.03	1.70	0.38	0.80	0.42	0.85	0.82	1.67	12199	158e9	0.78	1.63	15764	200e9	1.26
HS0818+1227	0.39	3.115	2.83	0.32	0.89	0.57	1.42	1.22	2.63	19185	392e9	0.79	2.20	22789	390e9	0.99

								3-spherical				Euclidian				
Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	phi	theta	r	mass	phi	theta	r	mass	ratio
HST14113+5211	0.46	2.81	1.80	0.36	0.87	0.51	0.90	0.82	1.72	12738	170e9	0.64	1.54	15950	190e9	1.12
HST14176+5226	0.81	3.40	2.83	0.53	0.90	0.37	1.42	1.53	2.95	19525	447e9	2.04	3.45	32819	880e9	1.97
HST15433+5352	0.497	2.092	1.18	0.38	0.81	0.43	0.59	0.57	1.16	8461	75.9e9	0.53	1.12	10907	94.7e9	1.25
J1004+1229	0.95	2.65	1.54	0.58	0.86	0.28	0.77	0.97	1.74	9980	135e9	1.62	2.39	18945	352e9	2.61
LBQS1009-0252	0.87	2.74	1.54	0.56	0.87	0.31	0.77	0.91	1.68	10364	136e9	1.37	2.14	18354	305e9	2.25
LRG3-757Horseshoe	0.444	2.379	10.2	0.35	0.84	0.49	5.10	4.56	9.66	71642	5.37e12	3.68	8.78	88604	6.04e12	1.12
MG0414+0534	0.96	2.64	2.40	0.59	0.86	0.27	1.20	1.53	2.73	15476	328e9	2.58	3.78	29632	870e9	2.65
MG0751+2716	0.35	3.20	0.7	0.29	0.89	0.60	0.35	0.29	0.64	4567	22.8e9	0.17	0.52	5273	21.3e9	0.93
MG1549+3047	0.11	1.17	1.7	0.10	0.65	0.55	0.85	0.28	1.13	5251	45.9e9	0.16	1.01	5345	42.0e9	0.92
MG1654+1346	0.25	1.74	2.1	0.22	0.76	0.55	1.05	0.67	1.72	11642	156e9	0.42	1.47	12619	144e9	0.93
MG2016+112	1.01	3.27	3.52	0.60	0.90	0.29	1.76	2.10	3.86	22116	662e9	3.63	5.39	44212	1.85e12	2.79
PG1115+080	0.31	1.72	2.32	0.26	0.76	0.50	1.16	0.85	2.01	14374	225e9	0.61	1.77	16159	223e9	0.99
PKS1830-211	0.89	2.51	0.99	0.56	0.85	0.29	0.50	0.62	1.11	6603	57.1e9	0.97	1.46	11899	135e9	2.37
PMNJ0134-0931	0.77	2.216	0.73	0.52	0.82	0.31	0.37	0.44	0.81	5110	32.1e9	0.61	0.98	8296	63.0e9	1.96
Q0047-2808	0.48	3.60	2.7	0.37	0.91	0.54	1.35	1.25	2.60	19257	389e9	0.94	2.29	24493	435e9	1.12
Q0142-100	0.49	2.72	2.24	0.38	0.87	0.49	1.12	1.04	2.16	16028	269e9	0.87	1.99	20548	318e9	1.18
Q0957+561	0.36	1.41	6.26	0.30	0.71	0.41	3.13	2.63	5.76	41280	1.85e12	2.29	5.42	47997	2.02e12	1.09
Q2237+030	0.04	1.69	1.78	0.04	0.76	0.72	0.89	0.14	1.03	2236	17.9e9	0.05	0.94	2242	16.3e9	0.91
QJ0158-4325	0.317	1.29	1.22	0.27	0.68	0.41	0.61	0.47	1.08	7636	64.3e9	0.40	1.01	8623	67.5e9	1.05
RXJ0911+0551	0.77	2.80	2.47	0.52	0.87	0.35	1.24	1.37	2.61	17290	350e9	1.80	3.03	28069	661e9	1.89
RXJ0921+4529	0.31	1.65	6.97	0.26	0.75	0.49	3.49	2.57	6.05	43184	2.03e12	1.89	5.37	48548	2.02e12	1.00
RXJ1131-1231	0.295	0.658	3.80	0.25	0.47	0.21	1.90	2.18	4.08	22996	729e9	2.25	4.15	25607	825e9	1.13
SBS0909+523	0.83	1.38	1.17	0.54	0.70	0.16	0.59	1.21	1.79	8009	111e9	1.98	2.56	13698	273e9	2.45
SBS1520+530	0.72	1.86	1.59	0.49	0.78	0.29	0.80	1.01	1.81	11302	159e9	1.37	2.16	17569	295e9	1.86
SDSS0806+2006	0.573	1.540	1.40	0.42	0.73	0.31	0.70	0.83	1.53	10151	120e9	0.97	1.67	13924	180e9	1.50
SDSS0903+5028	0.388	3.605	2.99	0.32	0.91	0.59	1.50	1.31	2.80	20236	441e9	0.80	2.29	24003	427e9	0.97
SDSS0924+0219	0.39	1.524	1.75	0.32	0.73	0.41	0.87	0.77	1.64	11864	151e9	0.68	1.55	14092	170e9	1.12
SDSS1004+4112	0.68	1.734	15.99	0.48	0.76	0.29	8.00	10.16	18.16	114752	16.2e12	13.27	21.27	172336	28.5e12	1.76
SDSS1011+0143	0.331	2.701	3.67	0.28	0.86	0.59	1.84	1.46	3.30	23406	599e9	0.87	2.71	26680	561e9	0.94
SDSS1029+2623	0.55	2.197	22.5	0.41	0.82	0.41	11.25	11.28	22.53	162905	28.5e12	11.32	22.57	219243	38.4e12	1.35
SDSS1138+0314	0.45	2.44	1.34	0.36	0.84	0.49	0.67	0.60	1.27	9440	93.3e9	0.49	1.16	11729	105e9	1.13
SDSS1155+6346	0.176	2.89	1.95	0.16	0.88	0.72	0.98	0.60	1.58	8635	106e9	0.22	1.19	9014	83.6e9	0.79
SDSS1226-0006	0.52	1.12	1.26	0.40	0.64	0.24	0.63	0.87	1.50	9083	106e9	1.04	1.67	11929	155e9	1.46
SDSS1332+0347	0.191	1.445	1.14	0.17	0.71	0.54	0.57	0.30	0.87	5341	36.0e9	0.18	0.75	5614	32.8e9	0.91
SDSS1353+1138	0.3	1.629	1.41	0.26	0.75	0.49	0.71	0.51	1.21	8602	81.1e9	0.37	1.07	9609	80.1e9	0.99
SDSS1402+6321	0.20	0.48	1.35	0.18	0.37	0.19	0.68	0.64	1.31	6523	66.4e9	0.63	1.31	6885	69.8e9	1.05
SDSS1406+6126	0.27	2.13	1.98	0.23	0.81	0.58	0.99	0.69	1.68	11453	149e9	0.40	1.39	12559	136e9	0.91
WFI2033-4723	0.66	1.66	2.33	0.47	0.75	0.28	1.17	1.49	2.65	16784	345e9	1.91	3.08	24778	592e9	1.71

Gravitational lenses as listed on https://www.cfa.harvard.edu/castles/ as of 2019-08-31

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Calculated for 3-sperical and Euclidean geometry of the universe

- o shown distance at which light rays pass the lensing object has been corrected for the (transverse) expansion of the universe during light travel time from lens to us
- o lens and source are assumed collinear
- o legend:
  - Lens : name of lens
  - zL : redshift of lensing object
  - zS : redshift of source object
  - size : apparent diameter of corresponding Einstein ring [arc seconds]
  - rhoL : dimensionless distance to lens (via rel. Doppler)
  - rhoS : dimension distance to source
  - rhoSL : dimensionless distance from source to lens
  - alpha : apparent radius (size/2) [arc seconds]
  - phi : angle from source to lens [arc seconds]
  - theta : total deflection angle (alpha + phi) [arc seconds]
  - r : distance at which ray passes lens [light years]
  - mass : calculated mass of lensing object [solar masses]
  - ratio : Euclidean/3-spherical mass ratio
- o ORDERED BY: lens redshift and source redshift

									3-spherical				Euclidian				
Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	phi	theta	r	mass	phi	theta	r	mass	ratio
Q2237+030	0.04	1.69	1.78	0.04	0.76	0.72	0.89	0.14	1.03	2236	17.9e9	0.05	0.94	2242	16.3e9	0.91
MG1549+3047	0.11	1.17	1.7	0.10	0.65	0.55	0.85	0.28	1.13	5251	45.9e9	0.16	1.01	5345	42.0e9	0.92
SDSS1155+6346	0.176	2.89	1.95	0.16	0.88	0.72	0.98	0.60	1.58	8635	106e9	0.22	1.19	9014	83.6e9	0.79
SDSS1332+0347	0.191	1.445	1.14	0.17	0.71	0.54	0.57	0.30	0.87	5341	36.0e9	0.18	0.75	5614	32.8e9	0.91
SDSS1402+6321	0.20	0.48	1.35	0.18	0.37	0.19	0.68	0.64	1.31	6523	66.4e9	0.63	1.31	6885	69.8e9	1.05
MG1654+1346	0.25	1.74	2.1	0.22	0.76	0.55	1.05	0.67	1.72	11642	156e9	0.42	1.47	12619	144e9	0.93
SDSS1406+6126	0.27	2.13	1.98	0.23	0.81	0.58	0.99	0.69	1.68	11453	149e9	0.40	1.39	12559	136e9	0.91
RXJ1131-1231	0.295	0.658	3.80	0.25	0.47	0.21	1.90	2.18	4.08	22996	729e9	2.25	4.15	25607	825e9	1.13
SDSS1353+1138	0.3	1.629	1.41	0.26	0.75	0.49	0.71	0.51	1.21	8602	81.1e9	0.37	1.07	9609	80.1e9	0.99
RXJ0921+4529	0.31	1.65	6.97	0.26	0.75	0.49	3.49	2.57	6.05	43184	2.03e12	1.89	5.37	48548	2.02e12	1.00
PG1115+080	0.31	1.72	2.32	0.26	0.76	0.50	1.16	0.85	2.01	14374	225e9	0.61	1.77	16159	223e9	0.99
QJ0158-4325	0.317	1.29	1.22	0.27	0.68	0.41	0.61	0.47	1.08	7636	64.3e9	0.40	1.01	8623	67.5e9	1.05
B2114+022	0.32	0.59	1.31	0.27	0.43	0.16	0.66	1.01	1.66	8234	106e9	1.09	1.75	9317	126e9	1.19
CY2201-3201	0.32	3.9	0.83	0.27	0.92	0.65	0.42	0.35	0.76	5217	31.0e9	0.17	0.59	5903	27.0e9	0.87
SDSS1011+0143	0.331	2.701	3.67	0.28	0.86	0.59	1.84	1.46	3.30	23406	599e9	0.87	2.71	26680	561e9	0.94
B1422+231	0.34	3.62	1.68	0.28	0.91	0.63	0.84	0.71	1.55	10835	130e9	0.38	1.22	12425	118e9	0.90
MG0751+2716	0.35	3.20	0.7	0.29	0.89	0.60	0.35	0.29	0.64	4567	22.8e9	0.17	0.52	5273	21.3e9	0.93
Q0957+561	0.36	1.41	6.26	0.30	0.71	0.41	3.13	2.63	5.76	41280	1.85e12	2.29	5.42	47997	2.02e12	1.09
SDSS0903+5028	0.388	3.605	2.99	0.32	0.91	0.59	1.50	1.31	2.80	20236	441e9	0.80	2.29	24003	427e9	0.97
SDSS0924+0219	0.39	1.524	1.75	0.32	0.73	0.41	0.87	0.77	1.64	11864	151e9	0.68	1.55	14092	170e9	1.12

