Cosmicflows-2

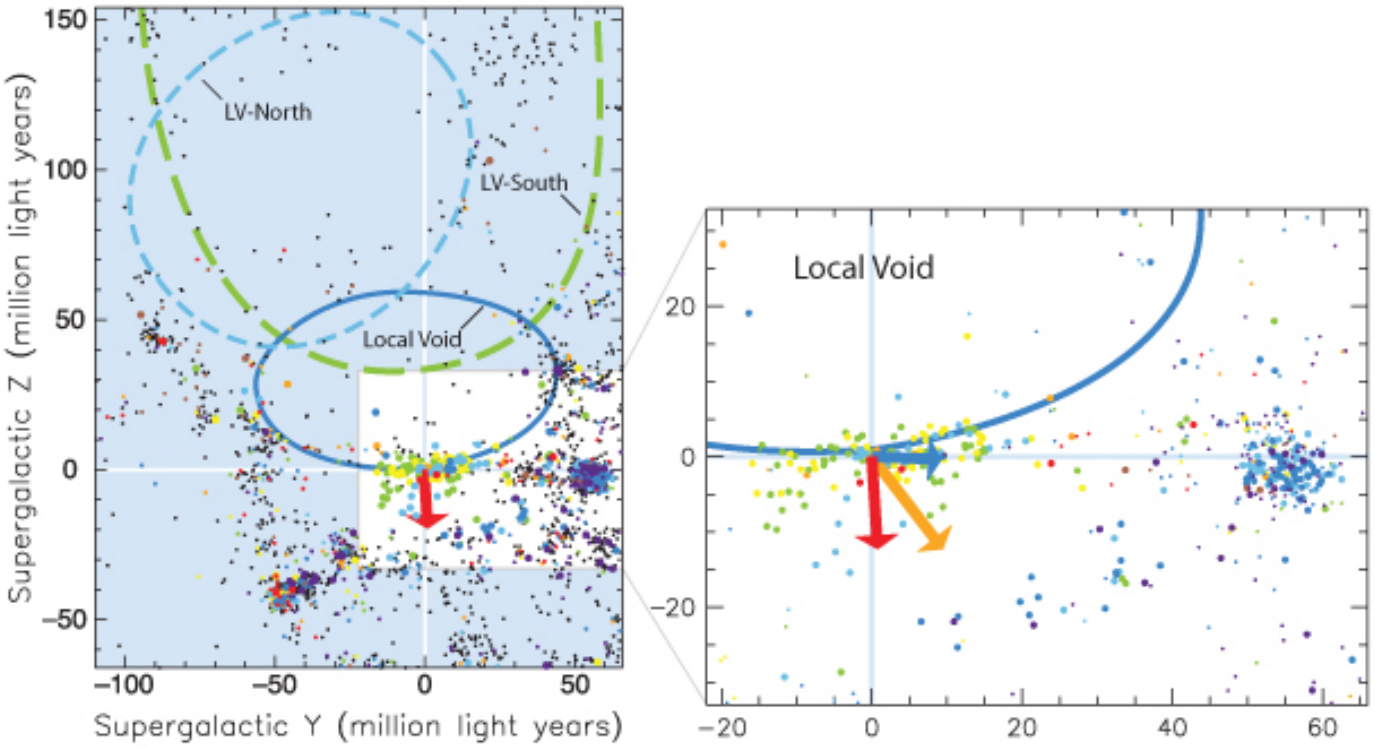
Don Neill, Frank Masci - Caltech

Mark Seibert - Carnegie Obs.

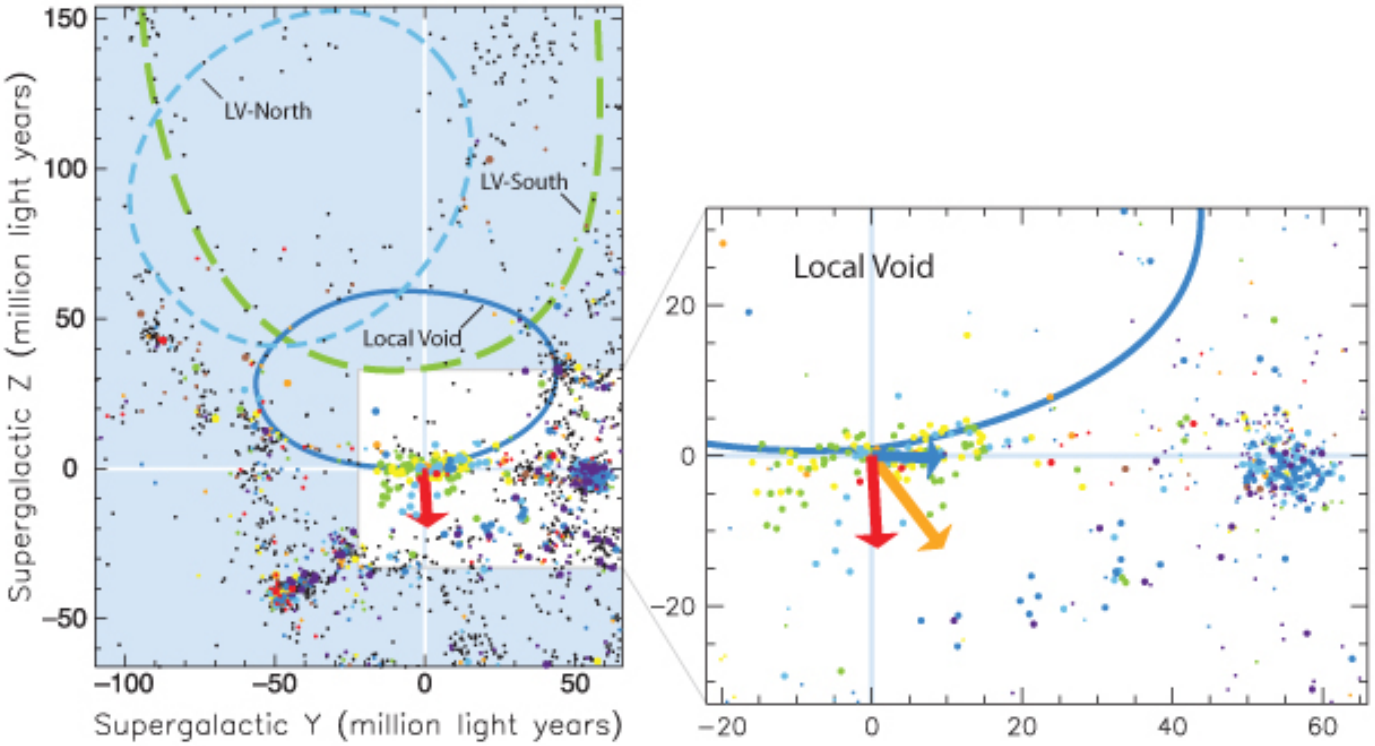
Cosmic Flows Program

- Measure distances d
- Peculiar velocities: $V_{pec} = V_{obs} - H_0 d$
- Infer 3D velocities and density field
- Project to initial conditions
- Simulate evolution to present conditions

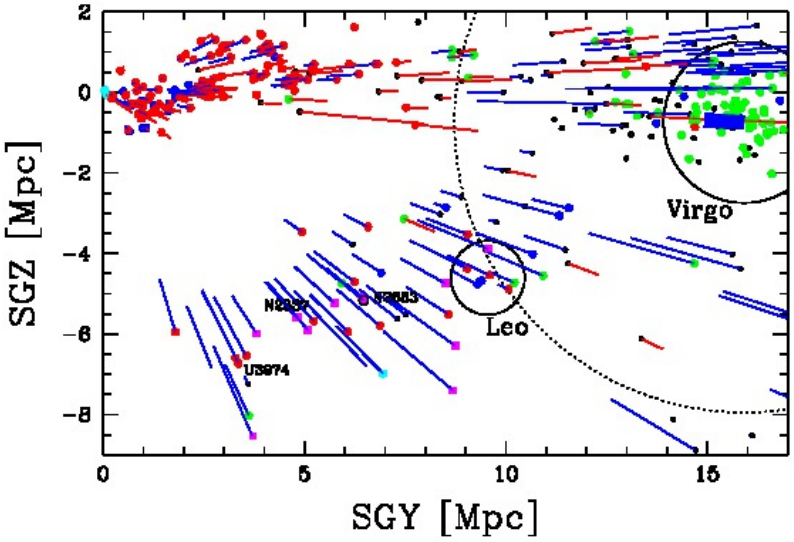
Gottloeber, Hoffman, Klypin, Yepes (CLUES collaboration)
Sorce, Kitaura



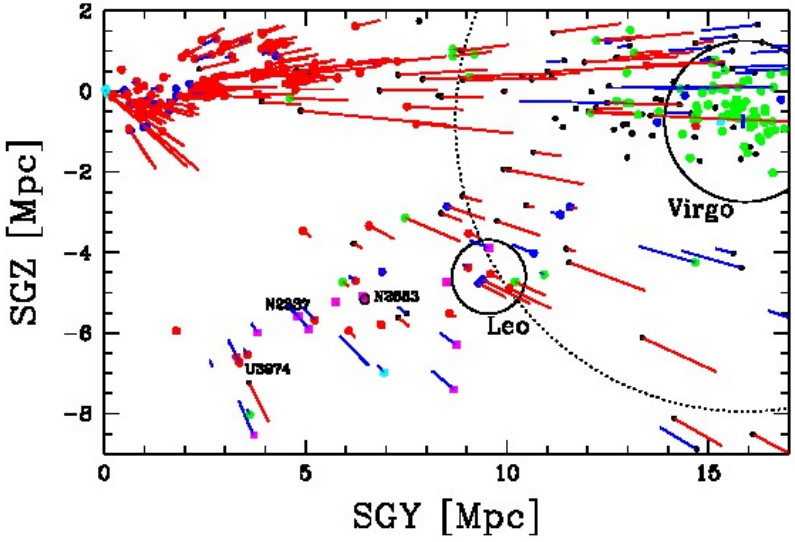
1. tiny peculiar velocities within Local Sheet
2. discontinuity in peculiar velocities passing to adjacent structures
3. 185 km/s motion toward Virgo Cluster
4. 260 km/s motion away from Local Void



Latest data, Local Group frame



After removal of local motion



Cosmicflows-1: 1797 distances within 3300 km/s
(catalog in EDD) Tully et al. 2008, ApJ, 676, 184

Contributions to Cosmicflows-2

1209
- 297 TRGB: Tip of the Red Giant Branch
- 133 TRGB Literature
  - 31 RR Lyr, Horiz Br, Eclip Bin, Maser
  - 60 Cepheid Period-Luminosity
- 382 SBF: Surface Brightness Fluctuation
- 306 SNIa: Type Ia Supernova

1508 FP: Fundamental Plane

5998 TF: Luminosity-Linewidth

8315 distance measures within 30,000 km/s

BT, Courtois, Dolphin, Fisher, Heraudeau, Jacobs, Karachentsev, Makarov, Makarova, Mitronova, Rizzi, Shaya, Sorce, Wu
2013, AJ, 146, 86

