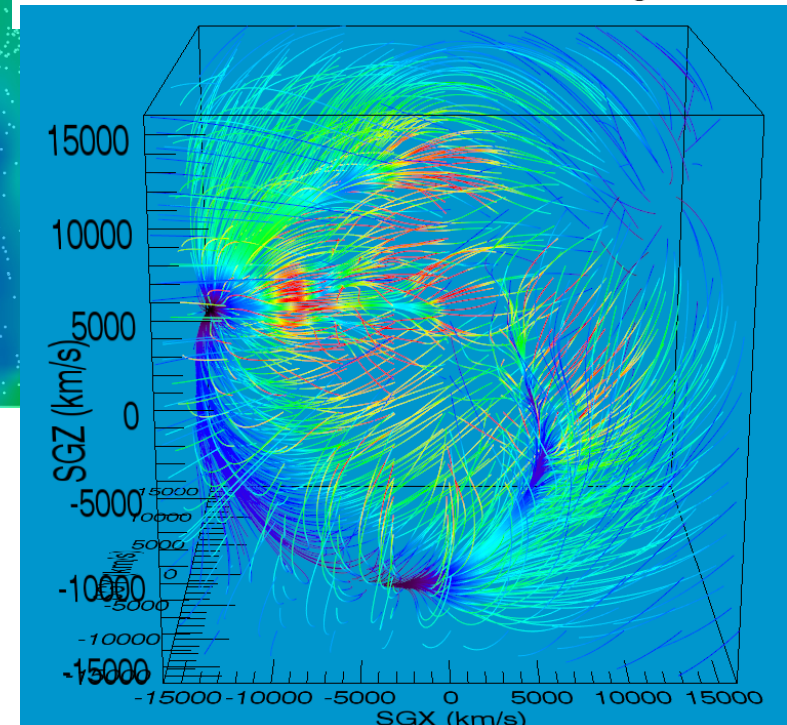
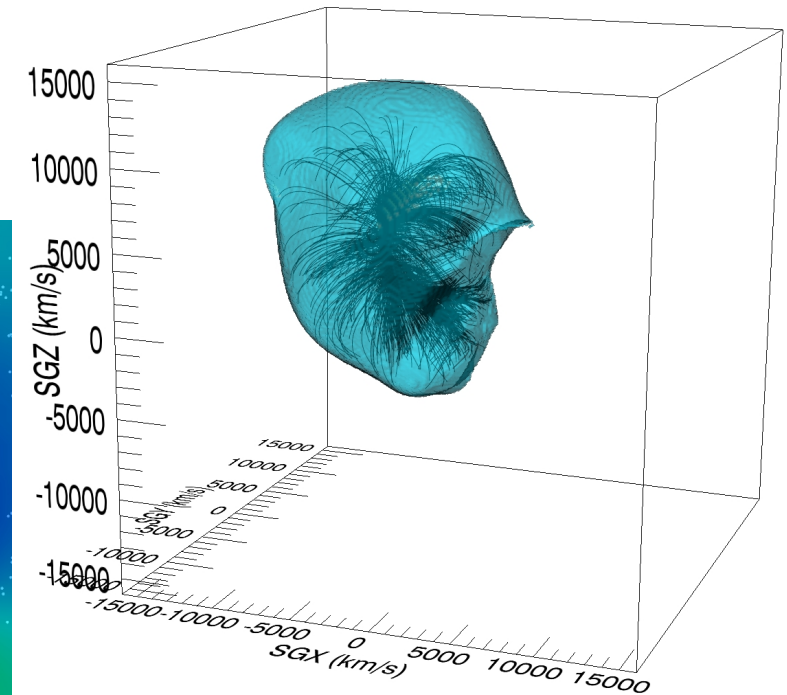
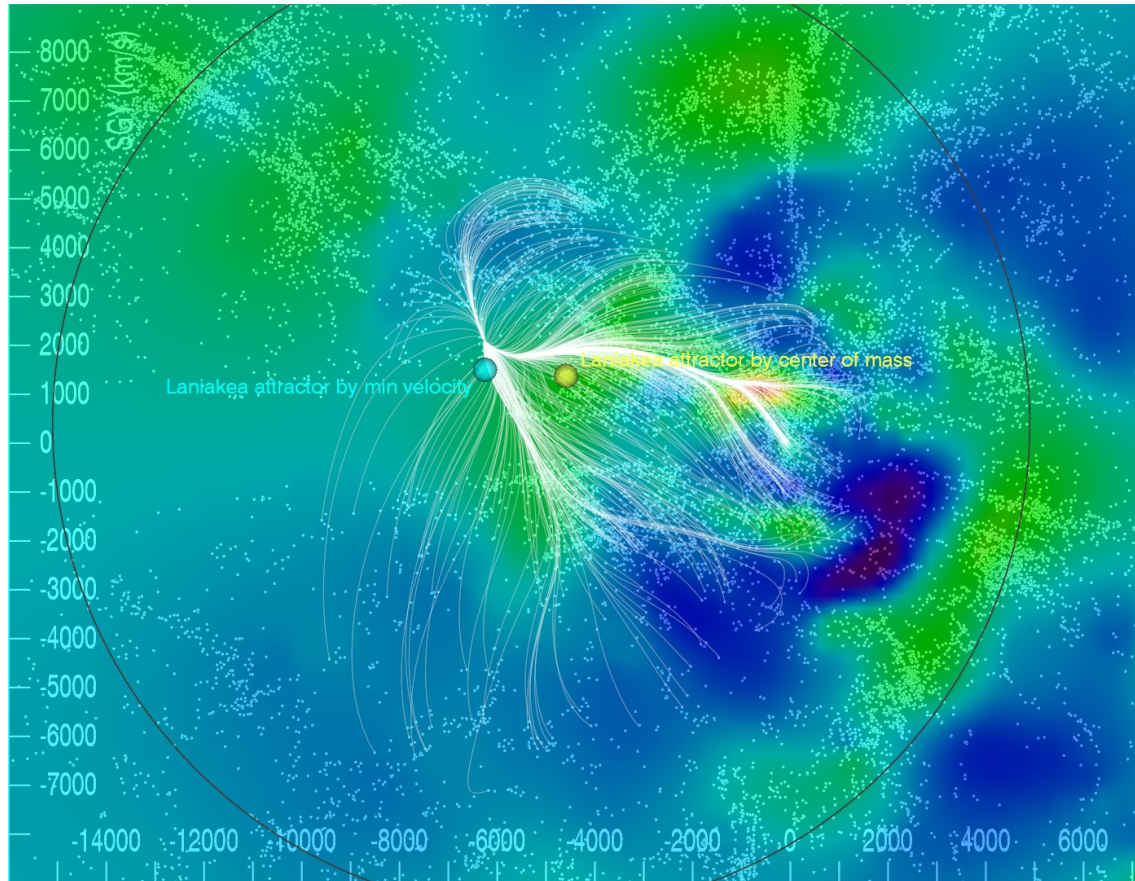


Cosmicflows-2



Brent Tully

with

Helene Courtois, Yehuda Hoffman, Daniel Pomarede, & Ed Shaya

Most important result from Cosmicflows-1

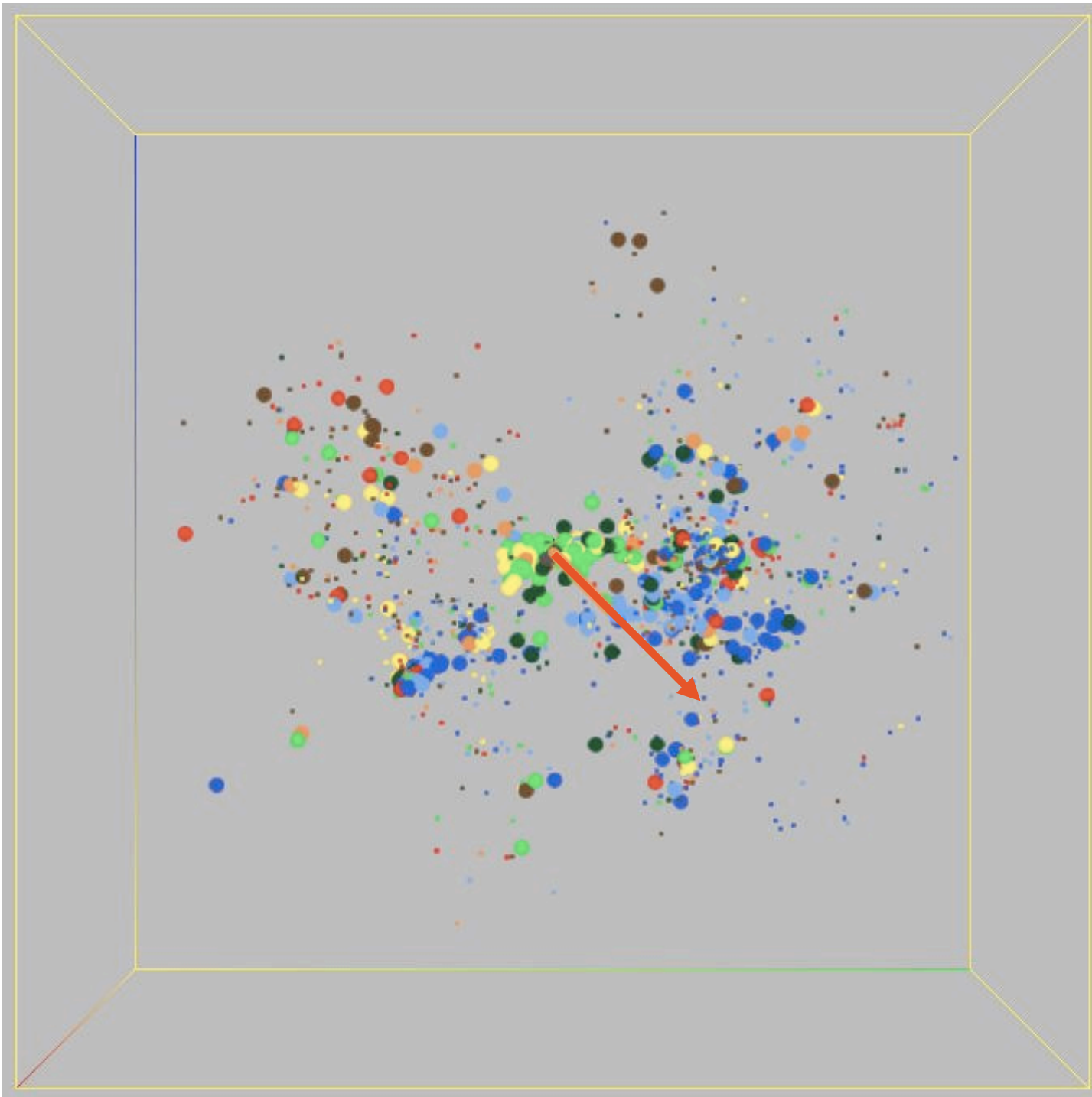
BT, Shaya, Karachentsev, Courtois
Kocevski, Rizzi, Peel [2008, ApJ,
676, 184]

The MW has a motion of 323
km/s w.r.t. 1800 galaxies
with measured distances
within 3000 km/s