								3-spherical				Euclidian				
Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	phi	theta	r	mass	phi	theta	r	mass	ratio
HS0818+1227	0.39	3.115	2.83	0.32	0.89	0.57	1.42	1.22	2.63	19185	392e9	0.79	2.20	22789	390e9	0.99
B0712+472	0.41	1.34	1.46	0.33	0.69	0.36	0.73	0.69	1.42	10048	111e9	0.67	1.40	12112	132e9	1.18
B1600+434	0.41	1.59	1.40	0.33	0.74	0.41	0.70	0.63	1.33	9635	99.4e9	0.56	1.26	11614	114e9	1.15
HE0047-1756	0.41	1.66	1.44	0.33	0.75	0.42	0.72	0.64	1.36	9910	105e9	0.56	1.28	11946	119e9	1.14
B1152+200	0.439	1.019	1.59	0.35	0.61	0.26	0.80	0.98	1.77	11139	153e9	1.08	1.87	13723	200e9	1.30
LRG3-757Horseshoe	0.444	2.379	10.2	0.35	0.84	0.49	5.10	4.56	9.66	71642	5.37e12	3.68	8.78	88604	6.04e12	1.12
SDSS1138+0314	0.45	2.44	1.34	0.36	0.84	0.49	0.67	0.60	1.27	9440	93.3e9	0.49	1.16	11729	105e9	1.13
HE0435-1223	0.46	1.689	2.42	0.36	0.76	0.40	1.21	1.16	2.37	17126	315e9	1.11	2.32	21444	385e9	1.22
HST14113+5211	0.46	2.81	1.80	0.36	0.87	0.51	0.90	0.82	1.72	12738	170e9	0.64	1.54	15950	190e9	1.12
Q0047-2808	0.48	3.60	2.7	0.37	0.91	0.54	1.35	1.25	2.60	19257	389e9	0.94	2.29	24493	435e9	1.12
Q0142-100	0.49	2.72	2.24	0.38	0.87	0.49	1.12	1.04	2.16	16028	269e9	0.87	1.99	20548	318e9	1.18
HST15433+5352	0.497	2.092	1.18	0.38	0.81	0.43	0.59	0.57	1.16	8461	75.9e9	0.53	1.12	10907	94.7e9	1.25
HE2149-2745	0.50	2.03	1.70	0.38	0.80	0.42	0.85	0.82	1.67	12199	158e9	0.78	1.63	15764	200e9	1.26
SDSS1226-0006	0.52	1.12	1.26	0.40	0.64	0.24	0.63	0.87	1.50	9083	106e9	1.04	1.67	11929	155e9	1.46
HE0230-2130	0.52	2.162	2.05	0.40	0.82	0.42	1.03	1.00	2.03	14778	232e9	0.96	1.99	19408	299e9	1.29
SDSS1029+2623	0.55	2.197	22.5	0.41	0.82	0.41	11.25	11.28	22.53	162905	28.5e12	11.32	22.57	219243	38.4e12	1.35
SDSS0806+2006	0.573	1.540	1.40	0.42	0.73	0.31	0.70	0.83	1.53	10151	120e9	0.97	1.67	13924	180e9	1.50
B1030+074	0.60	1.54	1.65	0.44	0.73	0.29	0.82	1.02	1.84	11962	171e9	1.23	2.06	16783	268e9	1.57
B1608+656	0.63	1.39	2.27	0.45	0.70	0.25	1.14	1.59	2.73	16420	348e9	2.07	3.20	23629	587e9	1.69
BRI0952-0115	0.632	4.50	1.00	0.45	0.94	0.48	0.50	0.50	1.00	7232	55.9e9	0.47	0.97	10425	78.6e9	1.41
WFI2033-4723	0.66	1.66	2.33	0.47	0.75	0.28	1.17	1.49	2.65	16784	345e9	1.91	3.08	24778	592e9	1.71
B0218+357	0.68	0.96	0.34	0.48	0.59	0.11	0.17	0.50	0.67	2440	12.7e9	0.74	0.91	3664	25.8e9	2.03
SDSS1004+4112	0.68	1.734	15.99	0.48	0.76	0.29	8.00	10.16	18.16	114752	16.2e12	13.27	21.27	172336	28.5e12	1.76
SBS1520+530	0.72	1.86	1.59	0.49	0.78	0.29	0.80	1.01	1.81	11302	159e9	1.37	2.16	17569	295e9	1.86
HE1104-1805	0.73	2.32	3.19	0.50	0.83	0.33	1.60	1.84	3.43	22612	603e9	2.38	3.97	35456	1.09e12	1.82
B1933+503	0.76	2.63	1.00	0.51	0.86	0.35	0.50	0.56	1.06	7023	58.0e9	0.74	1.24	11303	109e9	1.87
PMNJ0134-0931	0.77	2.216	0.73	0.52	0.82	0.31	0.37	0.44	0.81	5110	32.1e9	0.61	0.98	8296	63.0e9	1.96
RXJ0911+0551	0.77	2.80	2.47	0.52	0.87	0.35	1.24	1.37	2.61	17290	350e9	1.80	3.03	28069	661e9	1.89
HST14176+5226	0.81	3.40	2.83	0.53	0.90	0.37	1.42	1.53	2.95	19525	447e9	2.04	3.45	32819	880e9	1.97
SBS0909+523	0.83	1.38	1.17	0.54	0.70	0.16	0.59	1.21	1.79	8009	111e9	1.98	2.56	13698	273e9	2.45
B2045+265	0.87	1.28	2.74	0.56	0.68	0.12	1.37	3.61	4.98	18440	713e9	6.23	7.60	32657	1.93e12	2.71
LBQS1009-0252	0.87	2.74	1.54	0.56	0.87	0.31	0.77	0.91	1.68	10364	136e9	1.37	2.14	18354	305e9	2.25
B1938+666	0.881	2.059	1.0	0.56	0.81	0.25	0.50	0.70	1.20	6697	62.4e9	1.13	1.63	11974	152e9	2.43
PKS1830-211	0.89	2.51	0.99	0.56	0.85	0.29	0.50	0.62	1.11	6603	57.1e9	0.97	1.46	11899	135e9	2.37
CFRS03.1077	0.938	2.941	2.1	0.58	0.88	0.30	1.05	1.26	2.31	13690	245e9	2.03	3.08	25720	615e9	2.51
J1004+1229	0.95	2.65	1.54	0.58	0.86	0.28	0.77	0.97	1.74	9980	135e9	1.62	2.39	18945	352e9	2.61
MG0414+0534	0.96	2.64	2.40	0.59	0.86	0.27	1.20	1.53	2.73	15476	328e9	2.58	3.78	29632	870e9	2.65
MG2016+112	1.01	3.27	3.52	0.60	0.90	0.29	1.76	2.10	3.86	22116	662e9	3.63	5.39	44212	1.85e12	2.79

Gravitational lenses as listed on https://www.cfa.harvard.edu/castles/ as of 2019-08-31

Calculated for 3-sperical and Euclidean geometry of the universe

- shown distance at which light rays pass the lensing object has been corrected for the (transverse) expansion of the universe during light travel time from lens to us
- lens and source are assumed collinear
- legend:
  - Lens : name of lens
  - zL : redshift of lensing object
  - zS : redshift of source object
  - size : apparent diameter of corresponding Einstein ring [arc seconds]
  - rhoL : dimensionless distance to lens (via rel. Doppler)
  - rhoS : dimension distance to source
  - rhoSL : dimensionless distance from source to lens
  - alpha : apparent radius (size/2) [arc seconds]
  - phi : angle from source to lens [arc seconds]
  - theta : total deflection angle (alpha + phi) [arc seconds]
  - r : distance at which ray passes lens [light years]
  - mass : calculated mass of lensing object [solar masses]
  - ratio : Euclidean/3-spherical mass ratio
- ORDERED BY: lens distance

								3-spherical				Euclidian				
Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	phi	theta	r	mass	phi	theta	r	mass	ratio
Q2237+030	0.04	1.69	1.78	0.04	0.76	0.72	0.89	0.14	1.03	2236	17.9e9	0.05	0.94	2242	16.3e9	0.91
MG1549+3047	0.11	1.17	1.7	0.10	0.65	0.55	0.85	0.28	1.13	5251	45.9e9	0.16	1.01	5345	42.0e9	0.92
SDSS1155+6346	0.176	2.89	1.95	0.16	0.88	0.72	0.98	0.60	1.58	8635	106e9	0.22	1.19	9014	83.6e9	0.79
SDSS1332+0347	0.191	1.445	1.14	0.17	0.71	0.54	0.57	0.30	0.87	5341	36.0e9	0.18	0.75	5614	32.8e9	0.91
SDSS1402+6321	0.20	0.48	1.35	0.18	0.37	0.19	0.68	0.64	1.31	6523	66.4e9	0.63	1.31	6885	69.8e9	1.05
MG1654+1346	0.25	1.74	2.1	0.22	0.76	0.55	1.05	0.67	1.72	11642	156e9	0.42	1.47	12619	144e9	0.93
SDSS1406+6126	0.27	2.13	1.98	0.23	0.81	0.58	0.99	0.69	1.68	11453	149e9	0.40	1.39	12559	136e9	0.91
RXJ1131-1231	0.295	0.658	3.80	0.25	0.47	0.21	1.90	2.18	4.08	22996	729e9	2.25	4.15	25607	825e9	1.13
SDSS1353+1138	0.3	1.629	1.41	0.26	0.75	0.49	0.71	0.51	1.21	8602	81.1e9	0.37	1.07	9609	80.1e9	0.99
RXJ0921+4529	0.31	1.65	6.97	0.26	0.75	0.49	3.49	2.57	6.05	43184	2.03e12	1.89	5.37	48548	2.02e12	1.00
PG1115+080	0.31	1.72	2.32	0.26	0.76	0.50	1.16	0.85	2.01	14374	225e9	0.61	1.77	16159	223e9	0.99
QJ0158-4325	0.317	1.29	1.22	0.27	0.68	0.41	0.61	0.47	1.08	7636	64.3e9	0.40	1.01	8623	67.5e9	1.05
B2114+022	0.32	0.59	1.31	0.27	0.43	0.16	0.66	1.01	1.66	8234	106e9	1.09	1.75	9317	126e9	1.19
CY2201-3201	0.32	3.9	0.83	0.27	0.92	0.65	0.42	0.35	0.76	5217	31.0e9	0.17	0.59	5903	27.0e9	0.87
SDSS1011+0143	0.331	2.701	3.67	0.28	0.86	0.59	1.84	1.46	3.30	23406	599e9	0.87	2.71	26680	561e9	0.94
B1422+231	0.34	3.62	1.68	0.28	0.91	0.63	0.84	0.71	1.55	10835	130e9	0.38	1.22	12425	118e9	0.90
MG0751+2716	0.35	3.20	0.7	0.29	0.89	0.60	0.35	0.29	0.64	4567	22.8e9	0.17	0.52	5273	21.3e9	0.93
Q0957+561	0.36	1.41	6.26	0.30	0.71	0.41	3.13	2.63	5.76	41280	1.85e12	2.29	5.42	47997	2.02e12	1.09
SDSS0903+5028	0.388	3.605	2.99	0.32	0.91	0.59	1.50	1.31	2.80	20236	441e9	0.80	2.29	24003	427e9	0.97
SDSS0924+0219	0.39	1.524	1.75	0.32	0.73	0.41	0.87	0.77	1.64	11864	151e9	0.68	1.55	14092	170e9	1.12