Components of the Program

1. Extragalactic Distance Database

2. Tip of the Red Giant Branch distances

3. Luminosity-Linewidth (TF) distances
   - HI profiles
   - WISE photometry

4. Cosmicflows-2 distance compilation

5. Modeling

Absolute calibration

Pop I:
HST Key Project Cepheid PLR and follow up
LMC distance modulus 18.48 (IR Cepheid + Eclipsing Binary)

Pop II:
TRGB tied to RR Lyr, Horizontal Branch distances
to dSph companions of our Galaxy

Pop I and Pop II scales agree to within 0.01 mag

Cepheid, TRGB, and Maser distances to NGC 4258 agree

Absolute calibration

Pop I:
HST Key Project Cepheid PLR and follow up
LMC distance modulus 18.48 (IR Cepheid + Eclipsing Binary)

Pop II:
TRGB tied to RR Lyr, Horizontal Branch distances
to dSph companions of our Galaxy

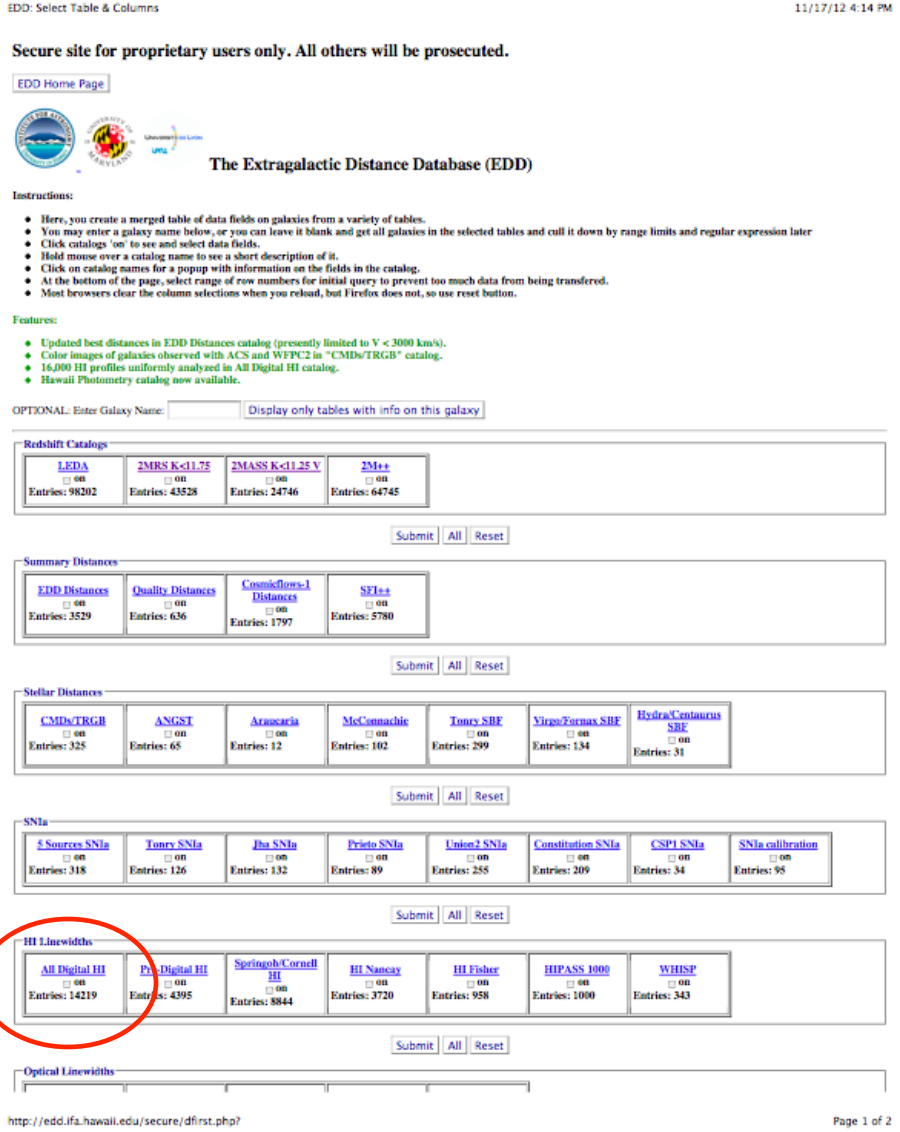
Pop I and Pop II scales agree to within 0.01 mag

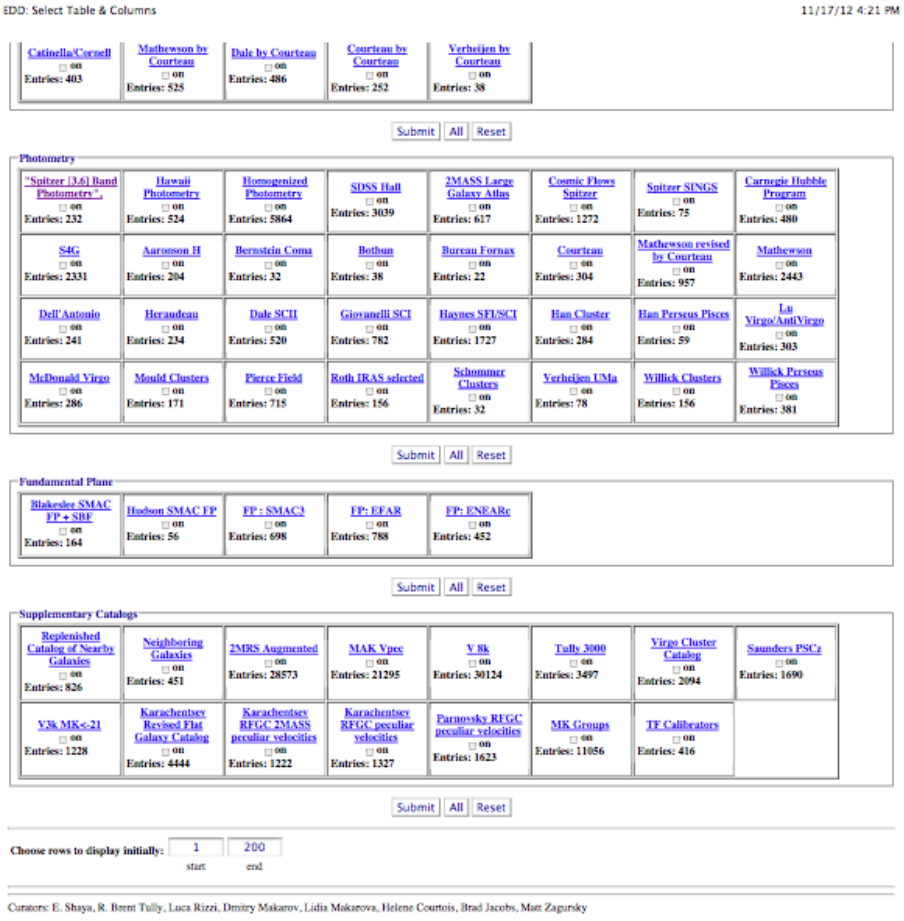
Cepheid, TRGB, and Maser distances to NGC 4258 agree

TO COME:
* GAIA parallaxes (supplemented by HST parallaxes)
* More eclipsing binaries within Local Group
* IR Cepheid calibrations

Luminosity-Linewidth (TF)

Extragalactic Distance Database





Courtois, Fisher, Koribalski, Makarov, Mitronova, Heraudeau, Sorce, Neill, Seibert, Jarrett

HI optical Spitzer WISE

Arecibo, GBT, Parkes, Nancay, Effelsberg, NRAO 300', 140'
-- new observations and archival

The Extragalactic Distance Database: Display Request

All Digital HI catalog

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PGC	Name/Profile	Vh_av	Wmx_av	eW_av	N_av	Source1	Tel1	Vhel1	Wm501	Wcm501	Wmx1	e_W1	SN1	Flux1	Res1	Ns1	Fm5
		km/s	km/s	km/s				km/s	km/s	km/s	km/s	km/s		Jy.km/s	km/s		mJ
4	AGC331060	4458	154	16	1	shg2005	AOIf	4458	173	162	154	16	8.5	1.85	8.5	2	
6	AGC331061	6002	217	20	1	shg2005	AOIf	6002	248	226	217	20	2.0	0.82	8.6	4	
12	PGC000012	6548	400	19	1	tmc2006	Nanc	6548	424	409	400	19	2.4	3.40	11.0	1	
16	PGC000016	5668	296	20	1	tmc2006	Nanc	5668	316	305	296	20	2.2	1.04	11.0	1	
20	AGC331066					shg2005	AOIf	7380	269	245		50	3.8	2.40	8.7	4	
29	AGC331067					shg2005	AOIf	12701	163	147		50	2.4	0.53	8.9	2	
38	UGC12893	1108	78	19	1	shg2005	AOIf	1108	87	82	78	19	3.8	2.41	8.5	1	
40	PGC000040	7282	289	20	1	tmc2006	Nanc	7282	316	298	289	20	5.0	5.20	10.8	2	
47	UGC12896					shg2005	AOIf	7676	181	172		25	3.6	2.61	8.8	1	
53	UGC12895	6769	158	17	1	shg2005	AOIf	6769	175	167	158	17	6.1	3.76	8.8	1	
54	UGC12897					shg2005	AOIf	8858	375	355		27	1.7	0.55	8.8	2	
55	UGC12898	4779	179	10	1	shg2005	AOIf	4779	195	188	179	10	14.9	4.30	8.5	1	
58	AGC331071					shg2005	AOIf	8795	488	457		100	0.7	0.36	8.7	4	
68	ESS38-017	7664	206	18	1	tmc2006	Nanc	7664	226	215	206	18	4.0	1.61	10.8	1	
70	UGC12900	6800	426	12	2	shg2005	AOIf	6804	449	435	426	15	7.9	8.55	8.6	1	
73	AGC036544	6909	139	14	2	shg2005	Nanc	6910	165	150	142	20	7.5	3.55	5.5	4	
76	UGC12901	6920	409	18	1	shg2005	AOIf	6920	432	418	409	18	4.6	3.82	8.8	1	
94	UGC012905	4098	188	14	1	ctm2010	GBT	4098	203	197	188	14	8.9	3.61	1.6	4	
101	UGC12906					shg2005	AOIf	5306	304	294		40	3.7	3.97	8.5	1	
102	UGC12909	5048	428	20	1	shg2005	AOIf	5048	449	437	428	20	2.5	5.58	8.7	1	
110	UGC12910	3974	56	12	1	shg2005	AOIf	3974	64	59	56	12	12.1	2.93	8.6	1	
112	UGC12911	4794	271	20	1	shg2005	AOIf	4794	289	280	271	20	2.5	1.29	8.7	1	
116	UGC12912	9268	318	19	1	shg2005	AOIf	9268	342	327	318	19	3.7	1.71	8.9	1	
117	AGC331079	9133	193	19	1	shg2005	AOIf	9133	213	202	193	19	2.1	0.92	8.8	1	

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17,738 galaxies!