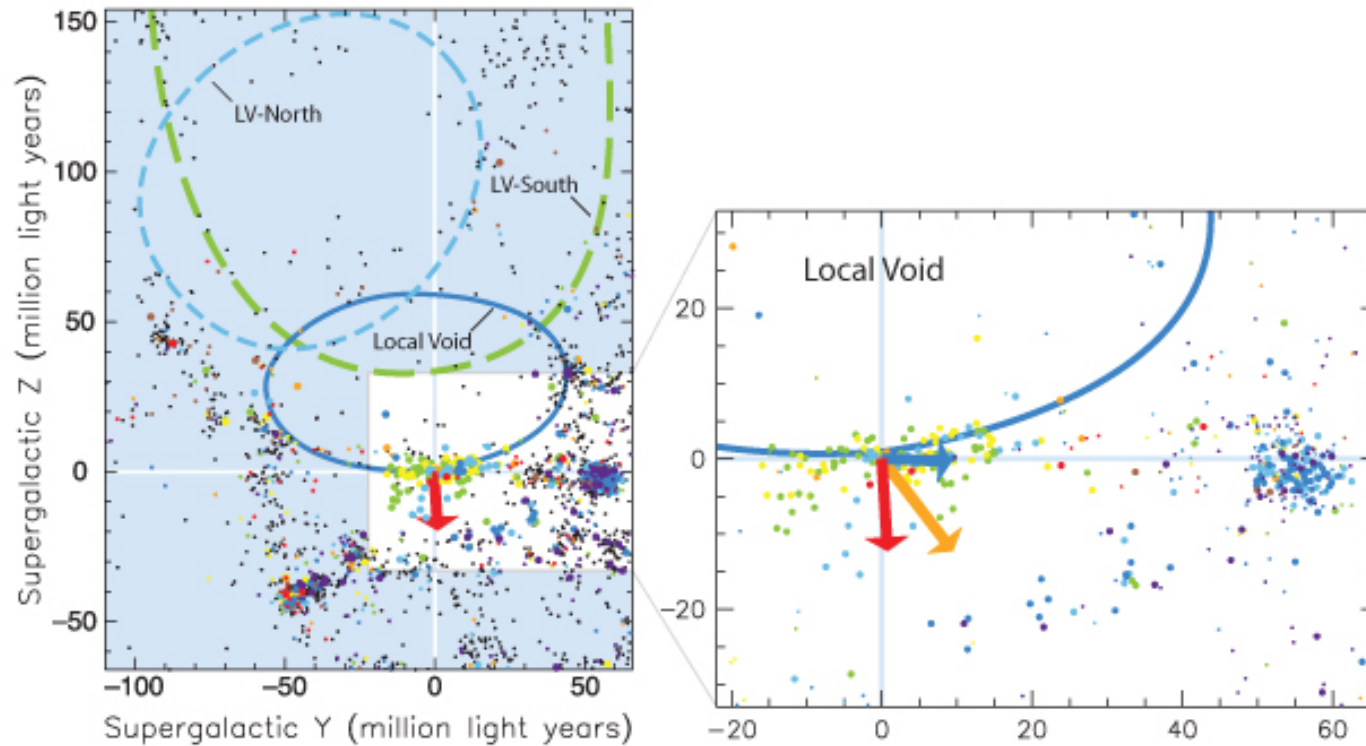
green/yellow $V_{\text{pec}} \sim 0$

red $V_{\text{pec}} > +100$

blue $V_{\text{pec}} < -100$



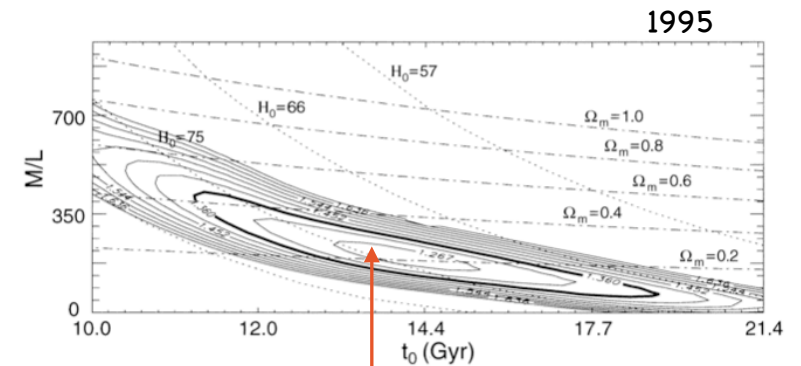
the local volume



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

Ed Shaya, Jim Peebles, Stephen Phelps

Flow out of Local Void

 $\Omega_m = 0.2$

Cosmic Flows Program

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

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

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	SN Ia: Type Ia Supernova
	1508	FP: Fundamental Plane
	5998	TF: Luminosity-Linewidth

8315 distance measures within 30,000 km/s

Components of the Program

1. Extragalactic Distance Database
2. Tip of the Red Giant Branch distances
3. Luminosity-Linewidth (TF) distances
 - HI profiles
 - photometry
4. Cosmicflows-2 distance compilation
5. Modeling

Secure site for proprietary users only. All others will be prosecuted.

[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 transferred.
- 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 ☐ on Entries: 98202	2MRS K<11.75 ☐ on Entries: 43528	2MASS K<11.25 V ☐ on Entries: 24746	2M++ ☐ on Entries: 64745

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

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

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SNIa						
5 Sources SNIa ☐ on Entries: 318	Tonry SNIa ☐ on Entries: 126	Iba SNIa ☐ on Entries: 132	Prieto SNIa ☐ on Entries: 89	Union2 SNIa ☐ on Entries: 255	Constitution SNIa ☐ on Entries: 209	CSPL SNIa ☐ on Entries: 34

[SNIa calibration](#)
☐ on
Entries: 95

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

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Optical Linewidths						
☐ on	☐ on	☐ on	☐ on	☐ on	☐ on	☐ on

<http://edd.ifa.hawaii.edu/secure/dfirst.php?>

Page 1 of 2

Extragalactic Distance Database

<http://edd.ifa.hawaii.edu>

EDD: Select Table & Columns

11/17/12 4:21 PM

Catinella/Cornell ☐ on Entries: 403	Mathewson by Courteau ☐ on Entries: 525	Dale by Courteau ☐ on Entries: 486	Courteau by Courteau ☐ on Entries: 252	Verheijen by Courteau ☐ on Entries: 38
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Photometry							
"Spitzer 3.61 Band Photometry" ☐ on Entries: 232	Hawaii Photometry ☐ on Entries: 524	Homogenized Photometry ☐ on Entries: 5864	SDSS H₈₁ ☐ on Entries: 3039	2MASS Large Galaxy Atlas ☐ on Entries: 617	Cosmicflows Spitzer ☐ on Entries: 1272	Spitzer SINGS ☐ on Entries: 75	Carnegie Hubble Program ☐ on Entries: 480
S4G ☐ on Entries: 2331	Aaronson H ☐ on Entries: 204	Bernstein Coma ☐ on Entries: 32	Bothun ☐ on Entries: 38	Burton Fornax ☐ on Entries: 22	Courteau ☐ on Entries: 304	Mathewson revised by Courteau ☐ on Entries: 957	Mathewson ☐ on Entries: 2443
DeL'Antonio ☐ on Entries: 241	Heraudeau ☐ on Entries: 234	Dale SCI ☐ on Entries: 520	Giovanelli SCI ☐ on Entries: 782	Haynes SFI/SCI ☐ on Entries: 1727	Han Cluster ☐ on Entries: 284	Han Perseus Pises ☐ on Entries: 59	Lu Virgo/Andromeda ☐ on Entries: 303
McDonald Virgo ☐ on Entries: 286	Mould Clusters ☐ on Entries: 171	Pierce Field ☐ on Entries: 715	Roth IRAS selected ☐ on Entries: 156	Schommer Clusters ☐ on Entries: 32	Verheijen UMa ☐ on Entries: 78	Willick Clusters ☐ on Entries: 156	Willick Perseus Pises ☐ on Entries: 381

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Fundamental Plane				
Blakeslee SMAC FP + SBI ☐ on Entries: 164	Hudson SMAC FP ☐ on Entries: 56	FP: SMAC3 ☐ on Entries: 698	FP: EFAR ☐ on Entries: 788	FP: ERIAR6 ☐ on Entries: 452

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Supplementary Catalogs							
Replenished Catalog of Nearby Galaxies ☐ on Entries: 826	Neighboring Galaxies ☐ on Entries: 451	2MRS Augmented ☐ on Entries: 28573	MAK Vpec ☐ on Entries: 21295	V.R. ☐ on Entries: 30124	Tully 2000 ☐ on Entries: 3497	Virgo Cluster Catalog ☐ on Entries: 2094	Saunders PSCz ☐ on Entries: 1690
V38 MKs<21 ☐ on Entries: 1228	Karachentsev Revised 13th Galaxy Catalog ☐ on Entries: 4444	Karachentsev REGC 2MASS peculiar velocities ☐ on Entries: 1222	Karachentsev REGC peculiar velocities ☐ on Entries: 1327	Parnovsky REGC peculiar velocities ☐ on Entries: 1623	MK Groups ☐ on Entries: 11056	TF Calibrators ☐ on Entries: 416	

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Choose rows to display initially:
start end

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

Luca Rizzi, Ed Shaya, Helene Courtois, Brad Jacobs, Dmitry Makarov, Matt Zagursky

[EDD Home Page](#)



Cosmicflows-2 now available!

- 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 transferred.
- Most browsers clear the column selections when you reload, but Firefox does not, so use reset button.

- Updated best distances in EDD Distances catalog (presently limited to $V < 3000$ km/s).
- Color images of galaxies observed with ACS and WFC2 in "CMDs/TRGB" catalog.
- 16,000 HI profiles uniformly analyzed in All Digital HI catalog.
- Hawaii Photometric catalog now available.

Cosmicflows-1

OPTIONAL: Enter Galaxy Name: [Display only tables with info on this galaxy](#)

LEDA [?] 00 Entries: 98202	2MRS K<11.75 [?] 00 Entries: 43528	2MASS K<11.25 V [?] 00 Entries: 24746	2M+ [?] 00 Entries: 64745
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Summary Distances

EPO Distances	Quality Distances	Cosmoflow Distances	SFI++
Entries: 3529	Entries: 636	Entries: 1797	Entries: 5780

Cluster Name	Entries
CMHD/TRGB	325
NGST	65
Araucaria	12
McConnachie	102
Tonry SBF	299
Virgo/Ternax SBF	134
Hydra/Centaurus SBF	31

SNIs							
4 Sources SNIs	Tommy SNIs	Jha SNIs	Prieto SNIs	Unio2 SNIs	Constitution SNIs	CSPI SNIs	SNI calibration
☐ on	☐ on	☐ on	☐ on	☐ on	☐ on	☐ on	☐ on
Entries: 318	Entries: 126	Entries: 132	Entries: 89	Entries: 285	Entries: 209	Entries: 34	Entries: 95

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

Optical Linewidths				

Extragalactic Distance Database

Catinella/Corsell ☐ on Entries: 403	Mathewson by Courteen ☐ on Entries: 525	Dale by Courteen ☐ on Entries: 486	Courteen by Courteen ☐ on Entries: 252	Verhelien by Courteen ☐ on Entries: 38
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Submit All Reset

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

Submit All Reset

Fundamental Plane				
Blinker-SMAC FP + SHF	Hudson-SMAC FP	FP: SMAC3	FP: EFAR	FP: ENEARc
☐ on	☐ on	☐ on	☐ on	☐ on
Entries: 164	Entries: 56	Entries: 698	Entries: 788	Entries: 452