								3-spherical				Euclidian				
Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	phi	theta	r	mass	phi	theta	r	mass	ratio
HS0818+1227	0.39	3.115	2.83	0.32	0.89	0.57	1.42	1.22	2.63	19185	392e9	0.79	2.20	22789	390e9	0.99
B0712+472	0.41	1.34	1.46	0.33	0.69	0.36	0.73	0.69	1.42	10048	111e9	0.67	1.40	12112	132e9	1.18
B1600+434	0.41	1.59	1.40	0.33	0.74	0.41	0.70	0.63	1.33	9635	99.4e9	0.56	1.26	11614	114e9	1.15
HE0047-1756	0.41	1.66	1.44	0.33	0.75	0.42	0.72	0.64	1.36	9910	105e9	0.56	1.28	11946	119e9	1.14
B1152+200	0.439	1.019	1.59	0.35	0.61	0.26	0.80	0.98	1.77	11139	153e9	1.08	1.87	13723	200e9	1.30
LRG3-757Horseshoe	0.444	2.379	10.2	0.35	0.84	0.49	5.10	4.56	9.66	71642	5.37e12	3.68	8.78	88604	6.04e12	1.12
SDSS1138+0314	0.45	2.44	1.34	0.36	0.84	0.49	0.67	0.60	1.27	9440	93.3e9	0.49	1.16	11729	105e9	1.13
HE0435-1223	0.46	1.689	2.42	0.36	0.76	0.40	1.21	1.16	2.37	17126	315e9	1.11	2.32	21444	385e9	1.22
HST14113+5211	0.46	2.81	1.80	0.36	0.87	0.51	0.90	0.82	1.72	12738	170e9	0.64	1.54	15950	190e9	1.12
Q0047-2808	0.48	3.60	2.7	0.37	0.91	0.54	1.35	1.25	2.60	19257	389e9	0.94	2.29	24493	435e9	1.12
Q0142-100	0.49	2.72	2.24	0.38	0.87	0.49	1.12	1.04	2.16	16028	269e9	0.87	1.99	20548	318e9	1.18
HST15433+5352	0.497	2.092	1.18	0.38	0.81	0.43	0.59	0.57	1.16	8461	75.9e9	0.53	1.12	10907	94.7e9	1.25
HE2149-2745	0.50	2.03	1.70	0.38	0.80	0.42	0.85	0.82	1.67	12199	158e9	0.78	1.63	15764	200e9	1.26
SDSS1226-0006	0.52	1.12	1.26	0.40	0.64	0.24	0.63	0.87	1.50	9083	106e9	1.04	1.67	11929	155e9	1.46
HE0230-2130	0.52	2.162	2.05	0.40	0.82	0.42	1.03	1.00	2.03	14778	232e9	0.96	1.99	19408	299e9	1.29
SDSS1029+2623	0.55	2.197	22.5	0.41	0.82	0.41	11.25	11.28	22.53	162905	28.5e12	11.32	22.57	219243	38.4e12	1.35
SDSS0806+2006	0.573	1.540	1.40	0.42	0.73	0.31	0.70	0.83	1.53	10151	120e9	0.97	1.67	13924	180e9	1.50
B1030+074	0.60	1.54	1.65	0.44	0.73	0.29	0.82	1.02	1.84	11962	171e9	1.23	2.06	16783	268e9	1.57
B1608+656	0.63	1.39	2.27	0.45	0.70	0.25	1.14	1.59	2.73	16420	348e9	2.07	3.20	23629	587e9	1.69
BRI0952-0115	0.632	4.50	1.00	0.45	0.94	0.48	0.50	0.50	1.00	7232	55.9e9	0.47	0.97	10425	78.6e9	1.41
WFI2033-4723	0.66	1.66	2.33	0.47	0.75	0.28	1.17	1.49	2.65	16784	345e9	1.91	3.08	24778	592e9	1.71
B0218+357	0.68	0.96	0.34	0.48	0.59	0.11	0.17	0.50	0.67	2440	12.7e9	0.74	0.91	3664	25.8e9	2.03
SDSS1004+4112	0.68	1.734	15.99	0.48	0.76	0.29	8.00	10.16	18.16	114752	16.2e12	13.27	21.27	172336	28.5e12	1.76
SBS1520+530	0.72	1.86	1.59	0.49	0.78	0.29	0.80	1.01	1.81	11302	159e9	1.37	2.16	17569	295e9	1.86
HE1104-1805	0.73	2.32	3.19	0.50	0.83	0.33	1.60	1.84	3.43	22612	603e9	2.38	3.97	35456	1.09e12	1.82
B1933+503	0.76	2.63	1.00	0.51	0.86	0.35	0.50	0.56	1.06	7023	58.0e9	0.74	1.24	11303	109e9	1.87
PMNJ0134-0931	0.77	2.216	0.73	0.52	0.82	0.31	0.37	0.44	0.81	5110	32.1e9	0.61	0.98	8296	63.0e9	1.96
RXJ0911+0551	0.77	2.80	2.47	0.52	0.87	0.35	1.24	1.37	2.61	17290	350e9	1.80	3.03	28069	661e9	1.89
HST14176+5226	0.81	3.40	2.83	0.53	0.90	0.37	1.42	1.53	2.95	19525	447e9	2.04	3.45	32819	880e9	1.97
SBS0909+523	0.83	1.38	1.17	0.54	0.70	0.16	0.59	1.21	1.79	8009	111e9	1.98	2.56	13698	273e9	2.45
B2045+265	0.87	1.28	2.74	0.56	0.68	0.12	1.37	3.61	4.98	18440	713e9	6.23	7.60	32657	1.93e12	2.71
LBQS1009-0252	0.87	2.74	1.54	0.56	0.87	0.31	0.77	0.91	1.68	10364	136e9	1.37	2.14	18354	305e9	2.25
B1938+666	0.881	2.059	1.0	0.56	0.81	0.25	0.50	0.70	1.20	6697	62.4e9	1.13	1.63	11974	152e9	2.43
PKS1830-211	0.89	2.51	0.99	0.56	0.85	0.29	0.50	0.62	1.11	6603	57.1e9	0.97	1.46	11899	135e9	2.37
CFRS03.1077	0.938	2.941	2.1	0.58	0.88	0.30	1.05	1.26	2.31	13690	245e9	2.03	3.08	25720	615e9	2.51
J1004+1229	0.95	2.65	1.54	0.58	0.86	0.28	0.77	0.97	1.74	9980	135e9	1.62	2.39	18945	352e9	2.61
MG0414+0534	0.96	2.64	2.40	0.59	0.86	0.27	1.20	1.53	2.73	15476	328e9	2.58	3.78	29632	870e9	2.65
MG2016+112	1.01	3.27	3.52	0.60	0.90	0.29	1.76	2.10	3.86	22116	662e9	3.63	5.39	44212	1.85e12	2.79

Gravitational lenses as listed on https://www.cfa.harvard.edu/castles/ as of 2019-08-31
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Calculated for 3-sperical and Euclidean geometry of the universe

- o shown distance at which light rays pass the lensing object has been corrected for the (transverse) expansion of the universe during light travel time from lens to us
- o lens and source are assumed collinear
- o legend:
  - Lens : name of lens
  - zL : redshift of lensing object
  - zS : redshift of source object
  - size : apparent diameter of corresponding Einstein ring [arc seconds]
  - rhoL : dimensionless distance to lens (via rel. Doppler)
  - rhoS : dimension distance to source
  - rhoSL : dimensionless distance from source to lens
  - alpha : apparent radius (size/2) [arc seconds]
  - phi : angle from source to lens [arc seconds]
  - theta : total deflection angle (alpha + phi) [arc seconds]
  - r : distance at which ray passes lens [light years]
  - mass : calculated mass of lensing object [solar masses]
  - ratio : Euclidean/3-spherical mass ratio
- o ORDERED BY: mass, calculated using Euclidean geometry

								3-spherical				Euclidian				
Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	phi	theta	r	mass	phi	theta	r	mass	ratio
Q2237+030	0.04	1.69	1.78	0.04	0.76	0.72	0.89	0.14	1.03	2236	17.9e9	0.05	0.94	2242	16.3e9	0.91
MG0751+2716	0.35	3.20	0.7	0.29	0.89	0.60	0.35	0.29	0.64	4567	22.8e9	0.17	0.52	5273	21.3e9	0.93
B0218+357	0.68	0.96	0.34	0.48	0.59	0.11	0.17	0.50	0.67	2440	12.7e9	0.74	0.91	3664	25.8e9	2.03
CY2201-3201	0.32	3.9	0.83	0.27	0.92	0.65	0.42	0.35	0.76	5217	31.0e9	0.17	0.59	5903	27.0e9	0.87
SDSS1332+0347	0.191	1.445	1.14	0.17	0.71	0.54	0.57	0.30	0.87	5341	36.0e9	0.18	0.75	5614	32.8e9	0.91
MG1549+3047	0.11	1.17	1.7	0.10	0.65	0.55	0.85	0.28	1.13	5251	45.9e9	0.16	1.01	5345	42.0e9	0.92
PMNJ0134-0931	0.77	2.216	0.73	0.52	0.82	0.31	0.37	0.44	0.81	5110	32.1e9	0.61	0.98	8296	63.0e9	1.96
QJ0158-4325	0.317	1.29	1.22	0.27	0.68	0.41	0.61	0.47	1.08	7636	64.3e9	0.40	1.01	8623	67.5e9	1.05
SDSS1402+6321	0.20	0.48	1.35	0.18	0.37	0.19	0.68	0.64	1.31	6523	66.4e9	0.63	1.31	6885	69.8e9	1.05
BRI0952-0115	0.632	4.50	1.00	0.45	0.94	0.48	0.50	0.50	1.00	7232	55.9e9	0.47	0.97	10425	78.6e9	1.41
SDSS1353+1138	0.3	1.629	1.41	0.26	0.75	0.49	0.71	0.51	1.21	8602	81.1e9	0.37	1.07	9609	80.1e9	0.99
SDSS1155+6346	0.176	2.89	1.95	0.16	0.88	0.72	0.98	0.60	1.58	8635	106e9	0.22	1.19	9014	83.6e9	0.79
HST15433+5352	0.497	2.092	1.18	0.38	0.81	0.43	0.59	0.57	1.16	8461	75.9e9	0.53	1.12	10907	94.7e9	1.25
SDSS1138+0314	0.45	2.44	1.34	0.36	0.84	0.49	0.67	0.60	1.27	9440	93.3e9	0.49	1.16	11729	105e9	1.13
B1933+503	0.76	2.63	1.00	0.51	0.86	0.35	0.50	0.56	1.06	7023	58.0e9	0.74	1.24	11303	109e9	1.87
B1600+434	0.41	1.59	1.40	0.33	0.74	0.41	0.70	0.63	1.33	9635	99.4e9	0.56	1.26	11614	114e9	1.15
B1422+231	0.34	3.62	1.68	0.28	0.91	0.63	0.84	0.71	1.55	10835	130e9	0.38	1.22	12425	118e9	0.90
HE0047-1756	0.41	1.66	1.44	0.33	0.75	0.42	0.72	0.64	1.36	9910	105e9	0.56	1.28	11946	119e9	1.14
B2114+022	0.32	0.59	1.31	0.27	0.43	0.16	0.66	1.01	1.66	8234	106e9	1.09	1.75	9317	126e9	1.19
B0712+472	0.41	1.34	1.46	0.33	0.69	0.36	0.73	0.69	1.42	10048	111e9	0.67	1.40	12112	132e9	1.18

Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	3-spherical phi	3-spherical theta	3-spherical r	3-spherical mass	Euclidian phi	Euclidian theta	Euclidian r	Euclidian mass	ratio
PKS1830-211	0.89	2.51	0.99	0.56	0.85	0.29	0.50	0.62	1.11	6603	57.1e9	0.97	1.46	11899	135e9	2.37
SDSS1406+6126	0.27	2.13	1.98	0.23	0.81	0.58	0.99	0.69	1.68	11453	149e9	0.40	1.39	12559	136e9	0.91
MG1654+1346	0.25	1.74	2.1	0.22	0.76	0.55	1.05	0.67	1.72	11642	156e9	0.42	1.47	12619	144e9	0.93
B1938+666	0.881	2.059	1.0	0.56	0.81	0.25	0.50	0.70	1.20	6697	62.4e9	1.13	1.63	11974	152e9	2.43
SDSS1226-0006	0.52	1.12	1.26	0.40	0.64	0.24	0.63	0.87	1.50	9083	106e9	1.04	1.67	11929	155e9	1.46
SDSS0924+0219	0.39	1.524	1.75	0.32	0.73	0.41	0.87	0.77	1.64	11864	151e9	0.68	1.55	14092	170e9	1.12
SDSS0806+2006	0.573	1.540	1.40	0.42	0.73	0.31	0.70	0.83	1.53	10151	120e9	0.97	1.67	13924	180e9	1.50
HST14113+5211	0.46	2.81	1.80	0.36	0.87	0.51	0.90	0.82	1.72	12738	170e9	0.64	1.54	15950	190e9	1.12
B1152+200	0.439	1.019	1.59	0.35	0.61	0.26	0.80	0.98	1.77	11139	153e9	1.08	1.87	13723	200e9	1.30
HE2149-2745	0.50	2.03	1.70	0.38	0.80	0.42	0.85	0.82	1.67	12199	158e9	0.78	1.63	15764	200e9	1.26
PG1115+080	0.31	1.72	2.32	0.26	0.76	0.50	1.16	0.85	2.01	14374	225e9	0.61	1.77	16159	223e9	0.99
B1030+074	0.60	1.54	1.65	0.44	0.73	0.29	0.82	1.02	1.84	11962	171e9	1.23	2.06	16783	268e9	1.57
SBS0909+523	0.83	1.38	1.17	0.54	0.70	0.16	0.59	1.21	1.79	8009	111e9	1.98	2.56	13698	273e9	2.45
SBS1520+530	0.72	1.86	1.59	0.49	0.78	0.29	0.80	1.01	1.81	11302	159e9	1.37	2.16	17569	295e9	1.86
HE0230-2130	0.52	2.162	2.05	0.40	0.82	0.42	1.03	1.00	2.03	14778	232e9	0.96	1.99	19408	299e9	1.29
LBQS1009-0252	0.87	2.74	1.54	0.56	0.87	0.31	0.77	0.91	1.68	10364	136e9	1.37	2.14	18354	305e9	2.25
Q0142-100	0.49	2.72	2.24	0.38	0.87	0.49	1.12	1.04	2.16	16028	269e9	0.87	1.99	20548	318e9	1.18
J1004+1229	0.95	2.65	1.54	0.58	0.86	0.28	0.77	0.97	1.74	9980	135e9	1.62	2.39	18945	352e9	2.61
HE0435-1223	0.46	1.689	2.42	0.36	0.76	0.40	1.21	1.16	2.37	17126	315e9	1.11	2.32	21444	385e9	1.22
HS0818+1227	0.39	3.115	2.83	0.32	0.89	0.57	1.42	1.22	2.63	19185	392e9	0.79	2.20	22789	390e9	0.99
SDSS0903+5028	0.388	3.605	2.99	0.32	0.91	0.59	1.50	1.31	2.80	20236	441e9	0.80	2.29	24003	427e9	0.97
Q0047-2808	0.48	3.60	2.7	0.37	0.91	0.54	1.35	1.25	2.60	19257	389e9	0.94	2.29	24493	435e9	1.12
SDSS1011+0143	0.331	2.701	3.67	0.28	0.86	0.59	1.84	1.46	3.30	23406	599e9	0.87	2.71	26680	561e9	0.94
B1608+656	0.63	1.39	2.27	0.45	0.70	0.25	1.14	1.59	2.73	16420	348e9	2.07	3.20	23629	587e9	1.69
WFI2033-4723	0.66	1.66	2.33	0.47	0.75	0.28	1.17	1.49	2.65	16784	345e9	1.91	3.08	24778	592e9	1.71
CFRS03.1077	0.938	2.941	2.1	0.58	0.88	0.30	1.05	1.26	2.31	13690	245e9	2.03	3.08	25720	615e9	2.51
RXJ0911+0551	0.77	2.80	2.47	0.52	0.87	0.35	1.24	1.37	2.61	17290	350e9	1.80	3.03	28069	661e9	1.89
RXJ1131-1231	0.295	0.658	3.80	0.25	0.47	0.21	1.90	2.18	4.08	22996	729e9	2.25	4.15	25607	825e9	1.13
MG0414+0534	0.96	2.64	2.40	0.59	0.86	0.27	1.20	1.53	2.73	15476	328e9	2.58	3.78	29632	870e9	2.65
HST14176+5226	0.81	3.40	2.83	0.53	0.90	0.37	1.42	1.53	2.95	19525	447e9	2.04	3.45	32819	880e9	1.97
HE1104-1805	0.73	2.32	3.19	0.50	0.83	0.33	1.60	1.84	3.43	22612	603e9	2.38	3.97	35456	1.09e12	1.82
MG2016+112	1.01	3.27	3.52	0.60	0.90	0.29	1.76	2.10	3.86	22116	662e9	3.63	5.39	44212	1.85e12	2.79
B2045+265	0.87	1.28	2.74	0.56	0.68	0.12	1.37	3.61	4.98	18440	713e9	6.23	7.60	32657	1.93e12	2.71
Q0957+561	0.36	1.41	6.26	0.30	0.71	0.41	3.13	2.63	5.76	41280	1.85e12	2.29	5.42	47997	2.02e12	1.09
RXJ0921+4529	0.31	1.65	6.97	0.26	0.75	0.49	3.49	2.57	6.05	43184	2.03e12	1.89	5.37	48548	2.02e12	1.00
LRG3-757Horseshoe	0.444	2.379	10.2	0.35	0.84	0.49	5.10	4.56	9.66	71642	5.37e12	3.68	8.78	88604	6.04e12	1.12
SDSS1004+4112	0.68	1.734	15.99	0.48	0.76	0.29	8.00	10.16	18.16	114752	16.2e12	13.27	21.27	172336	28.5e12	1.76
SDSS1029+2623	0.55	2.197	22.5	0.41	0.82	0.41	11.25	11.28	22.53	162905	28.5e12	11.32	22.57	219243	38.4e12	1.35

Gravitational lenses as listed on https://www.cfa.harvard.edu/castles/ as of 2019-08-31

Calculated for 3-sperical and Euclidean geometry of the universe

- shown distance at which light rays pass the lensing object has been corrected for the (transverse) expansion of the universe during light travel time from lens to us
- lens and source are assumed collinear
- legend:
  - Lens : name of lens
  - zL : redshift of lensing object
  - zS : redshift of source object
  - size : apparent diameter of corresponding Einstein ring [arc seconds]
  - rhoL : dimensionless distance to lens (via rel. Doppler)
  - rhoS : dimension distance to source
  - rhoSL : dimensionless distance from source to lens
  - alpha : apparent radius (size/2) [arc seconds]
  - phi : angle from source to lens [arc seconds]
  - theta : total deflection angle (alpha + phi) [arc seconds]
  - r : distance at which ray passes lens [light years]
  - mass : calculated mass of lensing object [solar masses]
  - ratio : Euclidean/3-spherical mass ratio
- ORDERED BY: mass, calculated using 3-spherical geometry

								3-spherical				Euclidian				
Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	phi	theta	r	mass	phi	theta	r	mass	ratio
B0218+357	0.68	0.96	0.34	0.48	0.59	0.11	0.17	0.50	0.67	2440	12.7e9	0.74	0.91	3664	25.8e9	2.03
Q2237+030	0.04	1.69	1.78	0.04	0.76	0.72	0.89	0.14	1.03	2236	17.9e9	0.05	0.94	2242	16.3e9	0.91
MG0751+2716	0.35	3.20	0.7	0.29	0.89	0.60	0.35	0.29	0.64	4567	22.8e9	0.17	0.52	5273	21.3e9	0.93
CY2201-3201	0.32	3.9	0.83	0.27	0.92	0.65	0.42	0.35	0.76	5217	31.0e9	0.17	0.59	5903	27.0e9	0.87
PMNJ0134-0931	0.77	2.216	0.73	0.52	0.82	0.31	0.37	0.44	0.81	5110	32.1e9	0.61	0.98	8296	63.0e9	1.96
SDSS1332+0347	0.191	1.445	1.14	0.17	0.71	0.54	0.57	0.30	0.87	5341	36.0e9	0.18	0.75	5614	32.8e9	0.91
MG1549+3047	0.11	1.17	1.7	0.10	0.65	0.55	0.85	0.28	1.13	5251	45.9e9	0.16	1.01	5345	42.0e9	0.92
BRI0952-0115	0.632	4.50	1.00	0.45	0.94	0.48	0.50	0.50	1.00	7232	55.9e9	0.47	0.97	10425	78.6e9	1.41
PKS1830-211	0.89	2.51	0.99	0.56	0.85	0.29	0.50	0.62	1.11	6603	57.1e9	0.97	1.46	11899	135e9	2.37
B1933+503	0.76	2.63	1.00	0.51	0.86	0.35	0.50	0.56	1.06	7023	58.0e9	0.74	1.24	11303	109e9	1.87
B1938+666	0.881	2.059	1.0	0.56	0.81	0.25	0.50	0.70	1.20	6697	62.4e9	1.13	1.63	11974	152e9	2.43
QJ0158-4325	0.317	1.29	1.22	0.27	0.68	0.41	0.61	0.47	1.08	7636	64.3e9	0.40	1.01	8623	67.5e9	1.05
SDSS1402+6321	0.20	0.48	1.35	0.18	0.37	0.19	0.68	0.64	1.31	6523	66.4e9	0.63	1.31	6885	69.8e9	1.05
HST15433+5352	0.497	2.092	1.18	0.38	0.81	0.43	0.59	0.57	1.16	8461	75.9e9	0.53	1.12	10907	94.7e9	1.25
SDSS1353+1138	0.3	1.629	1.41	0.26	0.75	0.49	0.71	0.51	1.21	8602	81.1e9	0.37	1.07	9609	80.1e9	0.99
SDSS1138+0314	0.45	2.44	1.34	0.36	0.84	0.49	0.67	0.60	1.27	9440	93.3e9	0.49	1.16	11729	105e9	1.13
B1600+434	0.41	1.59	1.40	0.33	0.74	0.41	0.70	0.63	1.33	9635	99.4e9	0.56	1.26	11614	114e9	1.15
HE0047-1756	0.41	1.66	1.44	0.33	0.75	0.42	0.72	0.64	1.36	9910	105e9	0.56	1.28	11946	119e9	1.14
SDSS1226-0006	0.52	1.12	1.26	0.40	0.64	0.24	0.63	0.87	1.50	9083	106e9	1.04	1.67	11929	155e9	1.46
SDSS1155+6346	0.176	2.89	1.95	0.16	0.88	0.72	0.98	0.60	1.58	8635	106e9	0.22	1.19	9014	83.6e9	0.79