The Extragalactic Distance Database: Display Request

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All Digital HI catalog

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PGC PGC no	Name/Profile	Vh_av	Wmx_av	eW_av	N_av	Source1	Tel1	Vhel1	Wm501	Wcm501	Wmx1	e_W1	SN1	Flux1	R
Min	String	Min	Min	Min	Min	String	String	Min	Min	Min	Min	Min	Min	Min	
Max	Sort	Max	Max	Max	Max	Sort	Sort	Max	Max	Max	Max	Max	Max	Max	
Sort	show hide	Sort	Sort	Sort	Sort	show hide	show hide	Sort	Sort	Sort	Sort	Sort	Sort	Sort	sho
show hide		show hide	show hide	show hide	show hide			show hide	show hide	show hide	show hide	show hide	show hide	show hide	

PGC	Name/Profile	Vh_av	Wmx_av	eW_av	N_av	Source1	Tel1	Vhel1	Wm501	Wcm501	Wmx1	e_W1	SN1	Flux1	Res1	Ns1	Fm5
		km/s	km/s	km/s				km/s	km/s	km/s	km/s	km/s		Jy.km/s	km/s		mJ
4	AGC331060	4458	154	16	1	shg2005	AOIf	4458	173	162	154	16	8.5	1.85	8.5	2	
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29	AGC331067					shg2005	AOIf	12701	163	147		50	2.4	0.53	8.9	2	
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117	AGC331079	9133	193	19	1	shg2005	AOIf	9133	213	202	193	19	2.1	0.92	8.8	1	

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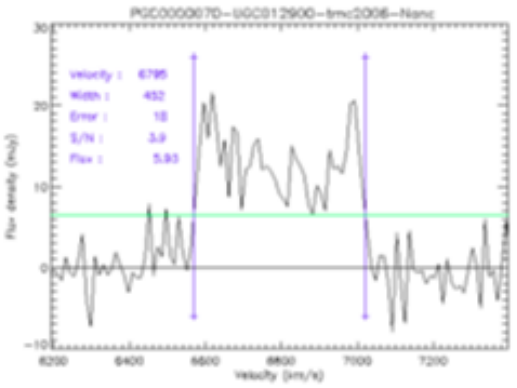
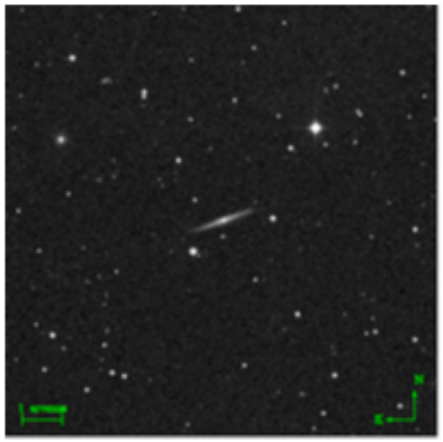
Results from the All Digital HI catalog

pgc	Name/Profile	Vh_av	Wmx_av	eW_av	N_av	Source1	Tel1	Vhel1	Wm501	Wcm501	Wmx1	e_W1	SN1	Flux1	Res1	Ns1	Fm501	Source2	Tel2	Vhel2	Wm502	W
70	UGC12900	6800	426	12	2	shg2005	AOIf	6804	449	435	426	15	7.9	8.55	8.6	1	6.5	tmc2006	Nanc	6795	452	4

Available profiles for PGC 70





Ascii Profile

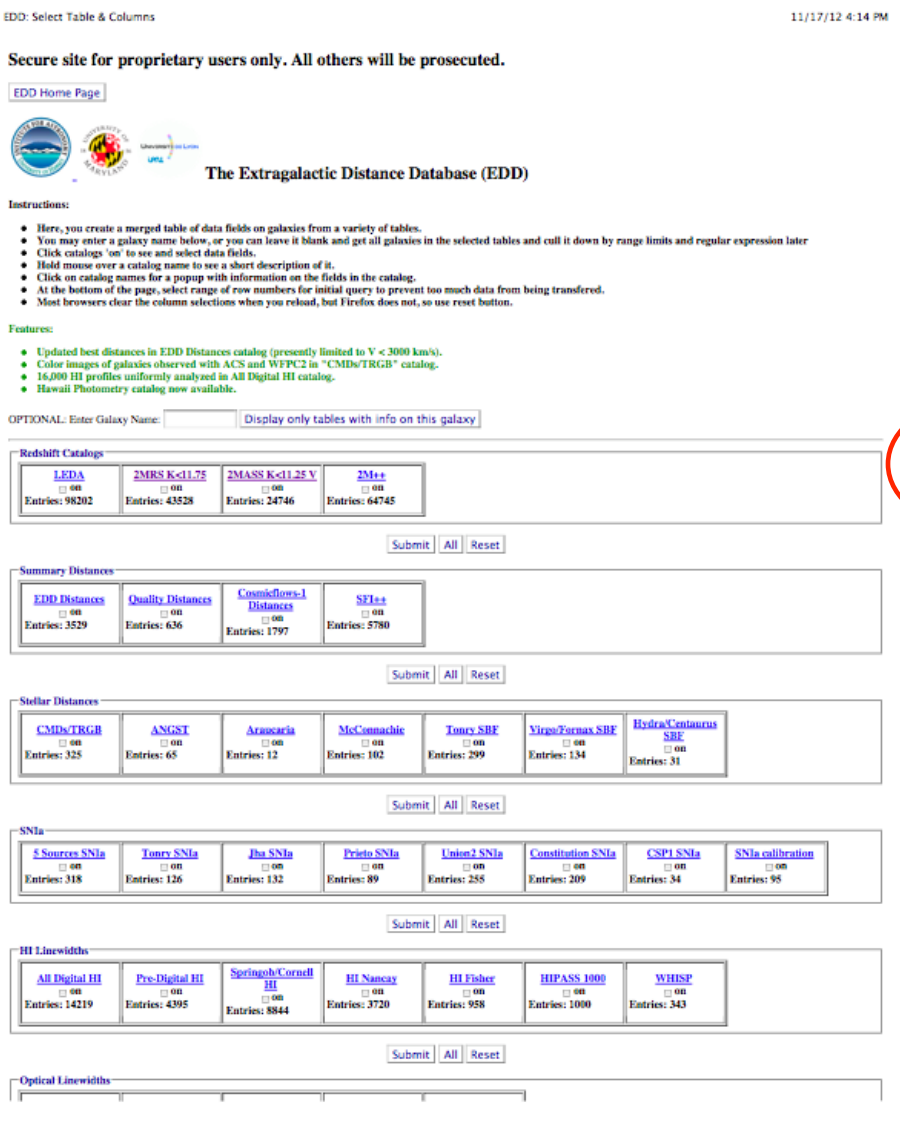
Ascii Profile

Select PGC 70

Profiles for 18,000 galaxies in EDD

Optical and IR Photometry

Extragalactic Distance Database



EDD: Select Table & Columns 11/17/12 4:14 PM

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EDD Home Page

The Extragalactic Distance Database (EDD)

Instructions:

- Here, you create a merged table of data fields on galaxies from a variety of tables.
- You may enter a galaxy name below, or you can leave it blank and get all galaxies in the selected tables and cull it down by range limits and regular expression later
- Click catalogs 'on' to see and select data fields.
- Hold mouse over a catalog name to see a short description of it.
- Click on catalog names for a popup with information on the fields in the catalog.
- At the bottom of the page, select range of row numbers for initial query to prevent too much data from being transfered.
- Most browsers clear the column selections when you reload, but Firefox does not, so use reset button.

Features:

- Updated best distances in EDD Distances catalog (presently limited to V < 3000 km/s).
- Color images of galaxies observed with ACS and WFPC2 in "CMDs/TRGB" catalog.
- 16,000 HI profiles uniformly analyzed in All Digital HI catalog.
- Hawaii Photometry catalog now available.

OPTIONAL: Enter Galaxy Name: Display only tables with info on this galaxy

Redshift Catalogs

LEDA	2MRS K<11.75	2MASS K<11.25 Y	2M++
on Entries: 98202	on Entries: 43528	on Entries: 24746	on Entries: 64745

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Summary Distances

EDD Distances	Quality Distances	Cosmicflows-1 Distances	SFI++
on Entries: 3529	on Entries: 636	on Entries: 1797	on Entries: 5780

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Stellar Distances

CMDs/TRGB	ANGST	Araucaria	McConnachie	Tonry SBF	Virgo/Fornax SBF	Hydra/Centaurus SBF
on Entries: 325	on Entries: 65	on Entries: 12	on Entries: 102	on Entries: 299	on Entries: 134	on Entries: 31

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SNIa

5 Sources SNIa	Tonry SNIa	Jha SNIa	Prieto SNIa	Union2 SNIa	Constitution SNIa	CSP1 SNIa	SNIa calibration
on Entries: 318	on Entries: 126	on Entries: 132	on Entries: 89	on Entries: 255	on Entries: 209	on Entries: 34	on Entries: 95

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HI Linewidths

All Digital HI	Pre-Digital HI	Springob/Cornell HI	HI Nancay	HI Fisher	HIPASS 1000	WHISP
on Entries: 14219	on Entries: 4395	on Entries: 8844	on Entries: 3720	on Entries: 958	on Entries: 1000	on Entries: 343

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Optical Linewidths

http://edd.ifa.hawaii.edu/secure/dfirst.php? Page 1 of 2

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Catinella/Cornell	Mathewson by Courteau	Dale by Courteau	Courteau by Courteau	Verheijen by Courteau
on Entries: 403	on Entries: 525	on Entries: 486	on Entries: 252	on Entries: 38

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Photometry

"Spitzer [3.6] Band Photometry".	Hawaii Photometry	Homogenized Photometry	SDSS Hall	2MASS Large Galaxy Atlas	Cosmic Flows Spitzer	Spitzer SINGS	Carnegie Hubble Program
on Entries: 232	on Entries: 524	on Entries: 5864	on Entries: 3039	on Entries: 617	on Entries: 1272	on Entries: 75	on Entries: 480
S4G	Aaronson H	Bernstein Coma	Bothun	Bureau Fornax	Courteau	Mathewson revised by Courteau	Mathewson
on Entries: 2331	on Entries: 204	on Entries: 32	on Entries: 38	on Entries: 22	on Entries: 304	on Entries: 957	on Entries: 2443
Dell'Antonio	Heraudeau	Dale SCII	Giovanelli SCI	Haynes SFI/SCI	Han Cluster	Han Perseus Pisces	Lu Virgo/AntiVirgo
on Entries: 241	on Entries: 234	on Entries: 520	on Entries: 782	on Entries: 1727	on Entries: 284	on Entries: 59	on Entries: 303
McDonald Virgo	Mould Clusters	Pierce Field	Roth IRAS selected	Schommer Clusters	Verheijen UMa	Willick Clusters	Willick Perseus Pisces
on Entries: 286	on Entries: 171	on Entries: 715	on Entries: 156	on Entries: 32	on Entries: 78	on Entries: 156	on Entries: 381

Submit All Reset

Fundamental Plane

Blakeslee SMAC FP + SBF	Hudson SMAC FP	FP : SMAC3	FP: EFAR	FP: ENEARc
on Entries: 164	on Entries: 56	on Entries: 698	on Entries: 788	on Entries: 452