Submit All Reset

Supplementary Catalogs							
Rebinshed Catalog of Nearby Galaxies ☐ 00 Entries: 826	Neighboring Galaxies ☐ 00 Entries: 451	2MRS Augmented ☐ 00 Entries: 28573	MAK Vps: ☐ 00 Entries: 21295	V 8k ☐ 00 Entries: 30124	Tully 3000 ☐ 00 Entries: 3497	Virgo Cluster Catalog ☐ 00 Entries: 2094	Saunders PSCs ☐ 00 Entries: 1690
Y38 MKc-21 ☐ 00 Entries: 1228	Karachentsev Revised Flat Galaxy Catalog ☐ 00 Entries: 4444	Karachentsev REGC-2MASs peculiar velocities ☐ 00 Entries: 1222	Karachentsev REGC-peculiar velocities ☐ 00 Entries: 1327	Pavoninsky REGC peculiar velocities ☐ 00 Entries: 1623	MK Groups ☐ 00 Entries: 11056	TF Calibrators ☐ 00 Entries: 416	

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Choose rows to display initially:
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Hide Control Panel

Requested Rows:

CMDs/TRGB Catalog

Control Panel: Column Min/Max, regular expression, sorting, visibility

PGC	PGC no	P	Name/CMD	Alt_Source	Dist	HST-GO	Camera	T814	T8_lo	T8_hi	606-814	eb_lo	eb_hi	555-814	ea_lo	ea
	Min	Min	String	String	Min	Min	String	Min	Min	Min	Min	Min	Min	Min	Min	
	Max	Max	Sort	Sort	Max	Max	Sort	Max	Max	Max	Max	Max	Max	Max	Max	
	Sort	Sort			Sort	Sort		Sort	Sort	Sort	Sort	Sort	Sort	Sort	Sort	Si
show	hide	show	hide	show	hide	show	hide	show	hide	show	hide	show	hide	show	hide	show
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

PGC	P	Name/CMD	Alt_Source	Dist	HST-GO	Camera	T814	T8_lo
				Mpc			mag	mag
143	1	DDO221		0.98	6813	WFPC2	20.99	20.90
621	1	ESO149-031	ANGRRR	3.21	9771	ACS	23.47	23.43
701	0	NGC24		7.26	12546	ACS	25.30	25.28
930	1	NGC45		6.61	9774	ACS	25.04	24.96
1014	1	NGC55	ANGST/4	2.11	8697	WFPC2	22.66	22.63
1038	1	ESO110-005	ANGST/6	1.92	10503	ACS	22.37	22.33
1305	1	IC10	LGS/P/10/html/ic10.html	0.79	9683	ACS	22.01	21.99
1641	1	ESO294-010	ANGST/10	2.03	10503	ACS	22.48	22.44
1772	0	UGC288		6.74	12546	ACS	25.19	25.15
2004	1	NGC147	LGS/P/ngc147/html/ngc147.html	0.73	6233	WFPC2	20.69	20.64
2329	1	NGC185	LGS/P/ngc185/html/ngc185.html	0.64	6699	WFPC2	20.42	20.40
2429	1	NGC205	LGS/P/ngc205/html/ngc205.html	0.78	6699	WFPC2	20.64	20.63
2555	1	NGC221	LGS/P/m32/html/m32.html	0.71	5464	WFPC2	20.66	20.65
2557	1	M31	LGS/P/m31/html/m31.html	0.81	6859	WFPC2	20.81	20.77
2578	1	DDO226		4.90	8192	WFPC2	24.44	24.32
2758	1	NGC247	ANGST/21	3.70	10915	ACS	23.84	23.82
2789	1	NGC253	ANGST/22	3.68	10523	ACS	23.82	23.80
2881	1	ESO540-030	ANGST/23	3.55	10503	ACS	23.71	23.67
2902	1	DDO6	ANGST/24	3.42	8192	WFPC2	23.63	23.55
2933	1	ESO540-032	ANGST/25	3.61	10503	ACS	23.75	23.72
3085	1	SMC	LGS/P/smc/html/smc.html		8059	WFPC2		
3238	1	NGC100	ANGST/27	2.08	10915	ACS	22.59	22.55
3792	1	LGS3	LCID/0004-637X/730/1/14/	0.65	6695	WFPC2	20.11	19.76
3844	1	IC1613	LCID/0004-637X/712/2/1259/	0.75	7496	WFPC2	20.40	20.37

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Hide Control Panel

Requested Rows:

CMDs/TRGB Catalog

Control Panel: Column Min/Max, regular expression, sorting, visibility

PGC	PGC no	P	Name/CMD	Alt_Source	Dist	HST-GO	Camera	T814	T8_lo	T8_hi	606-814	eb_lo	eb_hi	555-814	ea_lo	ea
	Min	Min	String	String	Min	Min	String	Min	Min	Min	Min	Min	Min	Min	Min	
	Max	Max	Sort	Sort	Max	Max	Sort	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
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

PGC	P	Name/CMD	Alt_Source	Dist	HST-GO	Camera	T814	T8_lo
				Mpc			mag	mag
143	1	D20221		0.98	6813	WFPC2	20.99	20.90
621	1	ESO149-031	ANGRRR	3.21	9771	ACS	23.47	23.43
701	0	NGC24		7.26	12546	ACS	25.30	25.28
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1038	1	ESO110-005	ANGST/6	1.92	10503	ACS	22.37	22.33
1305	1	NG10	LGS/9/10/html/ic10.html	0.79	9683	ACS	22.01	21.99
1641	1	ESO294-010	ANGST/10	2.03	10503	ACS	22.48	22.44
1772	0	UGC288		6.74	12546	ACS	25.19	25.15
2004	1	NGC147	LGS/9/ngc147/html/ngc147.html	0.73	6233	WFPC2	20.69	20.64
2329	1	NGC185	LGS/9/ngc185/html/ngc185.html	0.64	6699	WFPC2	20.42	20.40
2429	1	NGC205	LGS/9/ngc205/html/ngc205.html	0.78	6699	WFPC2	20.64	20.63
2555	1	NGC221	LGS/9/m32/html/m32.html	0.71	5464	WFPC2	20.66	20.65
2557	1	M31	LGS/9/m31/html/m31.html	0.81	6859	WFPC2	20.81	20.77
2578	1	D20226		4.90	8192	WFPC2	24.44	24.32
2758	1	NGC247	ANGST/21	3.70	10915	ACS	23.84	23.82
2789	1	NGC253	ANGST/22	3.68	10523	ACS	23.82	23.80
2881	1	ESO540-030	ANGST/23	3.55	10503	ACS	23.71	23.67
2902	1	D206	ANGST/24	3.42	8192	WFPC2	23.63	23.55
2933	1	ESO540-032	ANGST/25	3.61	10503	ACS	23.75	23.72
3085	1	SMC	LGS/9/smc/html/smc.html		8059	WFPC2		
3238	1	NGC100	ANGST/27	2.08	10915	ACS	22.59	22.55
3792	1	LGS3	LCID/0004-637X/730/1/14/	0.65	6695	WFPC2	20.11	19.76
3844	1	IC1613	LCID/0004-637X/712/2/1259/	0.75	7496	WFPC2	20.40	20.37

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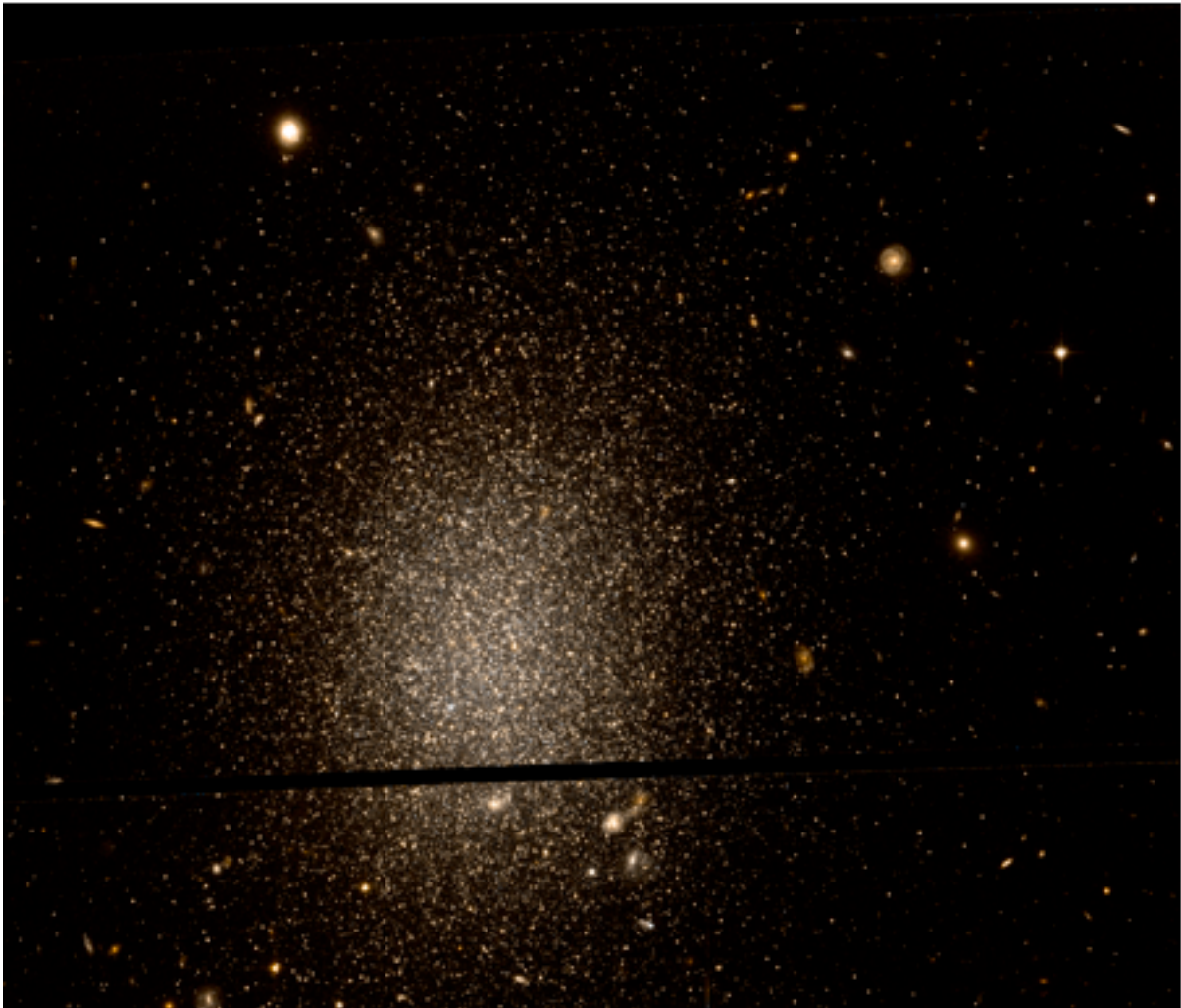
Select PGC 1038

pgc	P	Name/CMD	Alt_Source	Dist	HST- GO	Camera	T814	T8_lo	T8_hi	606- 814	eb_lo	eb_hi	555- 814	ea_lo	ea_hi	TRGB	T_lo	T_hi
1038	1	ESO410-005	ANGST/6	1.92	10503	ACS	22.37	22.33	22.40	1.13	1.12	1.14				22.38	22.33	22.40