Lens	zL	zS	size	rhoL	rhoS	rhoSL	alpha	3-spherical phi	3-spherical theta	3-spherical r	3-spherical mass	Euclidian phi	Euclidian theta	Euclidian r	Euclidian mass	ratio
B2114+022	0.32	0.59	1.31	0.27	0.43	0.16	0.66	1.01	1.66	8234	106e9	1.09	1.75	9317	126e9	1.19
B0712+472	0.41	1.34	1.46	0.33	0.69	0.36	0.73	0.69	1.42	10048	111e9	0.67	1.40	12112	132e9	1.18
SBS0909+523	0.83	1.38	1.17	0.54	0.70	0.16	0.59	1.21	1.79	8009	111e9	1.98	2.56	13698	273e9	2.45
SDSS0806+2006	0.573	1.540	1.40	0.42	0.73	0.31	0.70	0.83	1.53	10151	120e9	0.97	1.67	13924	180e9	1.50
B1422+231	0.34	3.62	1.68	0.28	0.91	0.63	0.84	0.71	1.55	10835	130e9	0.38	1.22	12425	118e9	0.90
J1004+1229	0.95	2.65	1.54	0.58	0.86	0.28	0.77	0.97	1.74	9980	135e9	1.62	2.39	18945	352e9	2.61
LBQS1009-0252	0.87	2.74	1.54	0.56	0.87	0.31	0.77	0.91	1.68	10364	136e9	1.37	2.14	18354	305e9	2.25
SDSS1406+6126	0.27	2.13	1.98	0.23	0.81	0.58	0.99	0.69	1.68	11453	149e9	0.40	1.39	12559	136e9	0.91
SDSS0924+0219	0.39	1.524	1.75	0.32	0.73	0.41	0.87	0.77	1.64	11864	151e9	0.68	1.55	14092	170e9	1.12
B1152+200	0.439	1.019	1.59	0.35	0.61	0.26	0.80	0.98	1.77	11139	153e9	1.08	1.87	13723	200e9	1.30
MG1654+1346	0.25	1.74	2.1	0.22	0.76	0.55	1.05	0.67	1.72	11642	156e9	0.42	1.47	12619	144e9	0.93
HE2149-2745	0.50	2.03	1.70	0.38	0.80	0.42	0.85	0.82	1.67	12199	158e9	0.78	1.63	15764	200e9	1.26
SBS1520+530	0.72	1.86	1.59	0.49	0.78	0.29	0.80	1.01	1.81	11302	159e9	1.37	2.16	17569	295e9	1.86
HST14113+5211	0.46	2.81	1.80	0.36	0.87	0.51	0.90	0.82	1.72	12738	170e9	0.64	1.54	15950	190e9	1.12
B1030+074	0.60	1.54	1.65	0.44	0.73	0.29	0.82	1.02	1.84	11962	171e9	1.23	2.06	16783	268e9	1.57
PG1115+080	0.31	1.72	2.32	0.26	0.76	0.50	1.16	0.85	2.01	14374	225e9	0.61	1.77	16159	223e9	0.99
HE0230-2130	0.52	2.162	2.05	0.40	0.82	0.42	1.03	1.00	2.03	14778	232e9	0.96	1.99	19408	299e9	1.29
CFRS03.1077	0.938	2.941	2.1	0.58	0.88	0.30	1.05	1.26	2.31	13690	245e9	2.03	3.08	25720	615e9	2.51
Q0142-100	0.49	2.72	2.24	0.38	0.87	0.49	1.12	1.04	2.16	16028	269e9	0.87	1.99	20548	318e9	1.18
HE0435-1223	0.46	1.689	2.42	0.36	0.76	0.40	1.21	1.16	2.37	17126	315e9	1.11	2.32	21444	385e9	1.22
MG0414+0534	0.96	2.64	2.40	0.59	0.86	0.27	1.20	1.53	2.73	15476	328e9	2.58	3.78	29632	870e9	2.65
WFI2033-4723	0.66	1.66	2.33	0.47	0.75	0.28	1.17	1.49	2.65	16784	345e9	1.91	3.08	24778	592e9	1.71
B1608+656	0.63	1.39	2.27	0.45	0.70	0.25	1.14	1.59	2.73	16420	348e9	2.07	3.20	23629	587e9	1.69
RXJ0911+0551	0.77	2.80	2.47	0.52	0.87	0.35	1.24	1.37	2.61	17290	350e9	1.80	3.03	28069	661e9	1.89
Q0047-2808	0.48	3.60	2.7	0.37	0.91	0.54	1.35	1.25	2.60	19257	389e9	0.94	2.29	24493	435e9	1.12
HS0818+1227	0.39	3.115	2.83	0.32	0.89	0.57	1.42	1.22	2.63	19185	392e9	0.79	2.20	22789	390e9	0.99
SDSS0903+5028	0.388	3.605	2.99	0.32	0.91	0.59	1.50	1.31	2.80	20236	441e9	0.80	2.29	24003	427e9	0.97
HST14176+5226	0.81	3.40	2.83	0.53	0.90	0.37	1.42	1.53	2.95	19525	447e9	2.04	3.45	32819	880e9	1.97
SDSS1011+0143	0.331	2.701	3.67	0.28	0.86	0.59	1.84	1.46	3.30	23406	599e9	0.87	2.71	26680	561e9	0.94
HE1104-1805	0.73	2.32	3.19	0.50	0.83	0.33	1.60	1.84	3.43	22612	603e9	2.38	3.97	35456	1.09e12	1.82
MG2016+112	1.01	3.27	3.52	0.60	0.90	0.29	1.76	2.10	3.86	22116	662e9	3.63	5.39	44212	1.85e12	2.79
B2045+265	0.87	1.28	2.74	0.56	0.68	0.12	1.37	3.61	4.98	18440	713e9	6.23	7.60	32657	1.93e12	2.71
RXJ1131-1231	0.295	0.658	3.80	0.25	0.47	0.21	1.90	2.18	4.08	22996	729e9	2.25	4.15	25607	825e9	1.13
Q0957+561	0.36	1.41	6.26	0.30	0.71	0.41	3.13	2.63	5.76	41280	1.85e12	2.29	5.42	47997	2.02e12	1.09
RXJ0921+4529	0.31	1.65	6.97	0.26	0.75	0.49	3.49	2.57	6.05	43184	2.03e12	1.89	5.37	48548	2.02e12	1.00
LRG3-757Horseshoe	0.444	2.379	10.2	0.35	0.84	0.49	5.10	4.56	9.66	71642	5.37e12	3.68	8.78	88604	6.04e12	1.12
SDSS1004+4112	0.68	1.734	15.99	0.48	0.76	0.29	8.00	10.16	18.16	114752	16.2e12	13.27	21.27	172336	28.5e12	1.76
SDSS1029+2623	0.55	2.197	22.5	0.41	0.82	0.41	11.25	11.28	22.53	162905	28.5e12	11.32	22.57	219243	38.4e12	1.35