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Supplementary Catalogs

Replenished Catalog of Nearby Galaxies	Neighboring Galaxies	2MRS Augmented	MAK Vpec	V 8k	Tully 3000	Virgo Cluster Catalog	Saunders PSCz
on Entries: 826	on Entries: 451	on Entries: 28573	on Entries: 21295	on Entries: 30124	on Entries: 3497	on Entries: 2094	on Entries: 1690
V3k MK<-21	Karachentsev Revised Flat Galaxy Catalog	Karachentsev RFGC 2MASS peculiar velocities	Karachentsev RFGC peculiar velocities	Parnovsky RFGC peculiar velocities	MK Groups	TF Calibrators	
on Entries: 1228	on Entries: 4444	on Entries: 1222	on Entries: 1327	on Entries: 1623	on Entries: 11056	on Entries: 416	

Submit All Reset

Choose rows to display initially: 1 (start) 200 (end)

Curators: E. Shaya, R. Brent Tully, Luca Rizzi, Dmitry Makarov, Lidia Makarova, Helene Courtois, Brad Jacobs, Matt Zagursky

The Extragalactic Distance Database: Display Request

Spitzer 3.6μm Photometry

Hide Control Panel

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"Spitzer [3.6] Band Photometry",

PGC	PGC no	P	Name/Photom	Date	Exp	a26.5	m_26.5	m_tot	e_m	m_ext	SB0	alpha	b/a	e_b/a	PA
Min	Min	Min	String	String	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min
Max	Max	Max	Sort	Sort	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Sort	Sort	Sort	show / hide	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort
show / hide	show / hide	show / hide		show / hide	show / hide	show / hide	show / hide	show / hide	show / hide	show / hide	show / hide	show / hide	show / hide	show / hide	show / hide

"Spitzer [3.6] Band Photom

PGC	P	Name/Photom	Date	Exp	a26.5	m_26.5	m_tot	e_m	m_ext	SB0	alpha	b/a	e_b/a	PA	a
			ymdhm	sec	arcsec	mag	mag	mag	mag	mag/as^2	arcsec			deg	ar
3664	1	UGC00633	2009.10.03T11:59:01.257	240.0	60	13.41	13.408	0.002	13.398	18.78	8.5	0.28	0.01	11	
3773	1	UGC00646	2009.10.03T12:14:19.244	240.0	76	12.92	12.925	0.007	12.902	19.56	11.9	0.39	0.01	103	
3866	1	UGC00669	2009.10.03T12:06:41.241	240.0	78	13.32	13.306	0.004	13.316	18.41	10.5	0.23	0.00	124	
3950	1	UGC00679	2009.10.03T12:21:58.033	240.0	56	15.76	15.726	0.005	15.724	20.77	10.7	0.23	0.00	99	
4210	1	UGC00732	2009.10.03T11:27:55.283	240.0	58	13.45	13.445	0.005	13.436	19.61	9.1	0.58	0.01	79	
4561	1	NGC0444	2009.10.03T11:11:42.894	240.0	75	14.00	13.998	0.003	13.986	19.75	12.1	0.26	0.01	161	
4596	1	NGC0452	2009.10.03T11:04:17.699	240.0	107	11.95	11.948	0.008	11.941	19.56	16.7	0.45	0.04	34	
4715	1	UGC00841	2009.10.03T10:56:17.704	240.0	68	13.99	14.002	0.003	13.984	19.35	10.4	0.25	0.00	54	
5061	1	NGC0496	2009.10.03T10:41:08.119	240.0	61	13.11	13.100	0.002	13.101	19.30	9.1	0.65	0.03	29	
5132	1	NGC0512	2009.10.03T10:33:38.526	240.0	77	12.29	12.299	0.003	12.288	17.44	9.2	0.27	0.01	114	
5284	1	UGC00987	2009.10.04T09:31:21.676	240.0	77	12.45	12.447	0.003	12.442	19.16	11.3	0.41	0.00	29	
5341	1	PGC005341	2009.08.29T23:18:31.199	120.0	108	12.87	12.862	0.002	12.863	19.03	15.7	0.20	0.01	22	
5344	1	NGC0536	2009.10.04T18:13:25.066	240.0	113	11.67	11.662	0.007	11.652	19.61	17.8	0.56	0.00	68	
6502	1	NGC0668	2009.10.03T10:17:09.738	240.0	67	12.58	12.572	0.006	12.567	19.67	10.6	0.71	0.02	28	
6607	1	UGC01257	2009.10.03T10:09:38.156	240.0	46	13.75	13.767	0.009	13.739	19.76	7.3	0.53	0.02	107	
6624	1	NGC0673	2009.08.29T15:33:50.353	120.0	91	12.04	12.027	0.003	12.031	18.82	12.9	0.56	0.03	16	
6799	1	NGC0688	2009.10.04T19:05:23.417	240.0	80	12.37	12.360	0.007	12.342	20.25	13.8	0.77	0.00	146	
6851	1	UGC01316	2009.10.04T17:57:20.688	240.0	30	15.63	15.628	0.005	15.604	20.41	5.4	0.47	0.02	177	
6865	1	UGC01319	2009.10.04T06:08:08.222	240.0	42	13.12	13.116	0.013	13.115	18.54	5.7	0.82	0.06	164	
7066	1	UGC01366	2009.10.04T06:00:32.223	240.0	79	12.85	12.847	0.006	12.839	18.65	10.9	0.32	0.02	138	
7387	1	NGC0753	2009.10.04T05:45:24.243	240.0	99	11.62	11.611	0.004	11.605	19.56	15.5	0.77	0.02	132	
7504	1	UGC01459	2009.10.04T03:37:16.339	240.0	180	13.11	13.067	0.026	13.103	19.00	26.0	0.17	0.01	107	
9332	1	NGC0925	2004.08.14T06:43:13.827	120.0	309	10.82	10.791	0.005	10.796	20.09	52.4	0.34	0.02	107	
9560	1	NGC0958	2009.10.07T15:36:31.447	240.0	97	11.13	11.130	0.002	11.126	17.55	11.7	0.36	0.05	11	

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The Extragalactic Distance Database: Display Request

Spitzer 3.6μm Photometry

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"Spitzer [3.6] Band Photometry",

PGC / PGC no	P	Name/Photom	Date	Exp	a26.5	m_26.5	m_tot	e_m	m_ext	SB0	alpha	b/a	e_b/a	PA
Min	Min	String	String	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min
Max	Max	Sort	Sort	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Sort	Sort			Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort
show hide	show hide	show hide	show hide	show hide	show hide	show hide	show hide	show hide	show hide	show hide	show hide	show hide	show hide	show hide

"Spitzer [3.6] Band Photom

PGC	P	Name/Photom	Date	Exp	a26.5	m_26.5	m_tot	e_m	m_ext	SB0	alpha	b/a	e_b/a	PA	a
			ymdhm	sec	arcsec	mag	mag	mag	mag	mag/as^2	arcsec			deg	ar
3664	1	UGC00633	2009.10.03T11:59:01.257	240.0	60	13.41	13.408	0.002	13.398	18.78	8.5	0.28	0.01	11	
3773	1	UGC00646	2009.10.03T12:14:19.244	240.0	76	12.92	12.925	0.007	12.902	19.56	11.9	0.39	0.01	103	
3866	1	UGC00669	2009.10.03T12:06:41.241	240.0	78	13.32	13.306	0.004	13.316	18.41	10.5	0.23	0.00	124	
3950	1	UGC00679	2009.10.03T12:21:58.033	240.0	56	15.76	15.726	0.005	15.724	20.77	10.7	0.23	0.00	99	
4210	1	UGC00732	2009.10.03T11:27:55.283	240.0	58	13.45	13.445	0.005	13.436	19.61	9.1	0.58	0.01	79	
4561	1	NGC0444	2009.10.03T11:11:42.894	240.0	75	14.00	13.998	0.003	13.986	19.75	12.1	0.26	0.01	161	
4596	1	NGC0452	2009.10.03T11:04:17.699	240.0	107	11.95	11.948	0.008	11.941	19.56	16.7	0.45	0.04	34	
4715	1	UGC00841	2009.10.03T10:56:17.704	240.0	68	13.99	14.002	0.003	13.984	19.35	10.4	0.25	0.00	54	
5061	1	NGC0496	2009.10.03T10:41:08.119	240.0	61	13.11	13.100	0.002	13.101	19.30	9.1	0.65	0.03	29	
5132	1	NGC0512	2009.10.03T10:33:38.526	240.0	77	12.29	12.299	0.003	12.288	17.44	9.2	0.27	0.01	114	
5284	1	UGC00987	2009.10.04T09:31:21.676	240.0	77	12.45	12.447	0.003	12.442	19.16	11.3	0.41	0.00	29	
5341	1	PGC005341	2009.08.29T23:18:31.199	120.0	108	12.87	12.862	0.002	12.863	19.03	15.7	0.20	0.01	22	
5344	1	NGC0536	2009.10.04T18:13:25.066	240.0	113	11.67	11.662	0.007	11.652	19.61	17.8	0.56	0.00	68	
6502	1	NGC0668	2009.10.03T10:17:09.738	240.0	67	12.58	12.572	0.006	12.567	19.67	10.6	0.71	0.02	28	
6607	1	UGC01257	2009.10.03T10:09:38.156	240.0	46	13.75	13.767	0.009	13.739	19.76	7.3	0.53	0.02	107	
6624	1	NGC0673	2009.08.29T15:33:50.353	120.0	91	12.04	12.027	0.003	12.031	18.82	12.9	0.56	0.03	16	
6799	1	NGC0688	2009.10.04T19:05:23.417	240.0	80	12.37	12.360	0.007	12.342	20.25	13.8	0.77	0.00	146	
6851	1	UGC01316	2009.10.04T17:57:20.688	240.0	30	15.63	15.628	0.005	15.604	20.41	5.4	0.47	0.02	177	
6865	1	UGC01319	2009.10.04T06:08:08.222	240.0	42	13.12	13.116	0.013	13.115	18.54	5.7	0.82	0.06	164	
7066	1	UGC01366	2009.10.04T06:00:32.223	240.0	79	12.85	12.847	0.006	12.839	18.65	10.9	0.32	0.02	138	
7387	1	NGC0753	2009.10.04T05:45:24.243	240.0	99	11.62	11.611	0.004	11.605	19.56	15.5	0.77	0.02	132	
7504	1	UGC01455	2009.10.04T03:37:16.339	240.0	180	13.11	13.067	0.026	13.103	19.00	26.0	0.17	0.01	107	
933	1	NGC0925	2004.08.14T06:43:13.827	120.0	309	10.82	10.791	0.005	10.796	20.09	52.4	0.34	0.02	107	
9560	1	NGC0958	2009.10.07T15:36:31.447	240.0	97	11.13	11.130	0.002	11.126	17.55	11.7	0.36	0.05	11	