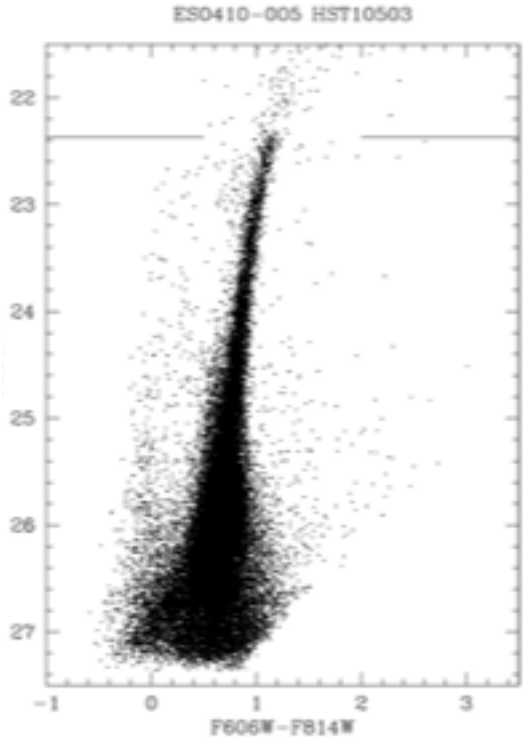
Available HST proposals for PGC 1038

144 pixels

11/18/12 3:12 PM



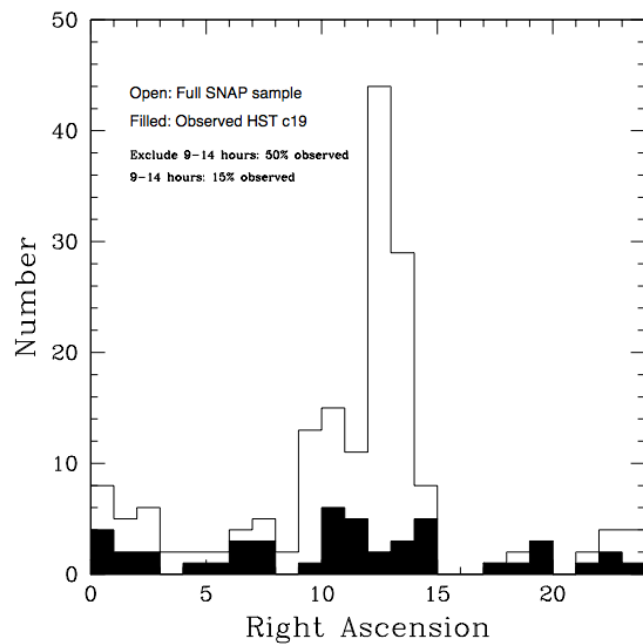
Proposal: 10503



int (in yellow) of ESO410-005 from Program 10503.

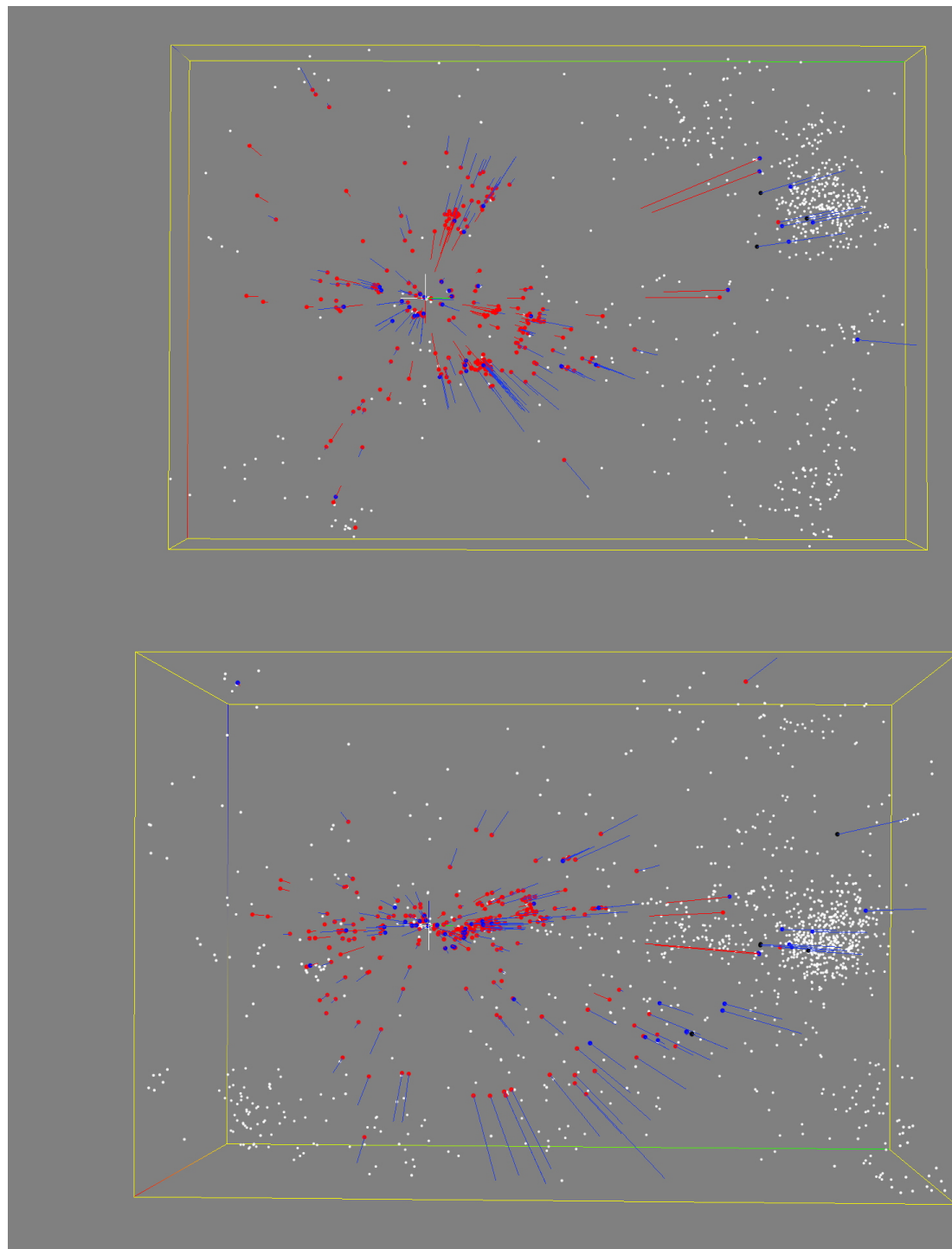
HST c19 SNAP Program

Added 46 new CMD;
now 340 available



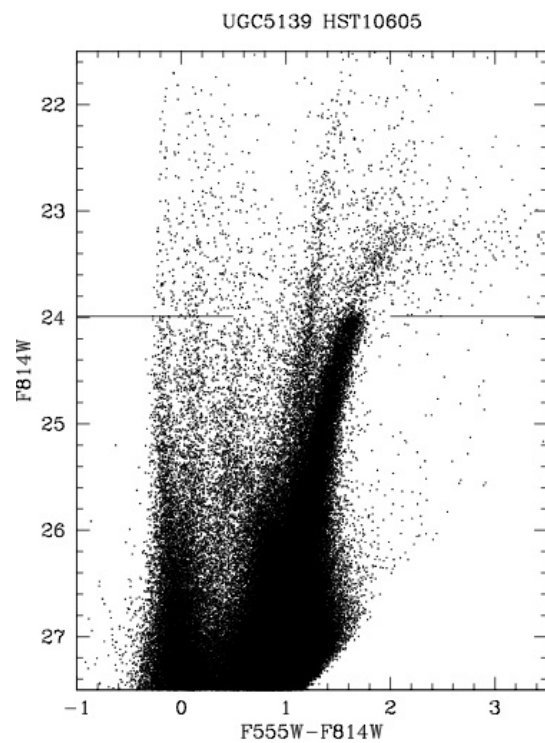
HST c21 SNAP Program

already added ~15 new
galaxies

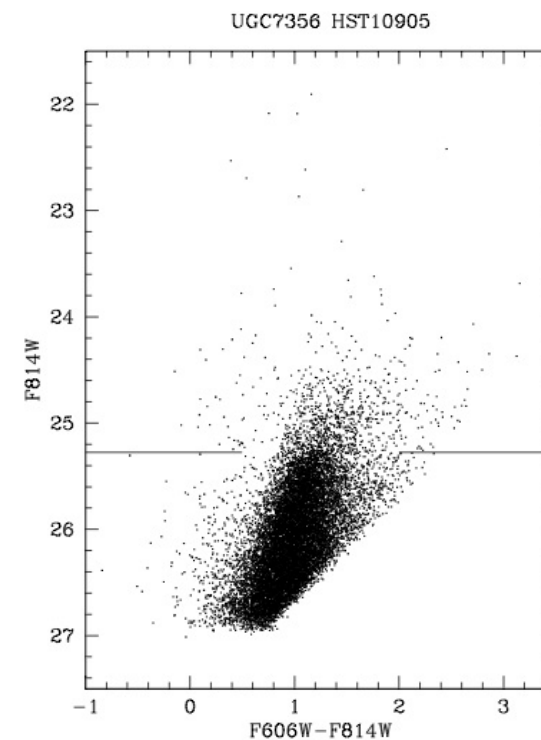
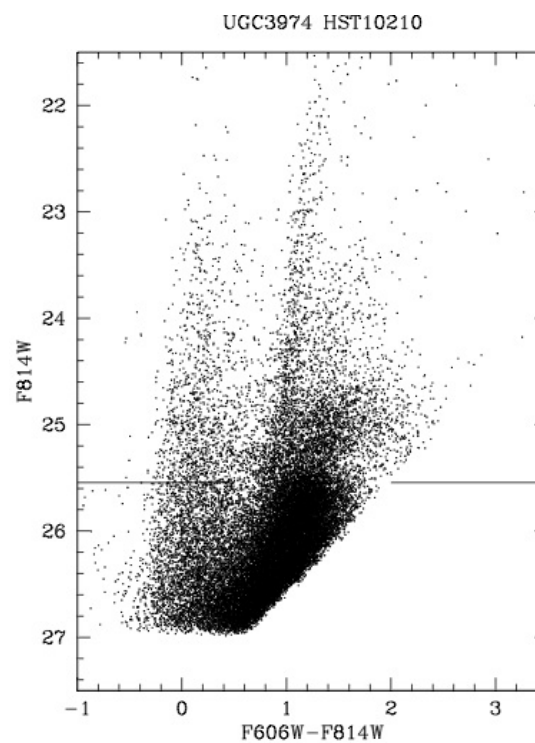