APPENDIX I: the script that was used

File: c:\ReintsH\Science\The-universe-HR\analyse\gravLensing.js

```
// ==========================================================================================================================
// Calculations on gravitational lensing
// Copyright © 2019 Henk Reints
// ==========================================================================================================================
var mode = 1;
var inputFile = "raw_data\\gravLensCatalogCASTLES.txt";
var fso = new ActiveXObject("Scripting.FileSystemObject");
var forReading = 1;
// ==========================================================================================================================
Number.prototype.zillion = function()
{       var a = Math.abs(this), zln = [["e15",1e15],["e12",1e12],["e9 ",1e9],["e6 ",1e6]], p = 3, w = p + 5;
        for (var N = zln.length, i = 0; i < N; i++)
        {       var zlni = zln[i], thr = zlni[1];
                if (a < thr) continue;
                var r = (this/thr).toPrecision(p);
                if (r.replace(/\D/g,"").length > p) break;
                return (r+zlni[0]).lpad(w);
        };
        return this.toPrecision(3);
};
// ==========================================================================================================================
String.prototype.center = function(w,p) {var result = ""+this, q = ""+[p]; if (q == "") q = " ";
                                          for (f = true; result.length < w; f = !f) if (f) result += q; else result = q+result; return result;};
String.prototype.lpad   = function(w,p) {var result = ""+this, q = ""+[p]; if (q == "") q = " "; while (result.length < w) result = q+result; return result;};
String.prototype.rpad   = function(w,p) {var result = ""+this, q = ""+[p]; if (q == "") q = " "; while (result.length < w) result += q; return result;};
// ==========================================================================================================================
// dimensionless distances and arcs (i.e. arc length) are scaled to the Hubble distance
// values are in S.I. base units unless spec'd otherwise, angles in radians, rho = dimensionless distance
// ==========================================================================================================================
var radiansPerDeg       = Math.PI/180;
var arcMinsPerDeg       = 60;
var arcSecsPerMin       = 60;
var kilo                = 1e3;
var mega                = 1e6;
var year                = 365.25*24*60*60;              // Julian year in seconds
var c                   = 299792458;                    // speed of light in m/s
var au                  = 149597870700;                 // astronomical unit in metres
var G                   = 6.67408e-11                   // gravitational constant in m3/kg/s2
var H0                  = 71;                           // Hubble constant in km/s/Mpc
//
var lightyear           = c*year;                       // in metres
```

```
var oneArcsecInRad      = radiansPerDeg/arcMinsPerDeg/arcSecsPerMin;
var parsec              = au/Math.tan(oneArcsecInRad);  // in metres
var megaparsec          = mega*parsec;                  // in metres
var kmPerMpc            = megaparsec/kilo;
var tH                  = kmPerMpc/H0;                  // Hubble time in seconds
var dH                  = c*tH;                         // Hubble distance in metres
var c2G4                = c*c/(4*G);                    // for calculating deflecting mass
var mSun                = 4*Math.PI*Math.PI*au*au*au/(G*year*year);     // solar mass
var c2G4mSun            = c2G4/mSun;                                    // factor actually used in mass calculation
//
function        betaToZeta(beta)                {return Math.sqrt((1+beta)/(1-beta));};
function        betaToZ(beta)                   {return zetaToZ(betaToZeta(beta));};
function        zetaToBeta(zeta)                {var zeta2 = zeta*zeta; return (zeta2-1)/(zeta2+1);};
function        zetaToZ(zeta)                   {return zeta-1;};
function        zToBeta(z)                      {return zetaToBeta(zToZeta(z));};
function        zToZeta(z)                      {return z+1;};
// arcs are dimensionless arc lengths:
function        arcFromAngleEucl(angle,rho)     {return rho*angle;};
function        arcFromAngle3sph(angle,rho)     {return Math.sin(Math.PI*rho)*angle/Math.PI;};
function        angleFromArcEucl(arc,rho)       {return arc/rho;};
function        angleFromArc3sph(arc,rho)       {return arc*Math.PI/Math.sin(Math.PI*rho);};
// ==============================================================================================================
if (mode == 1)
{       WScript.StdOut.WriteLine("Absolute transverse size in light years corresponding to a viewing angle of 1 arc second,");
        WScript.StdOut.WriteLine("as a function of the dimensionless distance, for 3-sperical and Euclidean geometry");
        WScript.StdOut.WriteLine("================================================================================");
        WScript.StdOut.WriteLine("");
        WScript.StdOut.WriteLine( " rho |  z    |  3sph |  Eucl | ratio");
        var separatorLine       = "-----+-------+-------+-------+------";
        var apparentDiameter = oneArcsecInRad;  // the apparent angle we'll use
        for (var N = 100, i = 0; i < N; i++)
        {       if (i%20 == 0) WScript.StdOut.WriteLine(separatorLine);
                var rho = i/N;
                var z = betaToZ(rho);
                var lyDiam3sph = arcFromAngle3sph(apparentDiameter,rho)*dH/lightyear;
                var lyDiamEucl = arcFromAngleEucl(apparentDiameter,rho)*dH/lightyear;
                var ratio = lyDiamEucl/lyDiam3sph;
                for (var f = 3, zz = z.toFixed(f); f >= 0 && zz.length > 5; f--) zz = z.toFixed(f);
                WScript.StdOut.WriteLine(
                        [rho            .toFixed(2)
                        ,zz
                        ,lyDiam3sph     .toFixed(0).lpad(5)
                        ,lyDiamEucl     .toFixed(0).lpad(5)
                        ,ratio          .toPrecision(3)
                        ].join(" | ")
```

```
                        );
        };
        WScript.StdOut.WriteLine(separatorLine);
};
// ==========================================================================================================
var sectionsList = [], sectionName = "", sectionObject = null;
for (var inputStream = fso.OpenTextFile(inputFile,forReading); !inputStream.AtEndOfStream; )
{       var inputLine = inputStream.ReadLine();
        if (inputLine.charAt(0) == ":")
        {       var sectionName = inputLine.slice(1);
                var sectionObject = {name:sectionName,content:[]};
                sectionsList.push(sectionObject);
        } else if (sectionObject != null)
        {       lineObject = {line:inputLine};
                if (sectionName == "DATA")
                {       var temp = inputLine.split("|");
                        lineObject.no = Number( temp[0].replace(/^\s+|\s+$/g,""));
                        lineObject.lensName =   temp[1].replace(/^\s+|\s+$/g,"");
                        lineObject.zs =         temp[3].replace(/^\s+|\s+$/g,"");
                        lineObject.zl =         temp[4].replace(/^\s+|\s+$/g,"");
                };
                sectionObject.content.push(lineObject);
        };
};
inputStream.Close();
// ==========================================================================================================
function compareDataSectionLines(a,b)
{       var na = a.no, nb = b.no, lna = a.lensName, lnb = b.lensName, za = a.zl, zb = b.zl;
        if (za == zb) za = a.zs, zb = b.zs;
        var za0 = za.charAt(0), zb0 = zb.charAt(0);
        if (za  == ""   && zb  != ""    ) return  1;
        if (za  != ""   && zb  == ""    ) return -1;
        if (za0 == "("  && zb0 != "("   ) return  1;
        if (za0 != "("  && zb0 == "("   ) return -1;
        if (za          >  zb           ) return  1;
        if (za          <  zb           ) return -1;
        if (lna         >  lnb          ) return  1;
        if (lna         <  lnb          ) return -1;
        return na - nb;
}
// ==========================================================================================================
function formatMatrix(matrix,columnSeparator,doTrim)
{       var result = [], widths = [], colSep = arguments.length > 1 && columnSeparator !== null ? ""+[columnSeparator] : "  ", nRows = matrix.length;
        for (var iRow = 0; iRow < nRows; iRow++)
        {       var row = matrix[iRow];
```

```
                if (typeof(row) != "object") continue;
                for (var nCols = row.length, iCol = 0; iCol < nCols; iCol++) widths[iCol] = Math.max(iCol < widths.length ? widths[iCol] : 0, (""+[row[iCol]]).length);
        };
        for (var iRow = 0; iRow < nRows; iRow++)
        {       var row = matrix[iRow], line = [];
                if (typeof(row) != "object")
                {       result.push(doTrim ? (""+[row]).replace(/\s$/,"") : ""+[row]);
                } else
                {       for (var nCols = row.length, iCol = 0; iCol < nCols; iCol++)
                        {       var col = row[iCol], x = ""+[col], w = widths[iCol];
                                switch (col.alignment)
                                {       case "center":  x = x.center(w);        break;
                                        case "right":   x = x.lpad(w);          break;
                                        case "left":    x = x.rpad(w);          break;
                                        default: switch(row.alignment)
                                                {       case "center":  x = x.center(w);        break;
                                                        case "right":   x = x.lpad(w);          break;
                                                        default:        x = x.rpad(w);          break;
                                                };
                                };
                                line.push(x);
                        };
                        result.push(doTrim ? line.join(colSep).replace(/\s+$/,"") : line.join(colSep));
                };
        };
        return result;
};
// ========================================================================================================================
var info =
        {head:  ["Gravitational lenses as listed on https://www.cfa.harvard.edu/castles/ as of 2019-08-31"
                ,"====================================================================================="
                ,"  Calculated for 3-sperical and Euclidean geometry of the universe"
                ,"  o  shown distance at which light rays pass the lensing object has been corrected for"
                ,"     the (transverse) expansion of the universe during light travel time from lens to us"
                ,"  o  lens and source are assumed collinear"
                ,"  o  legend:"
                ,"       Lens   : name of lens"
                ,"       zL     : redshift of lensing object"
                ,"       zS     : redshift of source object"
                ,"       size   : apparent diameter of corresponding Einstein ring   [arc seconds]"
                ,"       rhoL   : dimensionless distance to lens (via rel. Doppler)"
                ,"       rhoS   : dimension distance to source"
                ,"       rhoSL  : dimensionless distance from source to lens"
                ,"       alpha  : apparent radius (size/2)                           [arc seconds]"