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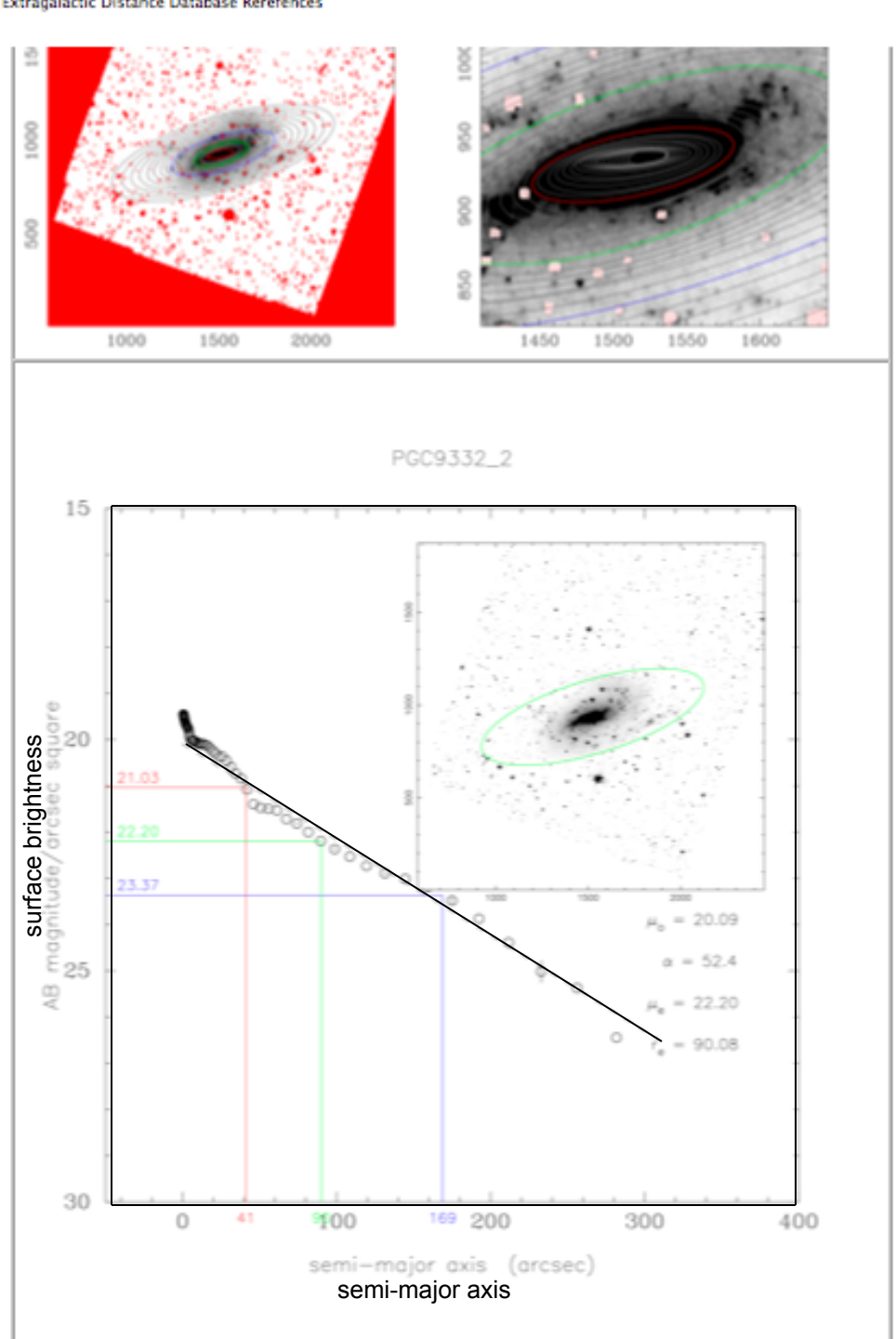
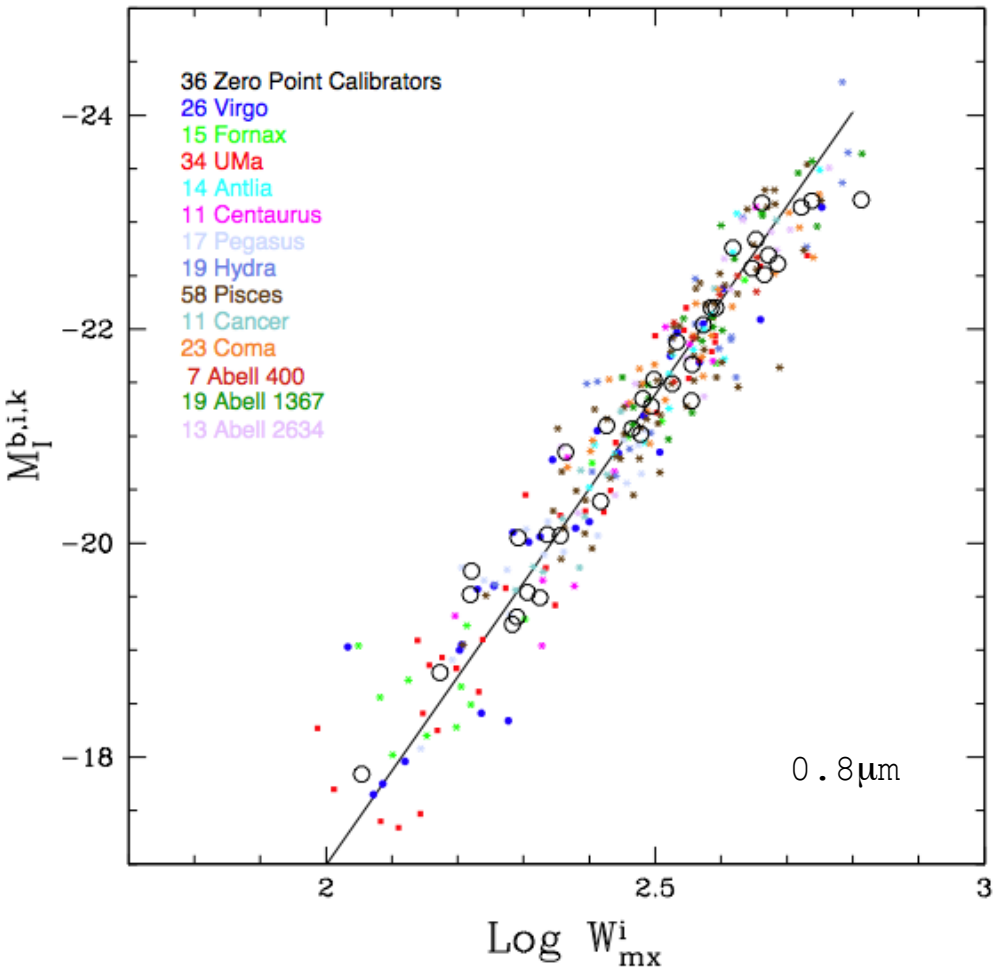
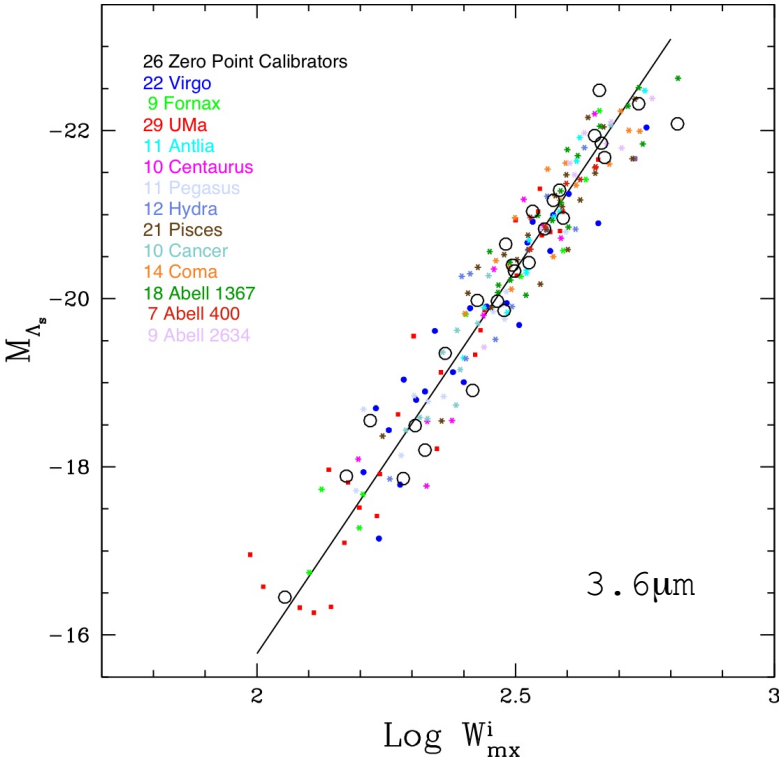
Spitzer photometry magnitudes for 4000 galaxies in EDD
- WISE magnitudes for all possible candidates



CF2: I & [3.6] band Luminosity - HI Linewidth Calibration

Tully & Courtois 2012, ApJ, 749: 78 (I band)

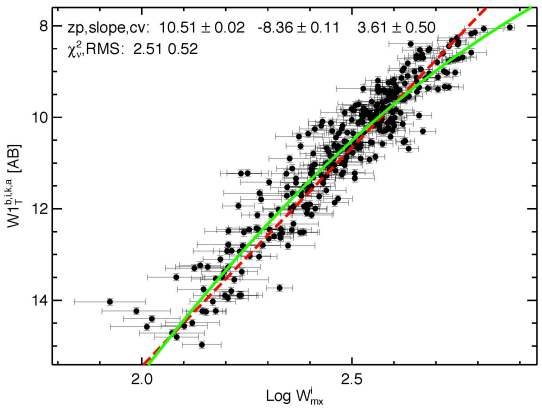


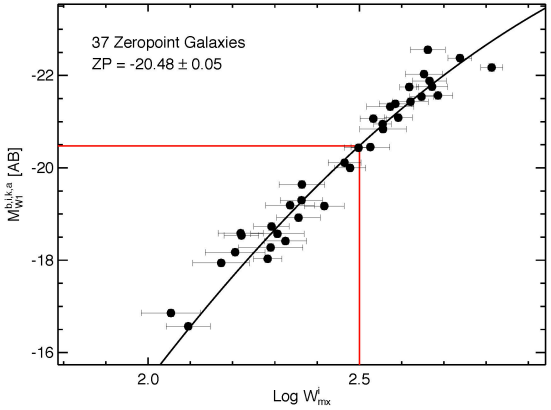


Sorce et al. 2013, ApJ, 765: 94 (Spitzer mid-IR)