Jacobs, Dolphin, Makarov, Rizzi, Wu

TRGB distances



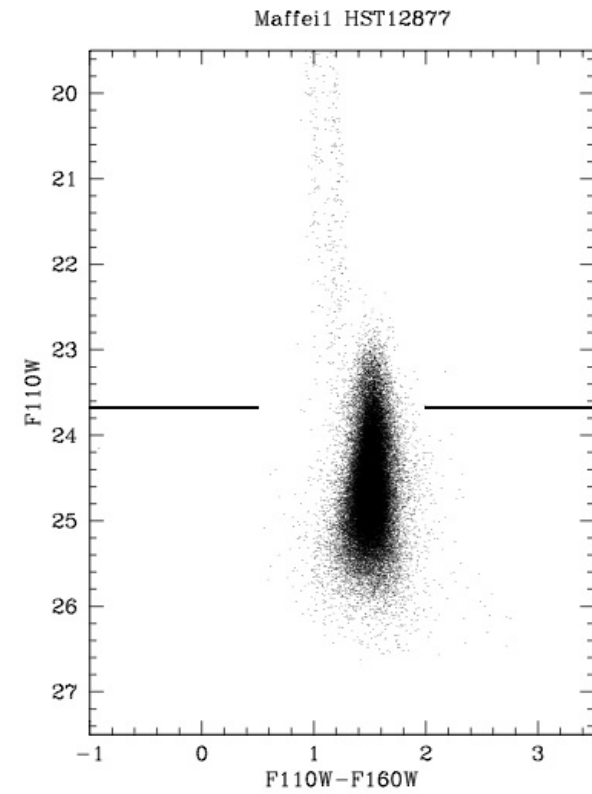
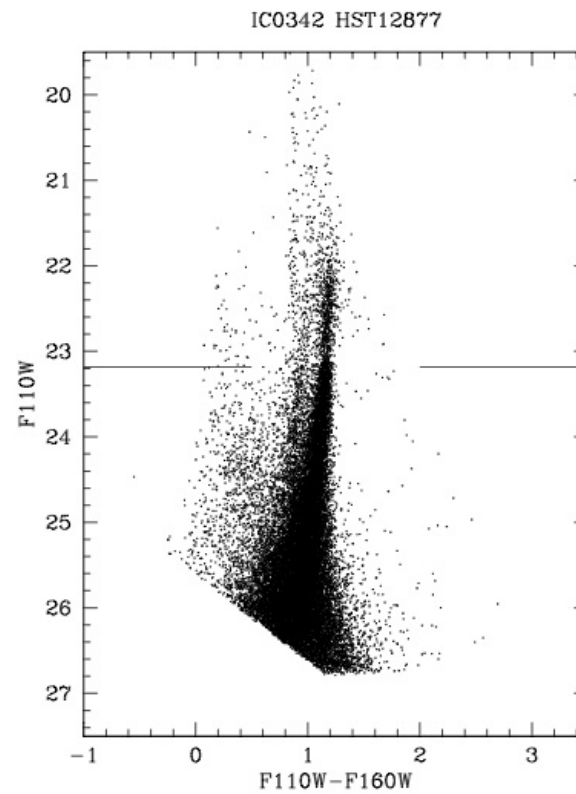
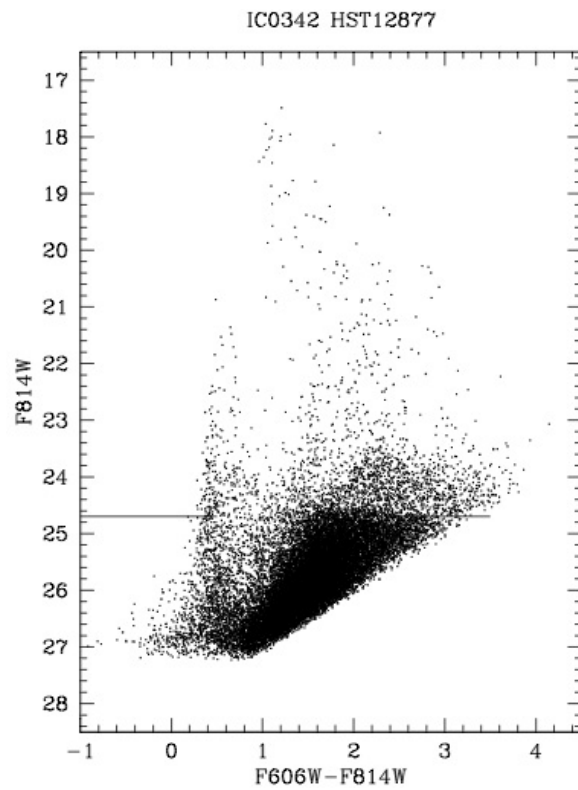
Holmberg I
 $d = 4.0$ Mpc



UGC 7356
 $d = 7.3$ Mpc

Wu, Dolphin, Rizzi

IR TRGB distances



optical ——— IC 342 ——— infrared

infrared
Maffei 1

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

SBF: Surface Brightness Fluctuation

Cosmicflows-2

Ground-based: ~ 300 distances within ~ 40 Mpc (Tonry et al. 2001)

HST: Virgo (Mei et al. 2007); Fornax (Blakeslee et al. 2009)

Cosmicflows-3??

HST IR: $\Rightarrow 100$ Mpc

Luminosity-Linewidth (TF)

EDD: Select Table & Columns

11/17/12 4:11 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 transferred.
- 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 ☐ on Entries: 98202	2MRS K<11.75 ☐ on Entries: 43528	2MASS K<11.25 V ☐ on Entries: 24746	2M++ ☐ on Entries: 64745

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

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

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SNIa						
5 Sources SNIa ☐ on Entries: 318	Tully SNIa ☐ on Entries: 126	Iba SNIa ☐ on Entries: 132	Prieto SNIa ☐ on Entries: 89	Union2 SNIa ☐ on Entries: 255	Constitution SNIa ☐ on Entries: 209	CSPL SNIa ☐ on Entries: 34

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HI Linewidths						
All Digital HI ☐ on Entries: 14219	Pr. Digital HI ☐ on Entries: 4395	Springob/Cornell HI ☐ on Entries: 8844	HI Nancy ☐ on Entries: 3720	HI Fisher ☐ on Entries: 958	HIPASS 1000 ☐ on Entries: 1000	WHISP ☐ on Entries: 343

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Optical Linewidths						
☐ on	☐ on	☐ on	☐ on	☐ on	☐ on	☐ on

<http://edd.ifa.hawaii.edu/secure/dfirst.php?>

Page 1 of 2

Extragalactic Distance Database

EDD: Select Table & Columns

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Catinella/Cornell ☐ on Entries: 403	Mathewson by Courteau ☐ on Entries: 525	Dale by Courteau ☐ on Entries: 486	Courteau by Courteau ☐ on Entries: 252	Verheijen by Courteau ☐ on Entries: 38
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Photometry							
"Spitzer 3.61 Band Photometry" ☐ on Entries: 232	Hawaii Photometry ☐ on Entries: 524	Homogenized Photometry ☐ on Entries: 5864	SDSS Hst ☐ on Entries: 3039	2MASS Large Galaxy Atlas ☐ on Entries: 617	Cosmicflows Spitzer ☐ on Entries: 1272	Spitzer SINGS ☐ on Entries: 75	Carnegie Hubble Program ☐ on Entries: 480
SAG ☐ on Entries: 2331	Aaronson H ☐ on Entries: 204	Bernstein Coma ☐ on Entries: 32	Bothun ☐ on Entries: 38	Bureau Fornax ☐ on Entries: 22	Courteau ☐ on Entries: 304	Mathewson revised by Courteau ☐ on Entries: 957	Mathewson ☐ on Entries: 2443
DeL'Antonio ☐ on Entries: 241	Heraudeau ☐ on Entries: 234	Dale SCI ☐ on Entries: 520	Giovanelli SCI ☐ on Entries: 782	Haynes SFI/SCI ☐ on Entries: 1727	Han Cluster ☐ on Entries: 284	Han Perseus Pisces ☐ on Entries: 59	Lu Virgo/Andromeda ☐ on Entries: 303
McDonald Virgo ☐ on Entries: 286	Mould Clusters ☐ on Entries: 171	Pierce Field ☐ on Entries: 715	Roth IRAS selected ☐ on Entries: 156	Schommer Clusters ☐ on Entries: 32	Verheijen UMa ☐ on Entries: 78	Willick Clusters ☐ on Entries: 156	Willick Perseus Pisces ☐ on Entries: 381

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Fundamental Plane				
Blakeslee SMAC FP + SBI ☐ on Entries: 164	Hudson SMAC FP ☐ on Entries: 56	FP: SMAC3 ☐ on Entries: 698	FP: EFAR ☐ on Entries: 788	FP: ERIARc ☐ on Entries: 452

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Supplementary Catalogs							
Replenished Catalog of Nearby Galaxies ☐ on Entries: 826	Neighboring Galaxies ☐ on Entries: 451	2MRS Augmented ☐ on Entries: 28573	MAK Vpec ☐ on Entries: 21295	V.R. ☐ on Entries: 30124	Tully 2000 ☐ on Entries: 3497	Virgo Cluster Catalog ☐ on Entries: 2094	Saunders PSCz ☐ on Entries: 1690
V38 MKs<21 ☐ on Entries: 1228	Karachentsev Revised 13th Galaxy Catalog ☐ on Entries: 4444	Karachentsev REGC 2MASS peculiar velocities ☐ on Entries: 1222	Karachentsev REGC peculiar velocities ☐ on Entries: 1327	Parnowski REGC peculiar velocities ☐ on Entries: 1623	MK Groups ☐ on Entries: 11056	TF Calibrators ☐ on Entries: 416	

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

HI

optical

Spitzer

WISE



University of Maryland, Baltimore

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

The Extragalactic Distance Database: Display Request

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Requested Rows:

All Digital HI catalog

Control Panel: Column Min/Max, regular expression, sorting, visibility

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		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
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

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	PG0000012	6548	400	19	1	tmc2006	Nanc	6548	424	409	400	19	2.4	3.40	11.0	1	
16	PG0000016	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	PG0000040	7282	289	20	1	tmc2006	Nanc	7282	316	298	289	20	5.0	5.20	10.8	2	
42	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	UGC12892					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	ES538-017	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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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		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	

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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58	AGC331071					shg2005	AOIf	8795	488	457		100	0.7	0.36	8.7	4	
60	AGC331072	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	
71	AGC331074	6909	139	14	2	shg2005	Nanc	6910	165	150	142	20	7.5	3.55	5.5	4	
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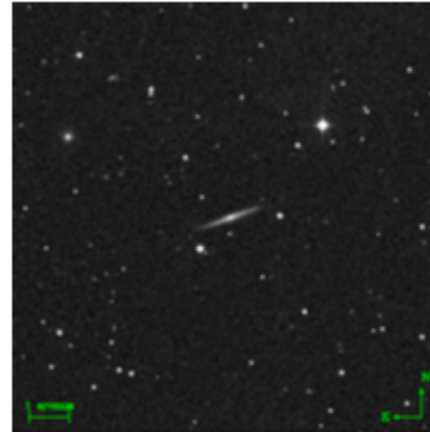
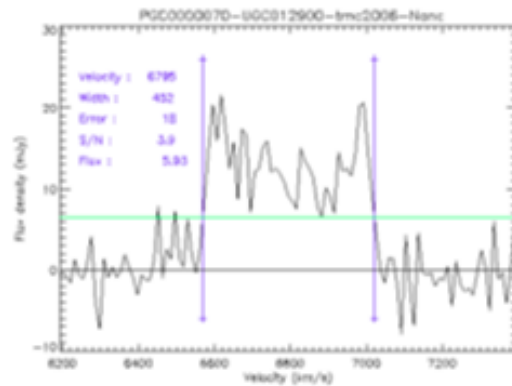
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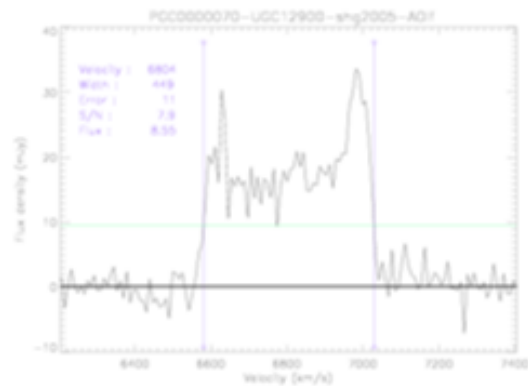
Results from the [All Digital HI catalog](#)

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	AO10	6804	449	435	426	15	7.9	8.55	8.6	1	6.5	lmc2006	Nanc	6795	452	4

Available profiles for PGC 70



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- Hawaii Photometry catalog now available.