                ,"       phi    : angle from source to lens                          [arc seconds]"
```

```
                ,"       theta  : total deflection angle (alpha + phi)               [arc seconds]"
                ,"       r      : distance at which ray passes lens                  [light years]"
                ,"       mass   : calculated mass of lensing object                  [solar masses]"
                ,"       ratio  : Euclidean/3-spherical mass ratio"
                ,"  o  %DESCRIPTION%"
                ]
        ,capt:  "Lens|zL|zS|size|#|rhoL|rhoS|rhoSL|alpha|#| phi|theta|r|mass|#|phi|theta|r|mass|#|ratio".split("|")
        };
// ========================================================================================================================
function LensInfo(lensName,zl,zs,size,rhoLens,rhoSrc,rhoSrcLens,alpha,phi3sph,theta3sph,r3sph,m3sph,phiEucl,thetaEucl,rEucl,mEucl,mRatio)
{       this.lensName   = lensName;
        this.zl         = zl;
        this.zs         = zs;
        this.size       = size;
        this.rhoLens    = rhoLens;
        this.rhoSrc     = rhoSrc;
        this.rhoSrcLens = rhoSrcLens;
        this.alpha      = alpha;
        this.phi3sph    = phi3sph;
        this.theta3sph  = theta3sph;
        this.r3sph      = r3sph;
        this.m3sph      = m3sph;
        this.phiEucl    = phiEucl;
        this.thetaEucl  = thetaEucl;
        this.rEucl      = rEucl;
        this.mEucl      = mEucl;
        this.mRatio     = mRatio;
};
// ========================================================================================================================
function showResult(result,description)
{       var headerSection = [].concat("",info.head,"").join("\n").replace(/%DESCRIPTION%/,description);
        WScript.StdOut.WriteLine(headerSection);
        var output = [info.capt.slice()];
        output[0].alignment = "center";
        output[0][0] = {value:output[0][0],alignment:"left",toString:function(){return this.value;}};
        for (var resultLength = result.length, resultIndex = 0; resultIndex < resultLength; resultIndex++)
        {       var record = result[resultIndex];
                output.push(
                        [ record.lensName
                        , record.zl
                        , record.zs
                        , record.size
                        ,"#"
                        , record.rhoLens                                .toFixed(2)
                        , record.rhoSrc                                 .toFixed(2)
```

```
                , record.rhoSrcLens                             .toFixed(2)
                ,(record.alpha/oneArcsecInRad)                  .toFixed(2).lpad(5)
                ,"#"
                ,(record.phi3sph        /oneArcsecInRad)        .toFixed(2).lpad(5)
                ,(record.theta3sph      /oneArcsecInRad)        .toFixed(2).lpad(5)
                ,(record.r3sph          /lightyear)             .toFixed(0).lpad(6)
                , record.m3sph                                  .zillion()
                ,"#"
                ,(record.phiEucl        /oneArcsecInRad)        .toFixed(2).lpad(5)
                ,(record.thetaEucl      /oneArcsecInRad)        .toFixed(2).lpad(5)
                ,(record.rEucl          /lightyear)             .toFixed(0).lpad(6)
                , record.mEucl                                  .zillion()
                ,"#"
                ,record.mRatio          .toFixed(2)
                ]);
        };
        var formatted = formatMatrix(output," | ",true);
        var header = formatted.shift().replace(/\| # \|/g,"|#|");
        var headerParts = header.split("#");
        for (var nHdr = headerParts.length, iHdr = 0; iHdr < nHdr; iHdr++) switch (iHdr)
        {       case 2:         headerParts[iHdr] = "  3-spherical"     .center (headerParts[iHdr].length);     break;
                case 3:         headerParts[iHdr] = "  Euclidian"       .center (headerParts[iHdr].length);     break;
                default:        headerParts[iHdr] = ""                  .rpad   (headerParts[iHdr].length);
        };
        WScript.StdOut.WriteLine(headerParts.join("#").replace(/ # /g,"|#|").replace(/\s+$/,""));
        var sepLine = header.replace(/[^\|#]/g,"-").replace(/\|/g,"+");
        WScript.StdOut.WriteLine(header);
        for (var formattedCount = formatted.length, formattedIndex = 0; formattedIndex < formattedCount; formattedIndex++)
        {       if (formattedIndex%20 == 0) WScript.StdOut.WriteLine(sepLine);
                WScript.StdOut.WriteLine(formatted[formattedIndex].replace(/\| # \|/g,"|#|"));
        };
        WScript.StdOut.WriteLine(sepLine);
};
// ========================================================================================================================
function compareLensName(a,b)
{       return  a.lensName < b.lensName ? -1
        :       a.lensName > b.lensName ?  1
        :       0;
};
function compareRedshift(a,b)
{       return  a.zl < b.zl ? -1
        :       a.zl > b.zl ?  1
        :       a.zs < b.zs ? -1
        :       a.zs > b.zs ?  1
        :       0;
```

```
};
function compareLensDistance    (a,b)   {return a.rhoLens - b.rhoLens;};
function compareMassEucl        (a,b)   {return a.mEucl - b.mEucl;};
function compareMass3sph        (a,b)   {return a.m3sph - b.m3sph;};
// ========================================================================================================================
var andromedaMass = 1.5e12, massThresholdFactor = 5, massThreshold = massThresholdFactor*andromedaMass;
var veryHeavyLenses = [];
for (var sectionCount = sectionsList.length, sectionIndex = 0; sectionIndex < sectionCount; sectionIndex++)
{       var sectionObject = sectionsList[sectionIndex];
        var sectionName = sectionObject.name;
        var sectionContent = sectionObject.content;
        var sectionContentLength = sectionContent.length;
        if (sectionName == "DATA")
        {       sectionContent.sort(compareDataSectionLines);
                if (mode == 1)
                {       // traverse the list of objects:
                        var temp = [];
                        for (var itemIndex = 0; itemIndex < sectionContentLength; itemIndex++)
                        {       var item = sectionContent[itemIndex], itemLine = item.line, itemFields = itemLine.split("|");
                                var lensName    = itemFields[ 1].replace(/^\s+|\s+$/g,"");
                                var zs          = itemFields[ 3].replace(/^\s+|\s+$/g,""),      zSrc    = zs != "" ? Number(zs) : NaN;  if (!isFinite(zSrc )) continue;
                                var zl          = itemFields[ 4].replace(/^\s+|\s+$/g,""),      zLens   = zl != "" ? Number(zl) : NaN;  if (!isFinite(zLens)) continue;
                                var size        = itemFields[12].replace(/^\s+|\s+$/g,"");
                                var alpha       = 0.5*size*oneArcsecInRad;
                        // as explained in my documents (e.g. http://henk-reints.nl/astro/HR-correct-Hubble-Lemaitre-law.pdf),
                        // the rho values below are the current proper distance and nothing else!
                        // but they are dimensionless, thus marking the position on the 3-sphere, so it also is the dimensionless comoving distance
                                var rhoLens     = zToBeta(zLens);
                                var rhoSrc      = zToBeta(zSrc );
                                var rhoSrcLens  = rhoSrc - rhoLens;
                        // now calculate the transverse true size of the viewing aangle and the entire light path, ASSUMING lens and source are collinear
                        // arc is the arc length corresponding to the viewing angle alpha as seen from here,
                        // which together with the source to lens distance yields phi, the corresponding viewing angle as seen from the source,
                        // then theta = alpha + phi is the total deflection angle,
                        // since all distances were dimensionless we must still multiply arc by dH to obtain r,
                        // the absolute distance at which the radiation passed the deflecting mass
                             var arc3sph = arcFromAngle3sph(alpha,rhoLens), phi3sph = angleFromArc3sph(arc3sph,rhoSrcLens), theta3sph = alpha + phi3sph, r3sph = arc3sph*dH;
                             var arcEucl = arcFromAngleEucl(alpha,rhoLens), phiEucl = angleFromArcEucl(arcEucl,rhoSrcLens), thetaEucl = alpha + phiEucl, rEucl = arcEucl*dH;
                        // we should now take light travel time and expansion of the universe into account
                        // the entire universe was smaller since the light passed the lens, and thus thus r needs a correction
                        // lookbackTime = beta/(1+beta), where beta equals rho, so age of universe by then was 1-lookbackTime = 1/(1+beta) = 1/(1+rhoLens)
                                r3sph /= 1+rhoLens;
                                rEucl /= 1+rhoLens;
                        // the formula for gravitational deflection is: theta = 4GM/rc2, so M = theta*r*c2/4G, we also divide by the solar mass:
                                var m3sph       = theta3sph*r3sph*c2G4mSun;     // in solar masses
```

```
                                var mEucl       = thetaEucl*rEucl*c2G4mSun;
                                var mRatio      = mEucl/m3sph;
                                temp.push(new LensInfo(lensName,zl,zs,size,rhoLens,rhoSrc,rhoSrcLens,alpha
                                         ,phi3sph,theta3sph,r3sph,m3sph,phiEucl,thetaEucl,rEucl,mEucl,mRatio));
                                if (m3sph > massThreshold) veryHeavyLenses.push(lensName);
                        };
                        temp.sort(compareLensName);     showResult(temp,"ORDERED BY: Lens name")
                        temp.sort(compareRedshift);     showResult(temp,"ORDERED BY: lens redshift and source redshift")
                        temp.sort(compareLensDistance); showResult(temp,"ORDERED BY: lens distance")
                        temp.sort(compareMassEucl);     showResult(temp,"ORDERED BY: mass, calculated using Euclidean geometry")
                        temp.sort(compareMass3sph);     showResult(temp,"ORDERED BY: mass, calculated using 3-spherical geometry")
                        WScript.StdOut.WriteLine("");
                        WScript.StdOut.WriteLine("Mass of Andromeda galaxy: "+andromedaMass.toExponential(1)+" solar masses");
                        if (veryHeavyLenses.length > 0)
                        {       WScript.StdOut.WriteLine("Arbitrary threshold: "+massThresholdFactor+" × Andromeda: "+massThreshold.toExponential(1)+" solar masses");
                                WScript.StdOut.WriteLine("    "+veryHeavyLenses.length+" out of "+temp.length
                                                        +" lenses are above it:\n        "+veryHeavyLenses.sort().join("\n        "));
                                WScript.StdOut.WriteLine("Does this substantiate dark matter all over the universe?");
                        };
                };
        };
        if (mode == 0)
        {       WScript.StdOut.WriteLine(":"+sectionName);
                for (var itemIndex = 0; itemIndex < sectionContentLength; itemIndex++) WScript.StdOut.WriteLine(sectionContent[itemIndex].line);
        };
};
// =====================================================================================================================
// that's it
```