Cosmicflows-3

curvature in mid-IR luminosity-linewidth correlation





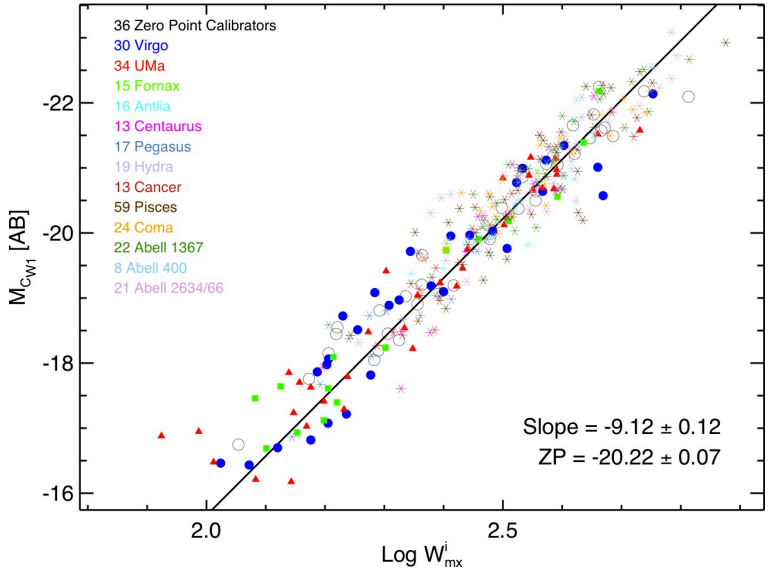
Anticipate sample of ~10,000 galaxies

Spitzer [3.6] photometry for 2300 galaxies
Sorce et al. 2014, MNRAS, 444, 527

WISE W1 and W2 photometry calibration
Neill et al. 2014, ApJ, 792, 129

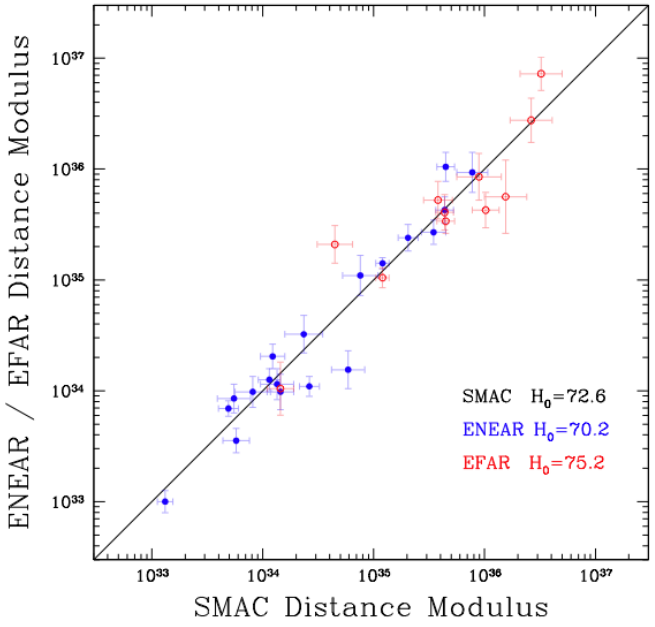
PanSTARRS g,r,i,z photometry
Zagursky et al. 2015??

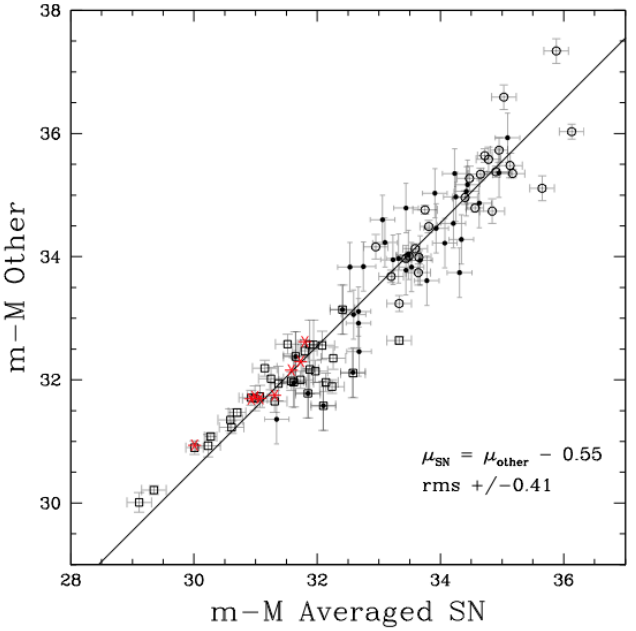
WISE 3.4 micron – color corrected



CF2: SNIa Calibration and H_0

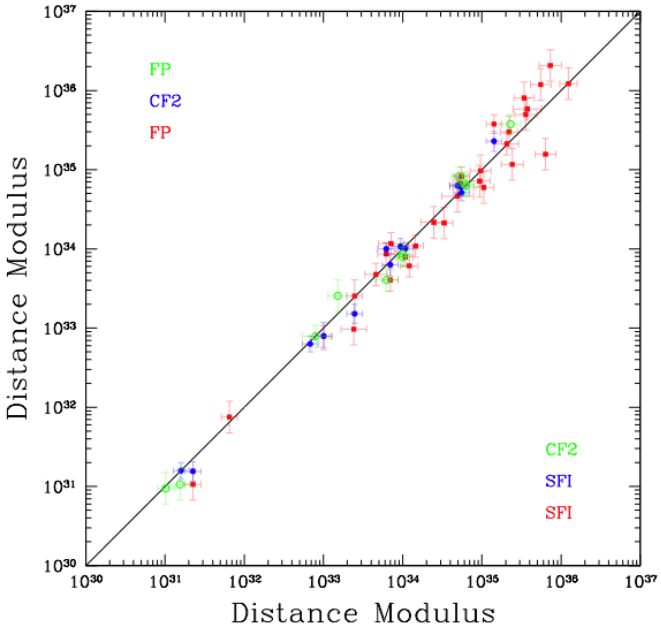
combine 3 FP sources





Cepheid, SBF, TF, FP set SNIa scale with I-band CF2 zero point

combine 2 TF and 3 FP with I-band CF2 zero point



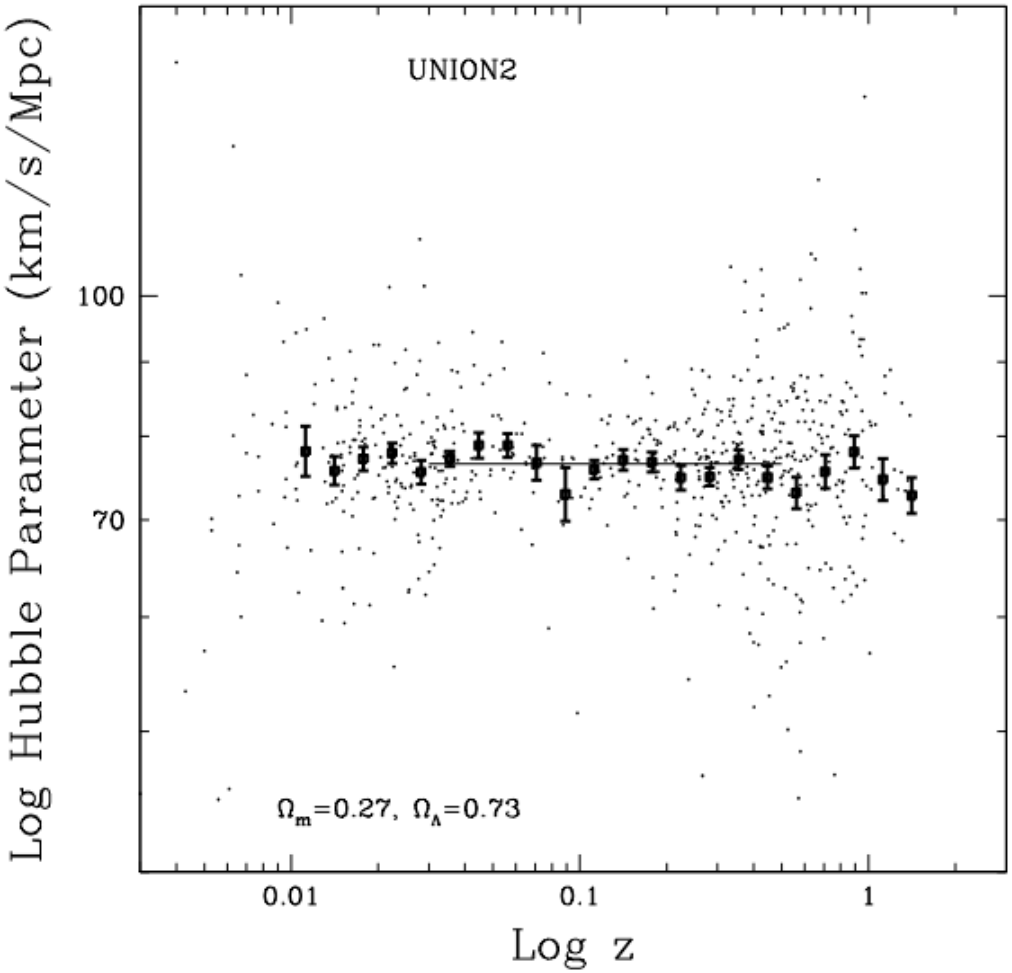
CF2: SNIa calibration and H_0
(continued)

UNION2 SNIa sample shifted to [3.6]-band CF2 zero point. Fit over interval 0.03 < z < 0.5

H_0 = 75.2 +-3.0 km/s/Mpc

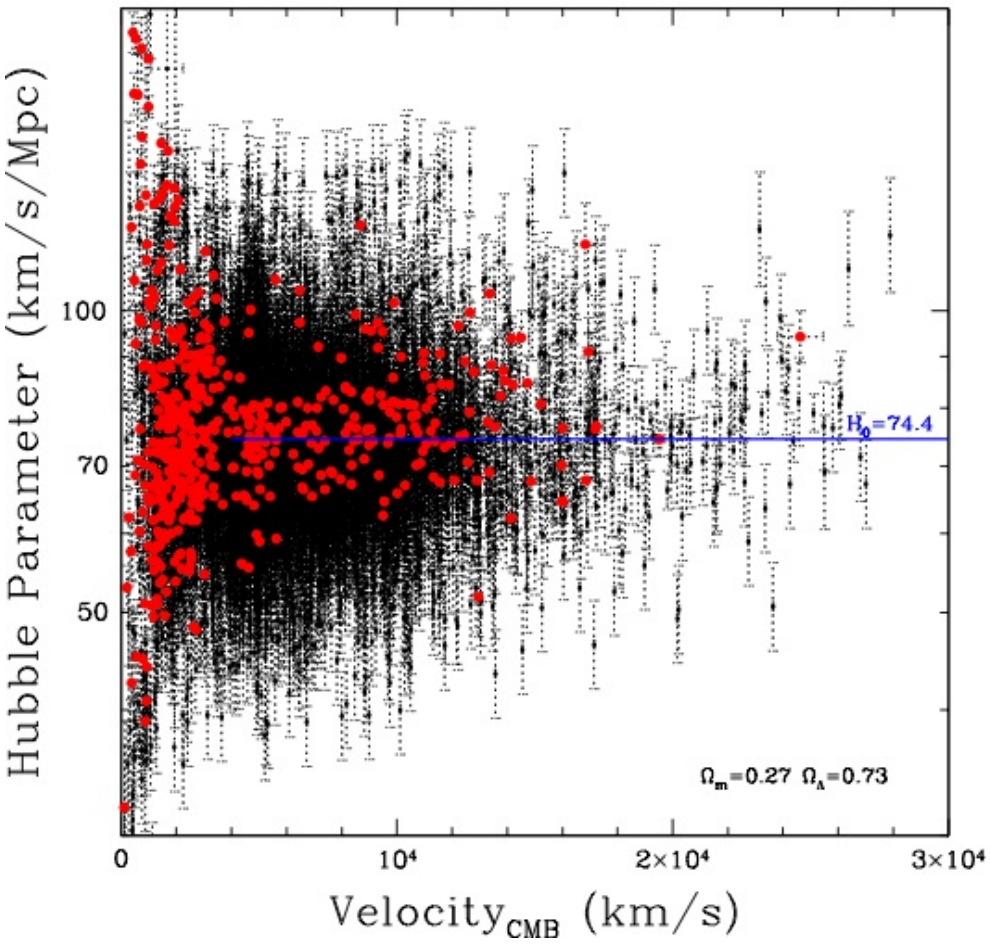
WISE recalibration (2014):
H_0 = 74.4 +-2.8 km/s/Mpc