OPTIONAL: Enter Galaxy Name: [Display only tables with info on this galaxy](#)

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Optical Linewidths	
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Extragalactic Distance Database

EDD: Select Table & Columns

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S4G ☐ on Entries: 2331	Aaronson H ☐ on Entries: 204	Bernstein Coma ☐ on Entries: 32	Bothun ☐ on Entries: 38	Bureau Fornax ☐ on Entries: 22	Courteau ☐ on Entries: 304	Mathewson revised by Courteau ☐ on Entries: 957	Mathewson ☐ on Entries: 2443				
DeL'Antonio ☐ on Entries: 241	Heraudeau ☐ on Entries: 234	Dale SCI ☐ on Entries: 520	Gonzalez SCI ☐ on Entries: 782	Haynes SFI/SCI ☐ on Entries: 1727	Han Cluster ☐ on Entries: 284	Han Perseus Pises ☐ on Entries: 59	Lu Virgo/AndVirgo ☐ on Entries: 303				
McDonald Virgo ☐ on Entries: 286	Mould Clusters ☐ on Entries: 171	Pierce Field ☐ on Entries: 715	Roth IRAS selected ☐ on Entries: 156	Schommer Clusters ☐ on Entries: 32	Verheijen UMa ☐ on Entries: 78	Willick Clusters ☐ on Entries: 156	Willick Perseus Pises ☐ on Entries: 381				

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The Extragalactic Distance Database: Display Request

Spitzer 3.6μm Photometry

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PGC		P	Name/Photom	Date	Exp	a26.5	m_26.5	m_tot	e_m	m_ext	SB0	"Spitzer [3.6] Band Photometry"				
PGC no												alpha	b/a	e_b/a	PA	
Min		Min			Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	
Max		Max			Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	
Sort		Sort	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	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

"Spitzer [3.6] Band Photometry"															
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	
			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	
4735	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	PGC05341	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	
6602	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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☐ XML (VOTable) ☐ comma ☒ pipe ☐ tab ☐ space ☐ fixed format

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Download rows 1 to 200



The Extragalactic Distance Database: Display Request

Spitzer 3.6μm Photometry

Hide Control Panel

Requested Rows:

Control Panel: Column Min/Max, regular expression, sorting, visibility

PGC		P	Name/Photom	Date	Exp	a26.5	m_26.5	m_tot	e_m	m_ext	SB0	"Spitzer [3.6] Band Photometry"				
PGC no												alpha	b/a	e_b/a	PA	
Min		Min			Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min	
Max		Max			Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	
Sort		Sort	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	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

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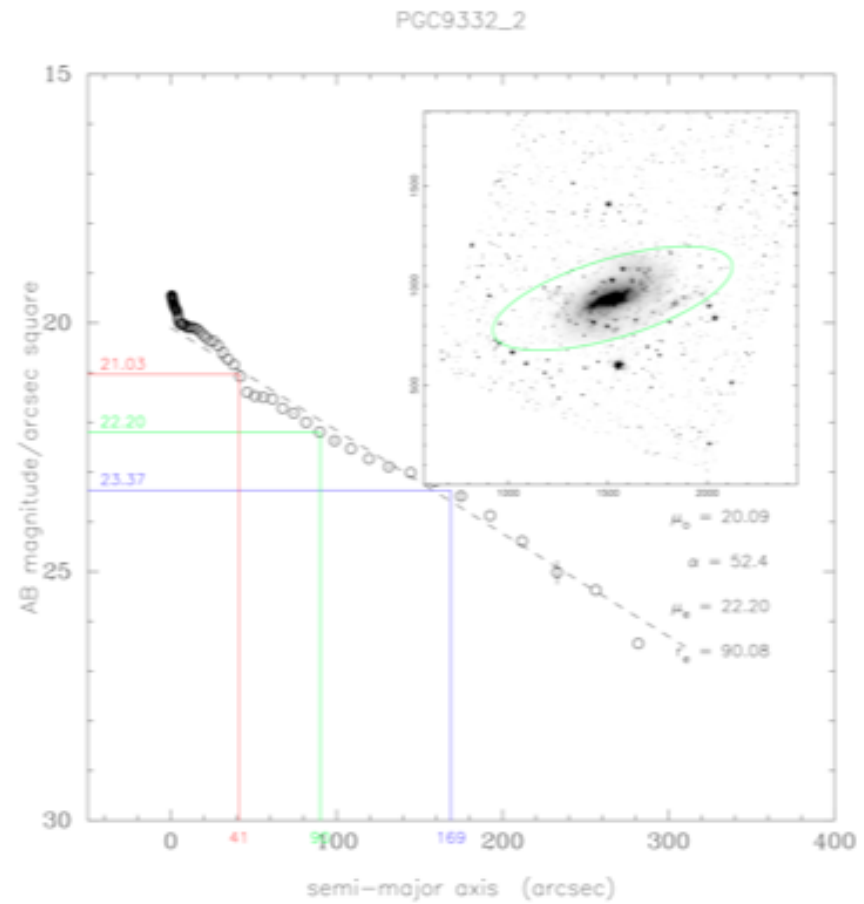
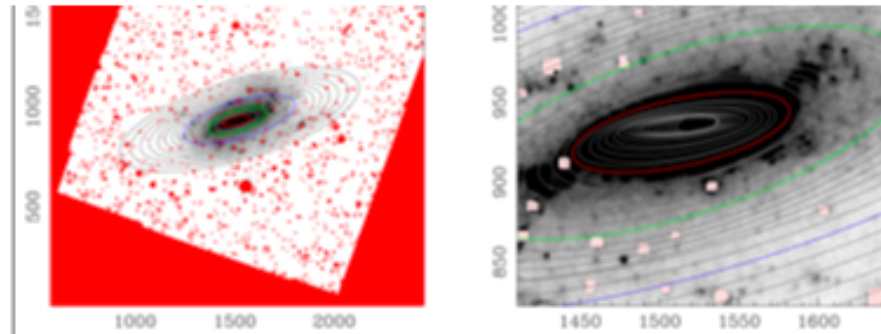
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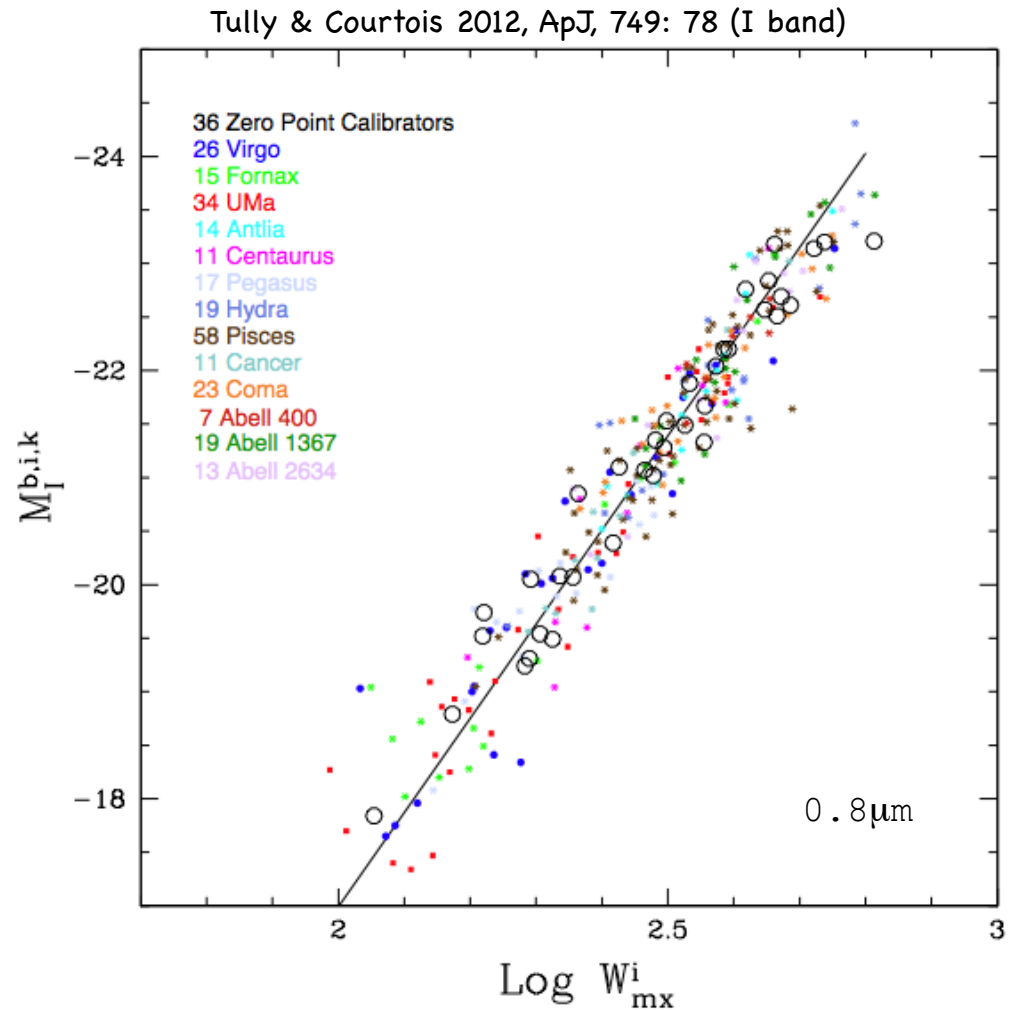
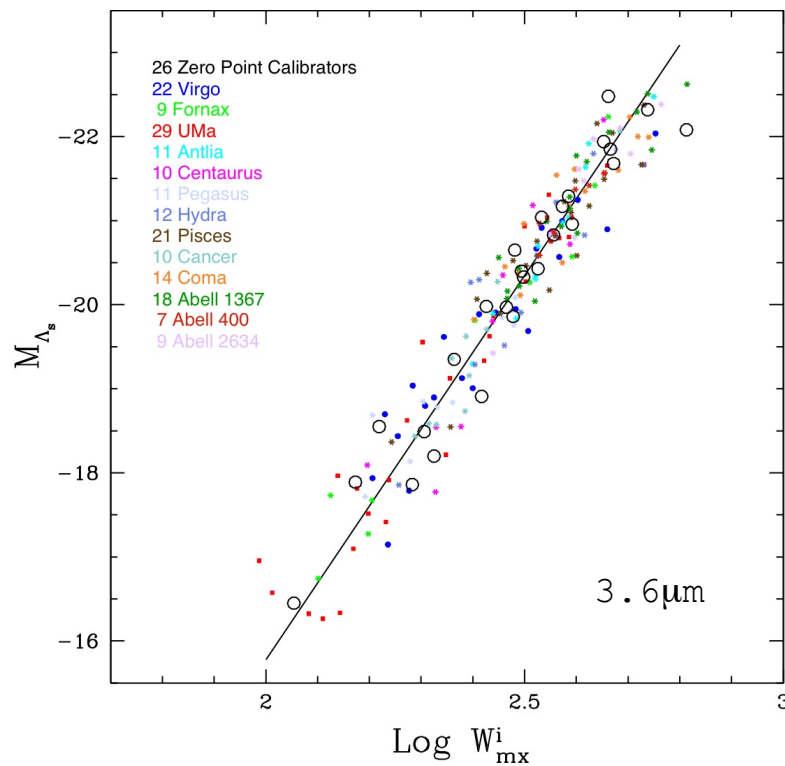
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Select PGC 9332