APPENDIX II: the input file to the above script

File: c:\ReintsH\Science\The-universe-HR\analyse\raw data\gravLensCatalogCASTLES.txt

```
:SOURCE
  CASTLES Survey at https://www.cfa.harvard.edu/castles/
  data copied from https://www.cfa.harvard.edu/castles/noimages.html
:DATE
  downloaded 2019-08-31
:COMMENT
  Data of the Cosmic Horseshoe (LRG 3-757) added by Henk Reints as last data line
:DESCRIPTION
  Summary of Multiply Imaged Systems
:FIELD_DESCRIPTIONS
  LENS NAME       : The standard name for the lens. Clicking on the name takes you to a page with further information on the system.
  G               : A grade for the likelihood that the object is a lens: A=I'd bet my life, B=I'd bet your life, and C=I'd bet your life and you should worry.
  SOURCE REDSHIFT : zs is the source redshift.
  LENS REDSHIFT   : zl is the lens redshift. If the lens redshift is enclosed in parentheses, the lens redshift has been estimated photometrically.
  E(B-V)          : The Galactic extinction for the lens based on Schlegel, Finkbeiner and Davis (1998)
  SOURCE MAGNITUDE: A rough, total optical magnitude for the lensed sources. Magnitudes derived  from the CASTLES survey are shown in red.
  LENS MAGNITUDE  : A rough, total optical magnitude for the lens galaxy. Magnitudes derived from the CASTLES survey are shown in red.
  RADIO FLUX      : Fn is the radio flux at a frequency of n GHz.
  NUMBER OF IMAGES: Nim is the number of images corresponding to each source component. The flag E means extended and the flag R means there is an Einstein ring.
  SIZE ESTIMATES  : The size estimates, which are meant to be twice the average (monopole) Einstein radius, are color coded by how they were derived.
                  > Except for the numbers from the literature, which may be only rough estimates, the formal errors in the estimates are usually under 10 mas.
                  > In most cases, only the 4-image lenses show significant differences between the definitions.
                  > BLACK = estimate from the literature
                  > BLUE = the maximum separation of any pair of images. This can be misleading for highly sheared lenses.
                  > GREEN = twice the average distance of the images from the lens center.
                  > RED = twice the critical radius of a naive SIS plus external shear model for the positions.
        DT        : Is the measured time delay for the system in days. Where more than one delay is measured, only the longest delay is shown.
        SIGMA     : Is the velocity dispersion of the primary lens galaxy in km/s.
:FIELD_NAMES
  # | Lens Name          | G | zs         | zl         | RA (J2000)   | Dec (J2000)  | E(B-V) | ms (mag)         | ml (mag)       | FGHz (mJy) | Nim  | size (") | dt (days)   | sigma (km/s)
:DATA
  1 | Q0047-2808         | A | 3.60       | 0.48       | 00:49:41.89  | -27:52:25.7  | 0.016  |                  | I=20.05        |            | 4ER  | 2.7      |             | 229±15
  2 | HE0047-1756        | A | 1.66       | 0.41       | 00:50:27.83  | -17:40:8.8   | 0.022  | I=16.53/2        | I=18.97        |            | 2    | 1.44     |             |
  3 | HST01247+0352      | C |            |            | 01:24:44.4   | +03:52:00    | 0.029  | I=24.13/2        | I=21.86        |            | 2    | 2.20     |             |
  4 | HST01248+0351      | C |            |            | 01:24:45.6   | +03:51:06    | 0.029  |                  |                |            | 2    | 0.74     |             |
  5 | B0128+437          | B | 3.124      |            | 01:31:13.405 | +43:58:13.14 | 0.082  |                  |                | F5=48      | 4    | 0.55     |             |
  6 | PMNJ0134-0931      | A | 2.216      | 0.77       | 01:34:35.67  | -09:31:02.9  | 0.031  | I=18.96/4        | I=19.31        | F5=529     | 5R   | 0.73     |             |
  7 | Q0142-100          | A | 2.72       | 0.49       | 01:45:16.5   | -09:45:17    | 0.031  | I=16.47/2        | I=18.72        | F5~1       | 2    | 2.24     |             |
  8 | QJ0158-4325        | A | 1.29       | 0.317      | 01:58:41.44  | -43:25:04.20 | 0.015  | I=17.39/2        | I=18.91        | F8<0.2     | 2    | 1.22     |             |
  9 | B0218+357          | A | 0.96       | 0.68       | 02:21:05.483 | +35:56:13.78 | 0.068  | I=19.28/2        | I=20.06        | F5=1209    | 2ER  | 0.34     | 10.5±0.4    |
 10 | HE0230-2130        | A | 2.162      | 0.52       | 02:32:33.1   | -21:17:26    | 0.022  | I=18.00/4        | I=20.39        |            | 4    | 2.05     |             |
 11 | SDSS0246-0825      | A | 1.68       |            | 02:46:34.11  | -08:25:36.2  | 0.026  | I=16.98/2        | I=20.82        |            | 2    | 1.19     |             |
 12 | CFRS03.1077        | B | 2.941      | 0.938      | 03:02:30.9   | +00:06:02.1  | 0.098  |                  | I=20.36        |            | 2ER  | 2.1      |             | 256±19
 13 | J0332-2756         | A |            | 0.617      | 03:32:38.22  | -27:56:52.9  | 0.008  | V=-1.95/6        | V=20.74        |            | 2E   | 3.64     |             |
 14 | MG0414+0534        | A | 2.64       | 0.96       | 04:14:37.73  | +05:34:44.3  | 0.303  | I=19.62/4        | I=20.91        | F5=977     | 4E   | 2.40     |             |
 15 | HE0435-1223        | A | 1.689      | 0.46       | 04:38:14.9   | -12:17:14.4  | 0.059  | i=16.84/4        | i=18.05        |            | 4    | 2.42     | 14.4±0.8    |
 16 | B0445+123          | B |            | 0.557      | 04:48:21.99  | +12:27:55.41 | 0.431  | I=22.80/2        | I=20.60        | F5=29      | 2    | 1.35     |             |
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17	HE0512-3329	A	1.57	(0.93)	05:14:10.78	-33:26:22.50	0.024	I=16.27/2	I=20.85		2	0.65		
18	B0631+519	A		0.09/0.62	06:35:12.31	+51:57:01.8	0.092			F8=45	2R	1.16		
19	B0712+472	A	1.34	0.41	07:16:03.58	+47:08:50.0	0.113	I=22.42/4	I=19.56	F5=38	4	1.46		
20	B0739+366	A			07:42:51.2	+36:34:43.7	0.076	I=25.25/2	I=21.91	F5=25	2	0.53		
21	SDSS0746+4403	A	2.00		07:46:53.03	+44:03:51.3		I=18.34/2	I=19.62		2	1.11		
22	MG0751+2716	A	3.20	0.35	07:51:41.46	+27:16:31.35	0.034		I=21.26	F5=202	R	0.7		
23	SDSS0806+2006	A	1.540	0.573	08:06:23.70	+20:06:31.9	0.034	I=17.93/2	I=20.16		2	1.40		
24	HS0810+2554	A	1.50		08:13:31.3	+25:45:03.2	0.040	I=15.03/4	I=16.63		4	0.96		
25	HS0818+1227	A	3.115	0.39	08:21:39.1	+12:17:29	0.031	I=18.54/2	I=19.07		2	2.83		
26	APM08279+5255	A	3.87		08:31:41.59	+52:45:17.0	0.050	I=14.55/3			3	0.38		
27	B0850+054	A	1.14/3.93?	0.59	08:52:53.58	+05:15:15.3	0.062	I=23.15/1	I=21.35	F5=68	2E	0.68		
28	SDSS0903+5028	A	3.605	0.388	09:03:34.92	+50:28:19.2	0.025	I=18.51/2	I=19.93		2	2.99		
29	RXJ0911+0551	A	2.80	0.77	09:11:27.50	+05:50:52.0	0.045	I=17.39/4	I=20.47		4	2.47	146.0±4.0	
30	SBS0909+523	A	1.38	0.83	09:13:01.05	+52:59:28.83	0.015	I=15.65/2	I=18.85		2	1.17	45.0±5.5	
31	RXJ0921+4529	B	1.65	0.31	09:21:12.81	+45:29:04.4	0.018	I=17.74/3	I=20.24		2	6.97		
32	SDSS0924+0219	A	1.524	0.39	09:24:55.87	+02:19:24.9	0.055	i=18.18/4	i=20.78		4	1.75		
33	FBQ0951+2635	A	1.24	(0.24)	09:51:22.57	+26:35:14.1	0.022	I=16.39/2	I=19.67	F5=1.7	2	1.11	16.0±2.0	
34	BRI0952-0115	A	4.50	0.632	09:55:00.01	-01:30:05.0	0.063	I=18.27/2	I=21.21		2	1.00		
35	Q0957+561	A	1.41	0.36	10:01:20.78	+55:53:49.4	0.009	I=15.99/2	I=17.12	F5=65.6	2E	6.26	417.0±3.0	288±9
36	SDSS1001+5027	A	1.84		10:01:28.61	+50:27:56.9	0.012	I=16.64/2	I=19.63		2	2.82		
37	J1004+1229	A	2.65	0.95	10:04:24.9	+12:29:22.3	0.036	I=19.65/2	I=21.60	F1.7=7	2	1.54		
38	SDSS1004+4112	A	1.734	0.68	10:04:34.91	+41:12:42.8	0.013	i=17.53/4	i=18.42		4	15.99	821.6±2.1	
39	SDSS1011+0143	A	2.701	0.331	10:11:29.49	+01:43:23.3		UNKNOWN=22.43/4	UNKNOWN=19.86		4	3.67		
40	LBQS1009-0252	A	2.74	0.87	10:12:15.71	-03:07:02.0	0.034	I=17.80/2	I=21.94		2	1.54		
41	Q1017-207	A	2.55	(0.78)	10:17:24.13	-20:47:00.4	0.046	I=16.78/2	I=21.82		2	0.85		
42	SDSS1021+4913	A	1.72		10:21:11.02	+49:13:30.4	0.009				2	1.14		
43	FSC10214+4724	A	2.29	(0.75)	10:24:34.6	+47:09:11	0.012		I=20.40		2E	1.59		
44	SDSS1029+2623	A	2.197	0.55	10:29:13.35	+26:23:31.8	0.022				4	22.5	746.±10.	
45	B1030+074	A	1.54	0.60	10:33:34.08	+07:11:25.5	0.022	I=19.41/2	I=20.02		2	1.65		
46	HE1104-1805	A	2.32	0.73	11:06:33.45	-18:21:24.2	0.056	I=16.17/2	I=20.01		2	3.19	152.2±3.0	
47	PG1115+080	A	1.72	0.31	11:18:17.00	+07:45:57.7	0.041	I=15.62/4	I=18.92		4	2.32	25.0±2.0	281±25
48	B1127+385	A			11:30:00.13	+38:12:03.1	0.027	I=25.62/2	I=23.00		2	0.74		
49	RXJ1131-1231	A	0.658	0.295	11:31:51.6	-12:31:57	0.035	I=16.74/5	I=17.88		4	3.80	87±8	
50	MG1131+0456	A		0.844	11:31:56.48	+04:55:49.8	0.036		I=21.21	F5=205	2R	2.1		
51	SDSS1138+0314	A	2.44	0.45	11:38:03.70	+03:14:58.0	0.019	I=18.43/4	I=20.04		4	1.34		
52	SDSS1155+6346	A	2.89	0.176	11:55:17.35	+63:46:22.0	0.014	I=17.67/2	I=17.82		2	1.95		
53	B1152+200	A	1.019	0.439	11:55:18.3	+19:39:42.2	0.031	I=16.53/2	I=19.26	F5=76	2	1.59		
54	SDSS1206+4332	A	1.79		12:06:29.65	+43:32:17.6	0.014				2	2.90		
55	Q1208+101	B	3.80		12:10:57.16	+09:54:25.6	0.022	I=16.96/2			2	0.48		
56	SDSS1226-0006	A	1.12	0.52	12:26:08.10	-00:06:02.0	0.024	I=18.32/2	I=19.72		2	1.26		
57	HST12368+6212	C			12:36:49.0	+62:12:22	0.012				2E	1.17		
58	HST12531-2914	A		(0.69)	12:53:06.70	-29:14:30.0	0.079	I=24.70/4	I=21.83		4	1.23		
59	SDSS1332+0347	A	1.445	0.191	13:32:22.62	+03:47:39.9	0.026	i=18.70/2	i=18.64		2	1.14		
60	LBQS1333+0113	A	1.57		13:35:34.79	+01:18:05.5	0.024	i=17.26/2	i=20.05		2	1.63		
61	SDSS1353+1138	A	1.629	0.3	13:53:06.35	+11:38:04.7	0.026				2	1.41		
62	Q1355-2257	A	1.37	(0.48)	13:55:43.38	-22:57:22.9	0.072	I=16.94/2	I=19.04		2	1.23		
63	B1359+154	A	3.235		14:01:35.55	+15:13:25.6	0.019	I=22.62/6	I=22.68	F5=66	6	1.71		
64	SDSS1402+6321	A	0.48	0.20	14:02:28.22	+63:21:33.3	0.017				4	1.35		267±17
65	SDSS1406+6126	A	2.13	0.27	14:06:24.82	+61:26:40.9	0.015	I=18.88/2	I=18.12		4	1.98		
66	HST14113+5211	A	2.81	0.46	14:11:19.60	+52:11:29.0	0.016	I=24.14/4	I=19.99		4	1.80		
67	H1413+117	A	2.55		14:15:46.40	11:29:41.4	0.024	I=16.44/4	H=18.61	F5~0.1	4	1.35		

68	HST14164+5215	C			14:16:25.2	+52:14:31	0.013	I=22.75/2	I=19.91		2	2.24		
69	HST14176+5226	A	3.40	0.81	14:17:36.51	+52:26:40.0	0.007	I=23.41/4	I=19.77		4	2.83		230±14
70	B1422+231	A	3.62	0.34	14:24:38.09	+22:56:00.6	0.048	I=14.81/4	I=19.66	F5=557	4E	1.68	8.2±2.0	
71	SBS1520+530	A	1.86	0.72	15:21:44.83	+52:54:48.6	0.016	I=17.61/2	I=20.16		2	1.59	129.0±3.0	
72	HST15433+5352	A	2.092	0.497	15:43:20.9	+53:51:52	0.012				2R	1.18		108±14
73	MG1549+3047	A	1.17	0.11	15:49:12.37	+30:47:16.6	0.029	H=20.52/1	I=16.70	F5=185	R	1.7		227±18
74	B1555+375	A			15:57:11.93	+37:21:35.9	0.022	H=20.65/2	H=20.01	F5=35	4	0.42		
75	B1600+434	A	1.59	0.41	16:01:40.45	+43:16:47.8	0.013	I=20.87/2	I=20.78	F5=132	2	1.40	51.0±2.0	
76	B1608+656	A	1.39	0.63	16:09:13.96	+65:32:29.0	0.031		I=19.02	F5=73.2	4	2.27	77.0±1.5	247±35
77	HST16302+8230	C			16:30:12.9	+82:29:59	0.087				2R	1.47		
78	HST16309+8230	C			16:30:52.7	+82:30:12	0.087				2E	0.76		
79	PMNJ1632-0033	B	3.424		16:32:57.68	-00:33:21.1	0.098	I=20.68/2	I=23.41	F5=227	2R	1.47		
80	FBQ1633+3134	B	1.52		16:33:48.99	+31:34:11.90	0.030	I=16.59/2	I=18.26		2	0.75		
81	SDSS1650+4251	B	1.54		16:50:43.44	+42:51:45.0	0.016	I=16.98/2	I=20.5		2	1.23	49.5±1.9	
82	MG1654+1346	A	1.74	0.25	16:54:41.83	+13:46:22.0	0.061	I=20.18/1	I=17.90	F5=130.0	R	2.1		
83	HST18078+4600	C			18:07:46.7	+45:59:56	0.037				2E	0.91		
84	PKS1830-211	A	2.51	0.89	18:33:39.94	-21:03:39.7	0.464	I=22.27/2	I=21.42	F2~10^4	2ER	0.99	26.0±4.0	
85	PMNJ1838-3427	A	2.78		18:38:28.5	-34:27:41.6	0.125	I=19.10/2	I=21.22	F5=213	2R	0.99		
86	B1933+503	A	2.63	0.76	19:34:30.95	+50:25:23.6	0.095		I=20.24	F5=59	10	1.00		
87	B1938+666	A	2.059	0.881	19:38:25.19	+66:48:52.2	0.121		I=21.46	F5=316	R	1.0		
88	PMNJ2004-1349	A			20:04:07.07	-13:49:30.7	0.202	I=21.93/2	I=21.61	F5=34	2R	1.18		
89	MG2016+112	A	3.27	1.01	20:19:18.15	+11:27:08.3	0.235	I=21.51/3	I=21.95	F5=84.6	2E	3.52		304±27
90	WFI2026-4536	A	2.23		20:26:10.43	-45:36:27.1	0.041	i=16.18/4	i=		4	1.34		
91	WFI2033-4723	A	1.66	0.66	20:33:42.08	-47:23:43.0	0.047	i=17.59/4	i=19.71		4	2.33		
92	B2045+265	A	1.28	0.87	20:47:20.35	+26:44:01.2	0.232	I=22.02/3	I=21.06		4	2.74		
93	B2108+213	A			21:10:54.02	+21:31:00.7	0.161	I=20.92/2		F8=19	2	4.57		
94	B2114+022	B	0.59	0.32	21:16:50.75	+02:25:46.9	0.072		I=18.63	F5=141	2+2?	1.31		
95	HE2149-2745	A	2.03	0.50	21:52:07.44	-27:31:50.2	0.032	I=16.29/2	I=19.56		2	1.70	103.0±12.0	
96	CY2201-3201	A	3.9	0.32	22:01:32.8	-32:01:44.0	0.028				2	0.83		130±20
97	HDFS2232509-603243	C			22:32:50.9	-60:32:43.0	0.028				4?E	0.9		
98	Q2237+030	A	1.69	0.04	22:40:30.34	+03:21:28.8	0.071	I=15.16/4	I=14.15	F5=0.336	4	1.78		215±30
99	B2319+052	A		0.62	23:21:40.8	+05:27:36.4	0.064		I=20.71	F5=32	2	1.36		
100	PSS2322+1944	B	4.12		23:22:07.2	+19:44:23	0.044	I=17.92/2	I=21.91		2	1.49		
901	LRG3-757Horseshoe	A	2.379	0.444	11:48:33.15	+19:30:03.5						10.2		

:END_OF_DATA