Galaxies and Extragalactic astronomy

Exercise 1: In 1918 Shapley measured the distance to 69 globular clusters. The following table contains the positions and the distances to the Sun of these globular clusters as measured by Shapley and the best current measured distance in kiloparsecs.

name	RA	DEC	dist (Shapley)	dist (nowadays)
NGC 104	00 24 05.2	-72 04 51	6.8	4.5
NGC 288	00 52 47.5	-26 35 24	18.9	8.8
NGC 362	01 03 14.3	-70 50 54	15.2	8.5
NGC1261	03 12 15.3	-55 13 01	25.6	16.4
NGC1851	05 14 06.3	-40 02 50	17.2	12.1
NGC1904	05 24 10.6	-24 31 27	25.6	12.9
NGC2298	06 48 59.2	-36 00 19	24.2	10.7
NGC2808	09 12 02.6	-64 51 47	17.0	9.6
NGC3201	10 17 36.8	-46 24 40	14.7	5.0
NGC4147	12 10 06.2	+18 32 31	52.6	19.3
NGC4372	12 25 45.4	-72 39 33	11.4	5.8
NGC4590	12 39 28.0	-26 44 34	16.1	10.2
NGC4833	12 59 35.0	-70 52 29	16.4	6.5
NGC5024	13 12 55.3	+18 10 09	18.9	17.8
NGC5139	13 26 45.9	-47 28 37	6.5	5.3
NGC5272	13 42 11.2	+28 22 32	13.9	10.4
NGC5286	13 46 26.5	-51 22 24	19.6	11.0
NGC5634	14 29 37.3	-05 58 35	30.3	25.2
NGC5897	15 17 24.5	-21 00 37	14.9	12.4
NGC5904	15 18 33.8	+02 04 58	12.5	7.5
NGC5986	15 46 03.5	-37 47 10	20.8	10.4
NGC6093	16 17 02.5	-22 58 30	20.0	10.0
NGC6101	16 25 48.6	-72 12 06	21.3	15.3
NGC6121	16 23 35.5	-26 31 31	11.4	2.2
NGC6144	16 27 14.1	-26 01 29	24.4	8.5
NGC6171	16 32 31.9	-13 03 13	16.1	6.4
NGC6205	16 41 41.5	+36 27 37	11.1	7.7
NGC6218	16 47 14.5	-01 56 52	12.3	4.9
NGC6229	16 46 58.9	+47 31 40	43.5	30.4
NGC6235	16 53 25.4	-22 10 38	50.0	11.4
NGC6254	16 57 08.9	-04 05 58	12.0	4.4
NGC6266	17 01 12.8	-30 06 49	15.2	6.9
NGC6273	17 02 37.8	-26 16 05	15.9	8.6
NGC6284	17 04 28.8	-24 45 53	37.0	15.3
NGC6287	17 05 09.4	-22 42 29	43.5	9.3
NGC6293	17 10 10.2	-26 34 55	26.3	8.8
NGC6304	17 14 32.1	-29 27 44	32.2	6.0
NGC6316	17 16 37.3	-28 08 24	52.6	11.0
NGC6333	17 19 11.8	-18 30 59	25.0	7.9
NGC6341	17 17 07.3	+43 08 11	12.3	8.2
NGC6352	17 25 29.2	-48 25 22	22.7	5.7
NGC6356	17 23 35.0	-17 48 47	38.5	15.2

name	RA	DEC	dist (Shapley)	dist (nowadays)
NGC6362	17 31 54.8	-67 02 53	13.0	7.6
NGC6368	17 27 11.5	+11 32 37	27.8	galaxy
NGC6397	17 40 41.3	-53 40 25	8.3	2.3
NGC6402	17 37 36.1	-03 14 45	23.3	9.3
NGC6441	17 50 12.9	-37 03 05	45.5	11.7
NGC6541	18 08 02.2	-43 30 00	14.7	7.0
NGC6584	18 18 37.7	-52 12 54	26.3	13.4
NGC6624	18 23 40.5	-30 21 40	28.6	7.9
NGC6626	18 24 32.9	-24 52 12	18.5	5.6
NGC6637	18 31 23.2	-32 20 53	21.3	9.1
NGC6638	18 30 56.1	-25 29 51	34.5	9.6
NGC6642	18 31 54.1	-23 28 31	38.5[1]	8.4
NGC6652	18 35 45.7	-32 59 25	31.2	10.1
NGC6656	18 36 24.2	-23 54 12	8.5	3.2
NGC6681	18 43 12.7	-32 17 31	18.2	9.0
NGC6712	18 53 04.3	-08 42 22	31.2	6.9
NGC6715	18 55 03.3	-30 28 42	16.1	26.8
NGC6723	18 59 33.2	-36 37 54	12.7	8.7
NGC6752	19 10 52.0	-59 59 05	8.8	4.0
NGC6779	19 16 35.5	+30 11 05	25.0	10.1
NGC6809	19 39 59.4	-30 57 44	10.0	5.3
NGC6864	20 06 04.8	-21 55 17	45.5	20.7
NGC6934	20 34 11.6	+07 24 15	33.3	15.7
NGC6981	20 53 27.9	-12 32 13	29.4	17.0
NGC7006	21 01 29.5	+16 11 15	66.7	41.5
NGC7078	21 29 58.3	+12 10 01	14.7	10.3
NGC7089	21 33 29.3	-00 49 23	15.6	11.5
NGC7099	21 40 22.0	-23 10 45	17.2	8.0

[1] Although Shapley measured the distance to NGC6642, he did not use this cluster as it was not clear at the time whether this object was a globular cluster or not

Making the same assumptions as Shapley (the centre of the distribution of globular clusters is the same as the Milky Way), compute:

1) The coordinates (RA & DEC) and the distance to the centre of the Milky Way using the distances measured by Shapley

2) The coordinates (RA & DEC) and the distance to the centre of the Milky Way using the current distance measurements