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



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

Cosmicflows-3?? Neill et al. (WISE mid-IR)

Luminosity-Linewidth Summary

~2000 in common CF2 and SFI++

~2000 CF2 only

~2000 SFI++ only

~6000 total

CF2: our analysis

SFI++: Springob et al. 2007

Fundamental Plane (FP)

EFAR: Colless et al. (2001)	— 11	— 28 clusters
SMAC: Hudson et al. (2001)	— 19	
ENEARc: Bernardi et al. (2002)		

1508 galaxies in 133 clusters

Type Ia Supernovae (SNIa)

Backbone (all z)

Amanullah et al. 2010 (UNION2)

Supplements ($z < 0.1$)

Prieto et al. 2006

Jha et al. 2007

Hicken et al. 2009

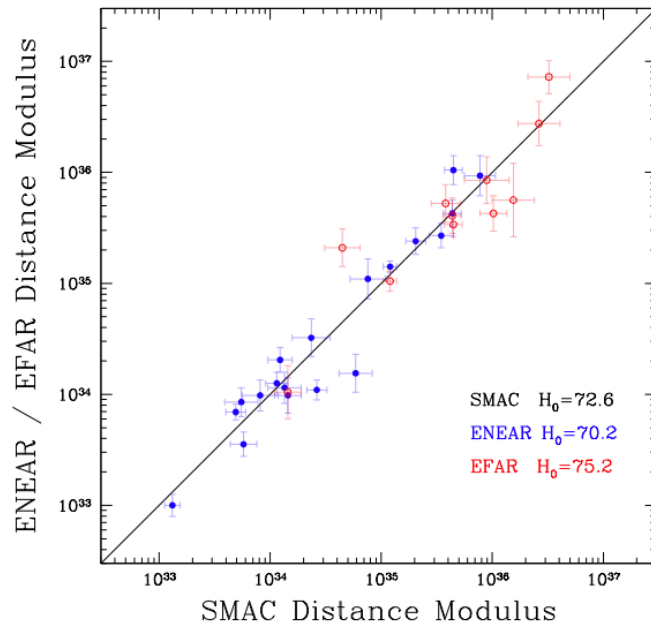
Folatelli et al. 2010

306 SNIa distances $z < 0.1$

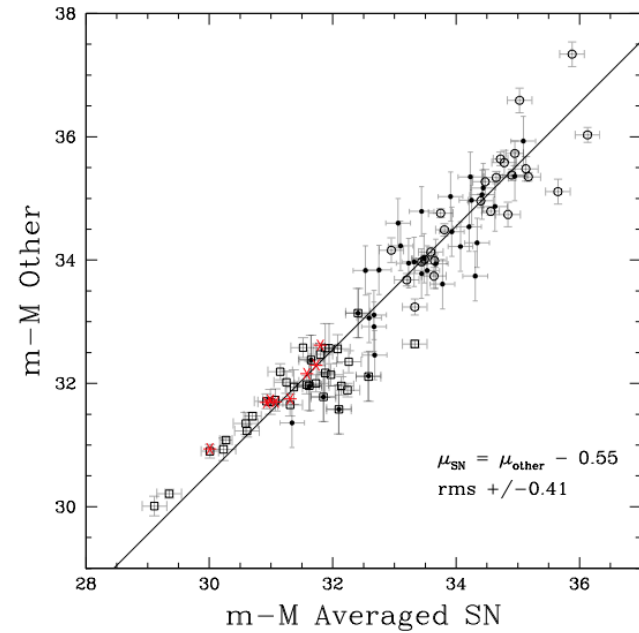
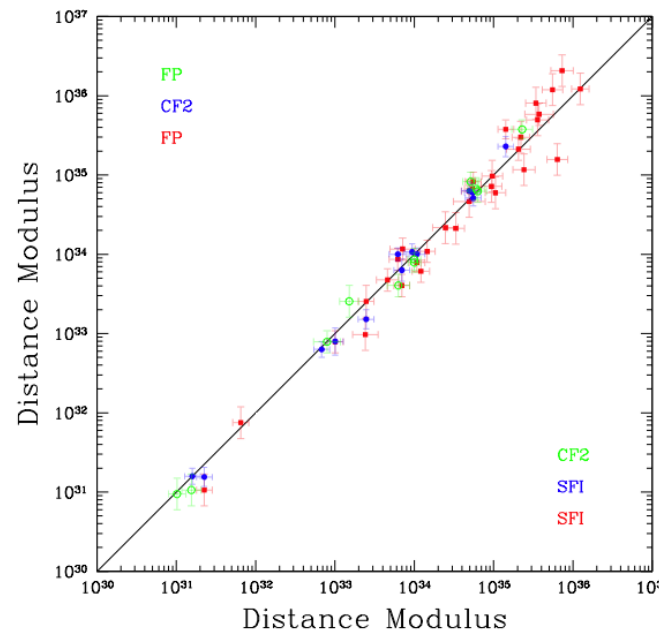
CF2: SNIa Calibration and H_0



combine 3 FP sources



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



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

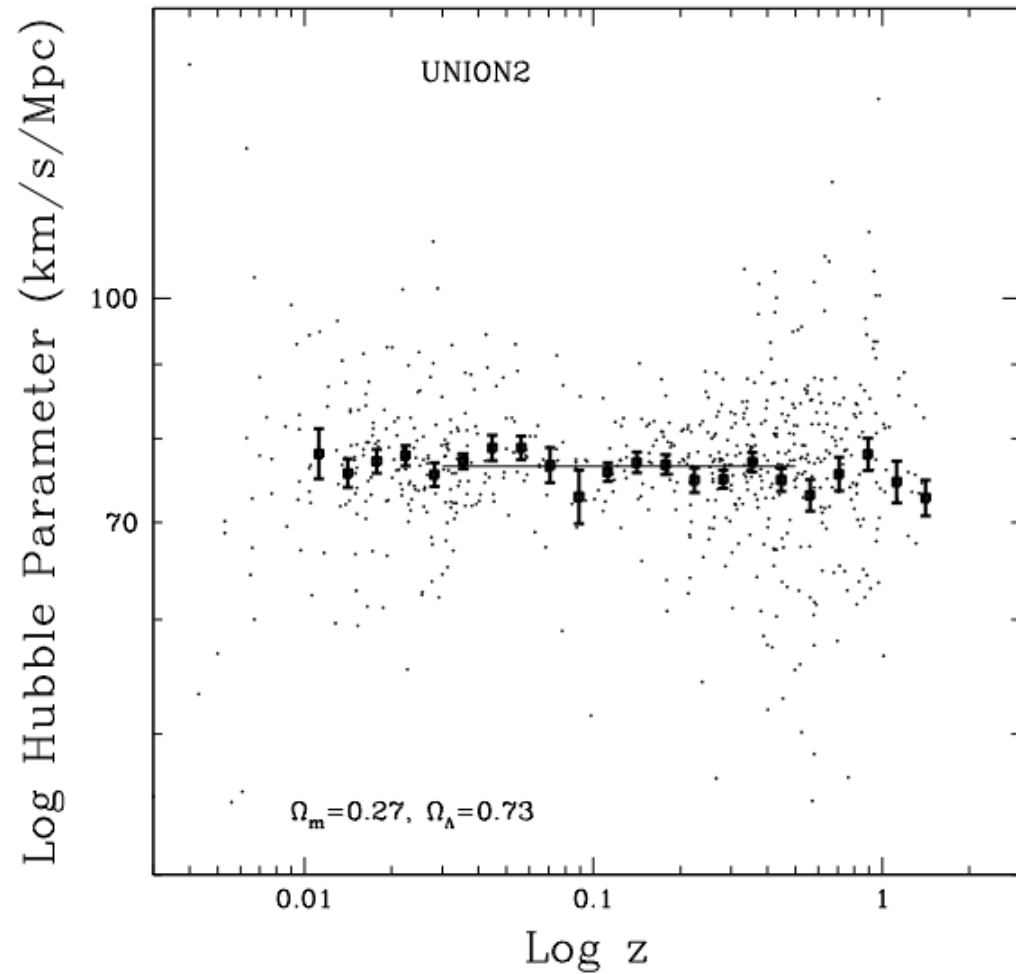
CF2: SNIa calibration and H_0

(continued)

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

$$H_0 = 75.2 \pm 3.0 \text{ km/s/Mpc}$$

I $\rightarrow$ [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

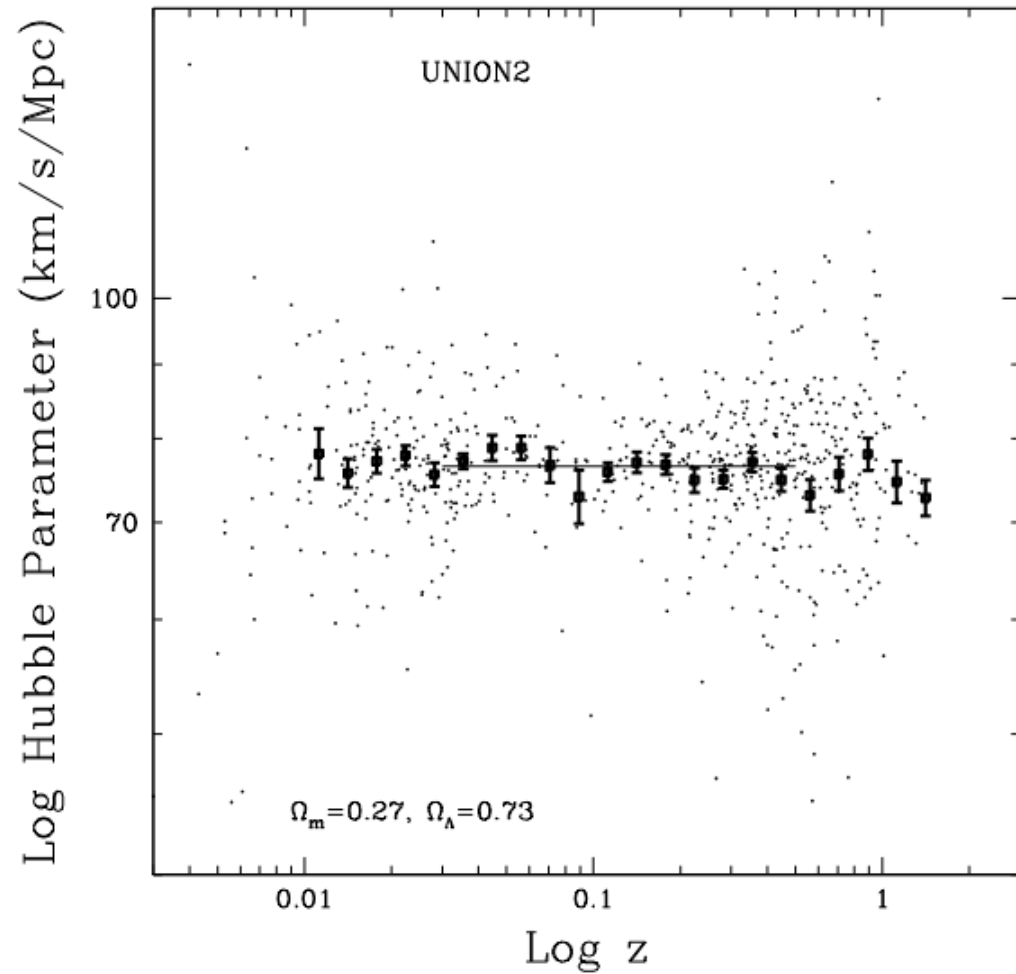
CF2: SNIa calibration and H_0

(continued)