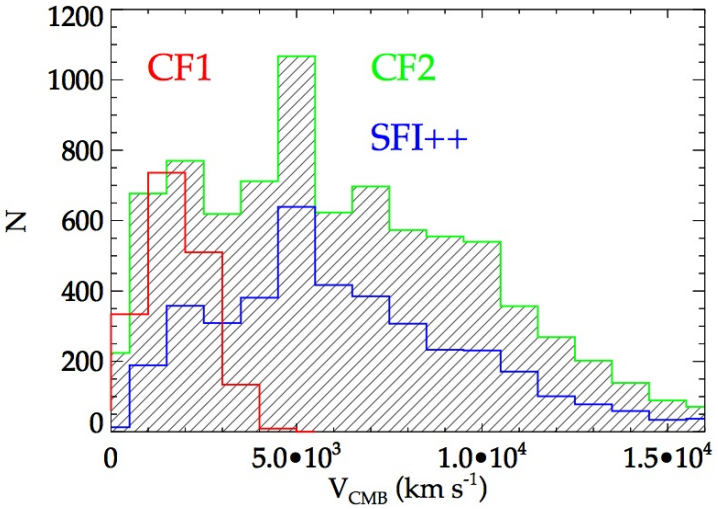
I -> [3.6] lowers H_0 2%
LMC revision raises H_0 1%

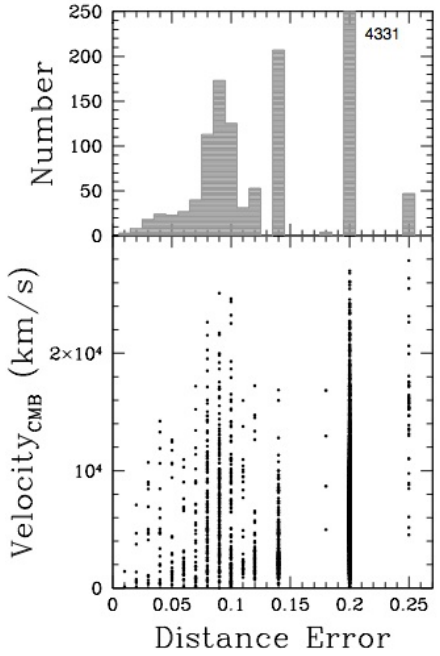


Courtois & Tully 2012, ApJ, 749, 174
Sorce, Tully, Courtois 2012, ApJL, 758, L12
Neill, Seibert, Tully et al., 2014, ApJ, 792, 129

Cosmicflows-2 Ensemble





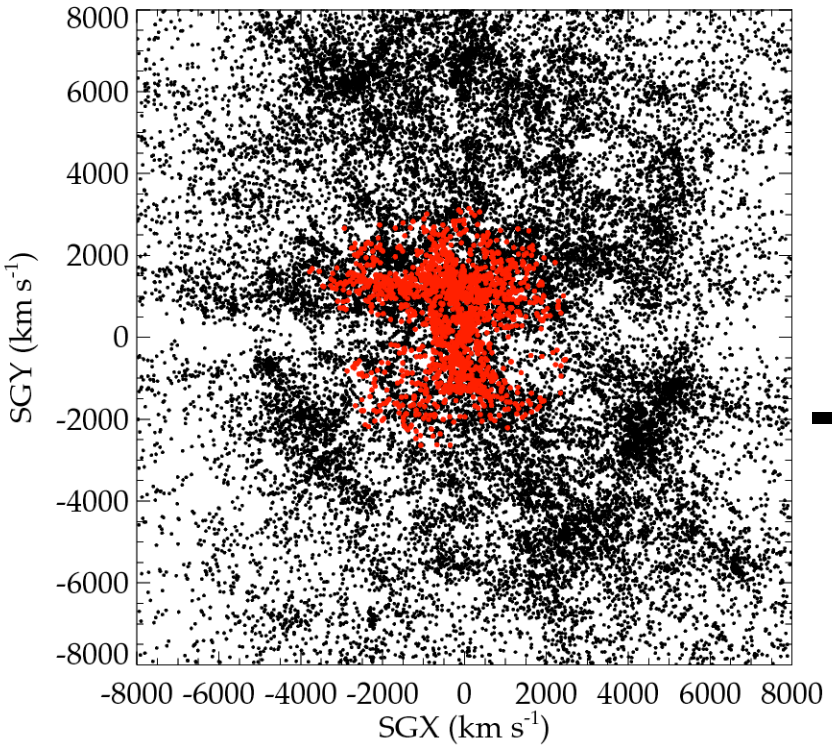


534 groups + 4691 individuals = 5225 entities

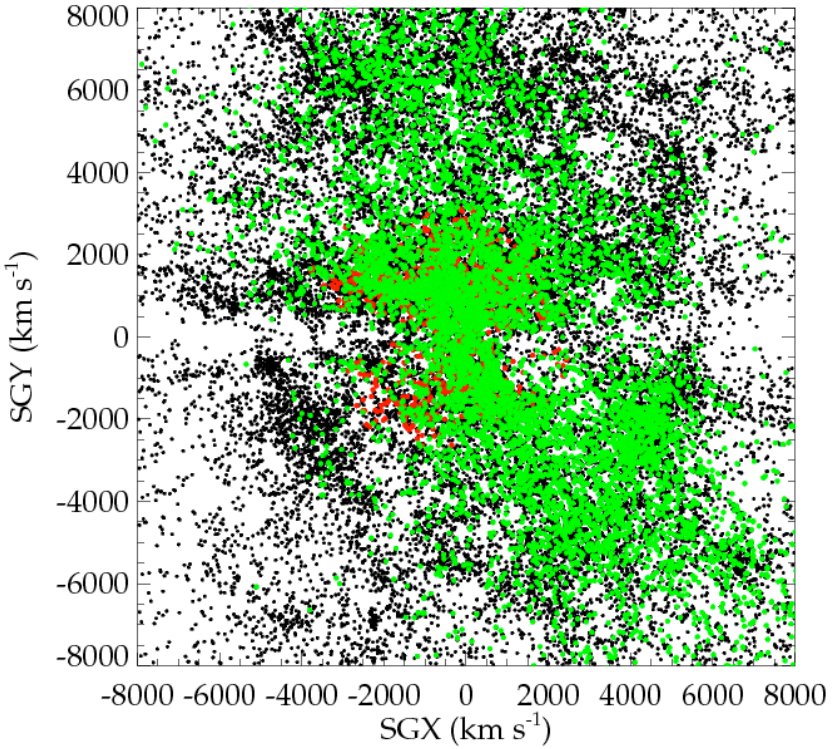
Cosmicflows-1 => Cosmicflows-2

CF1: 1800 galaxies
V < 3,000 km/s

CF2: 8000 galaxies
V < 30,000 km/s



2008



2013

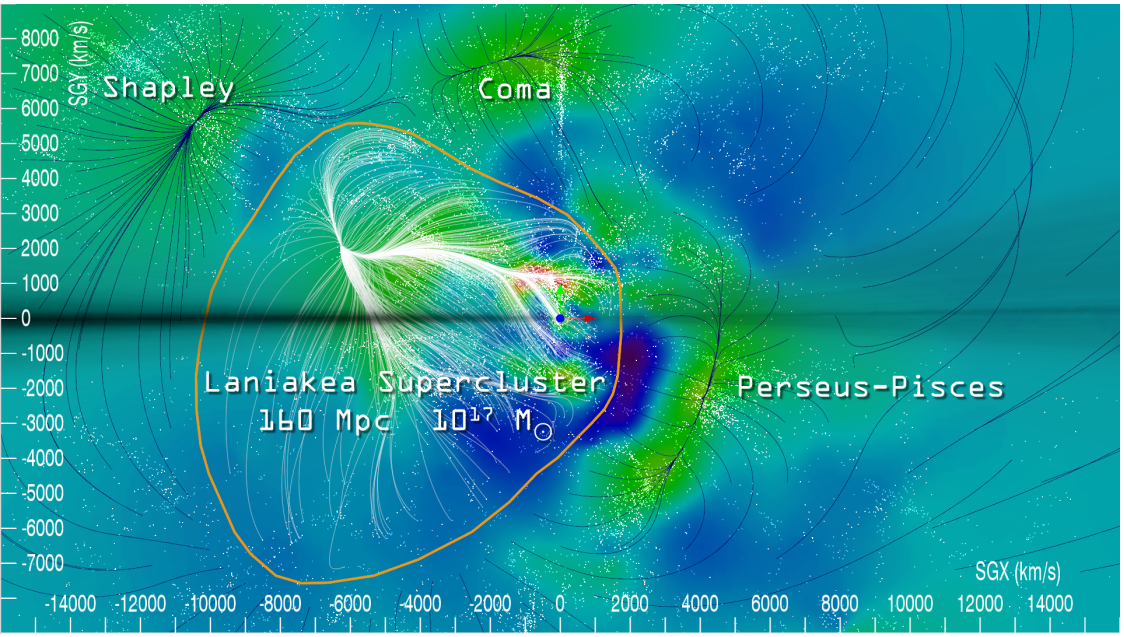
Wiener Filter with Constrained Realizations

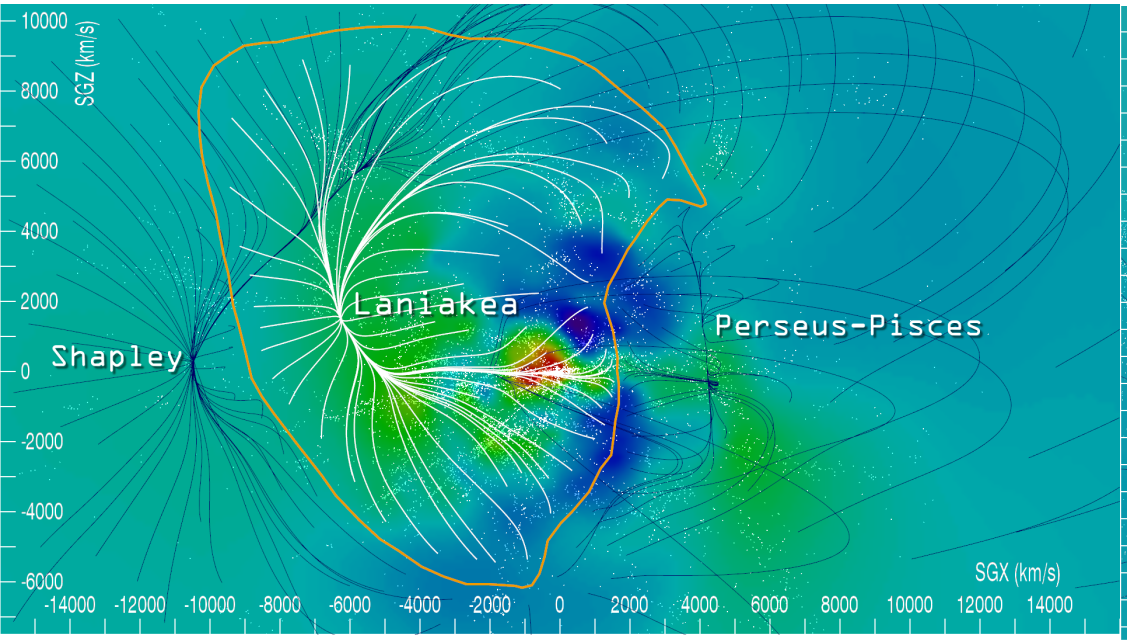
- Estimate Bayesian probability that data fits prior model that structure emerged from initial Gaussian fluctuations.
- Model assumes ΛCDM WMAP power spectrum.
- Wiener filter schematic: $P_k/(P_k+\sigma^2)$ where P_k is power spectrum and σ is error => data dominates estimator if errors are small but filter attenuates to zero if errors dominate.
- Constrained realization: sample variation of actual field by drawing from Gaussian field consistent with power spectrum => in regions dominated by good quality data CR are dominated by data but in regions of poor data the realizations reflect random sampling.
- CR's sample the statistical scatter about mean WF field.

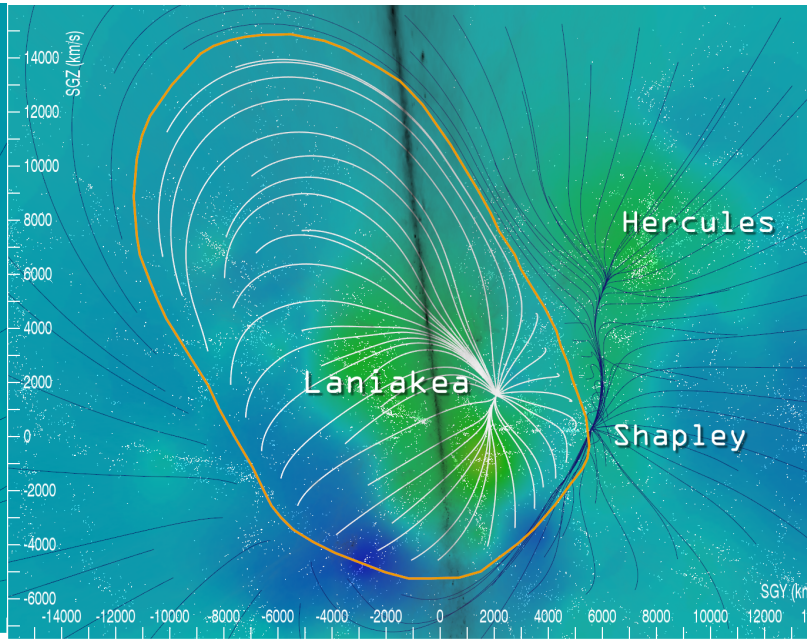
Laniakea Supercluster

supercluster: a bounded region of infall toward a local basin of attraction

lani – sky, heaven
akea – broad, wide, spacious, immeasurable



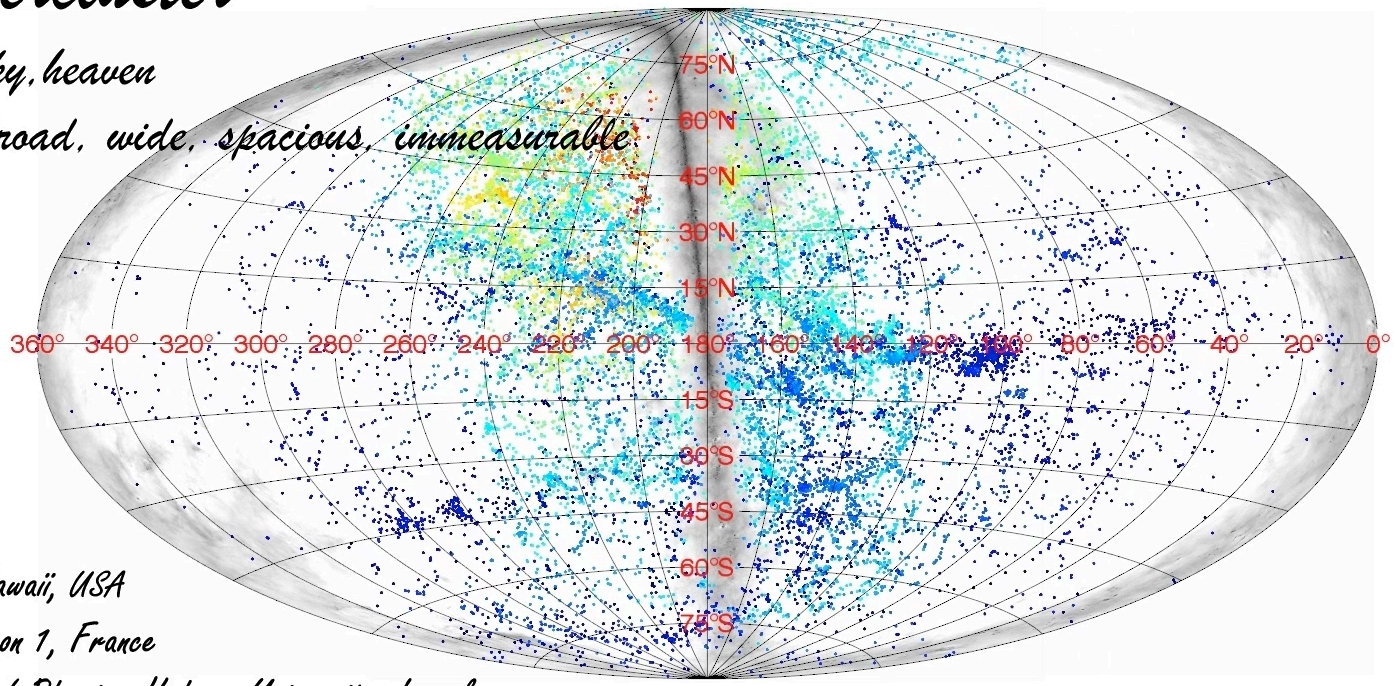




Laniakea Supercluster

In Hawaiian: lani – sky, heaven

akea – broad, wide, spacious, immeasurable



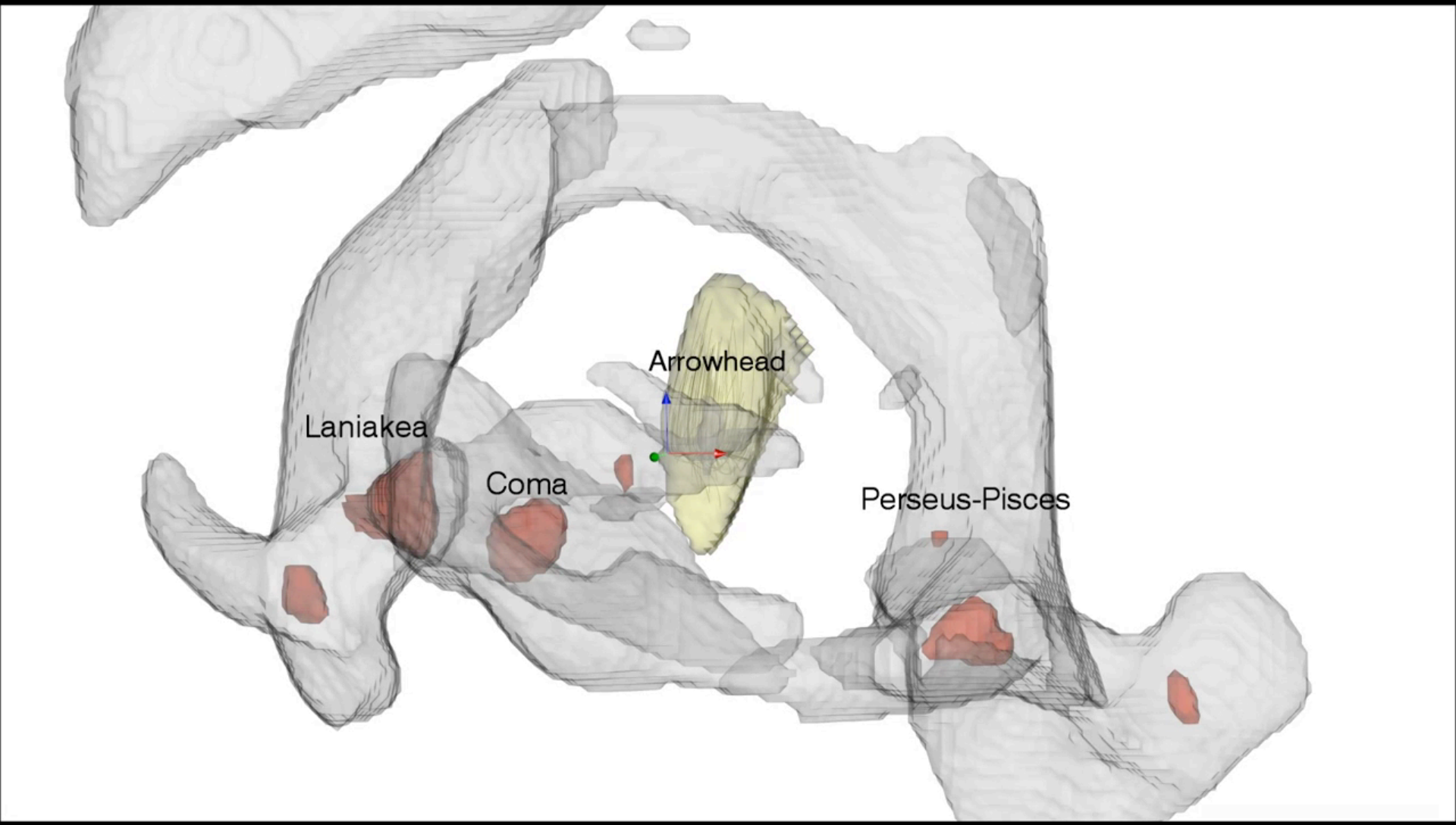
R. Brent Tully, University of Hawaii, USA

Hélène Courtois, University of Lyon 1, France

Yehuda Hoffman, Racah Institute of Physics, Hebrew University, Israel

Daniel Pomarède, Institute of Research into the Fondamental Laws of the Universe, Saclay, France

Let's embark on the discovery of our home supercluster: Laniakea.


Arrowhead
Laniakea
Coma
Perseus-Pisces