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

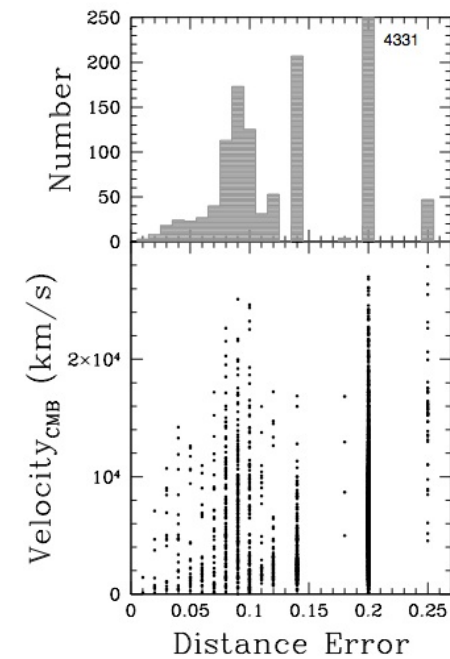
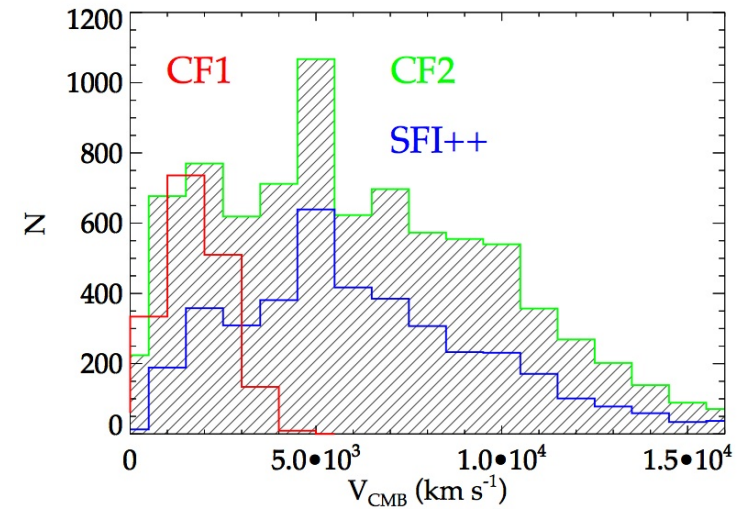
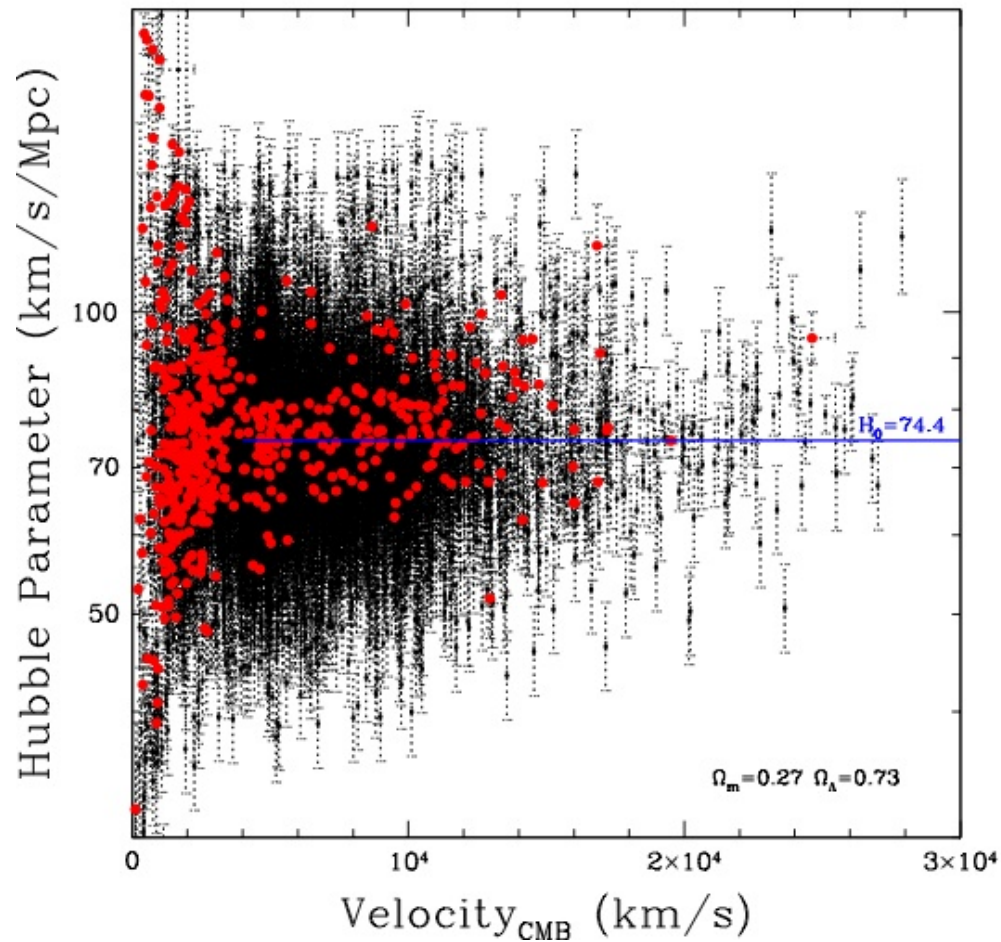
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Cosmicflows-2 Ensemble



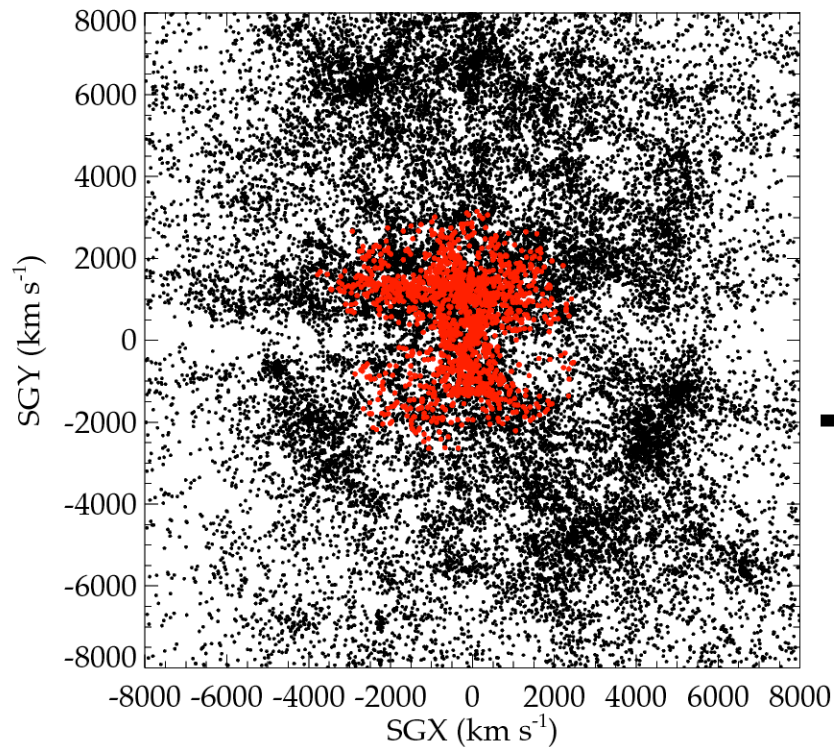
534 groups + 4691 individuals = 5225 entities

Cosmicflows-1 => Cosmicflows-2

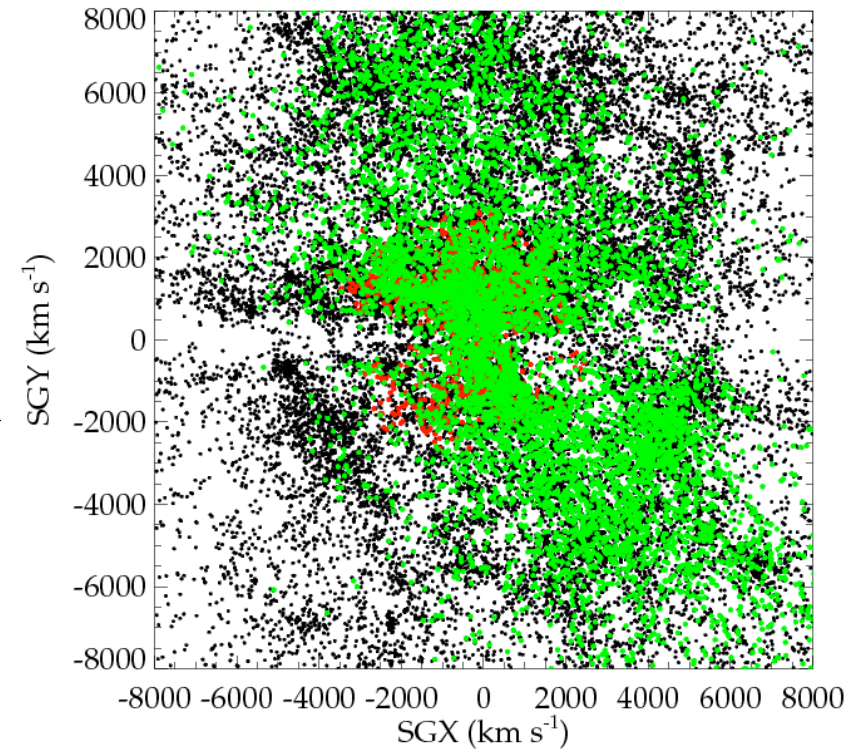
CF1: 1800 galaxies
 $V < 3,000 \text{ km/s}$



CF2: 8000 galaxies
 $V < 30,000 \text{ km/s}$



2008

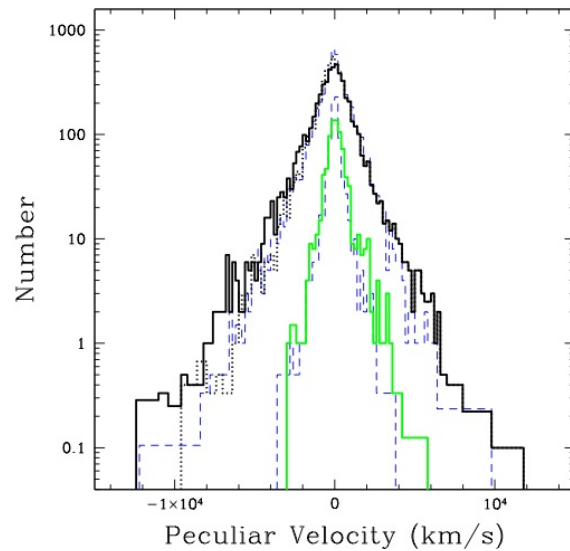


2013

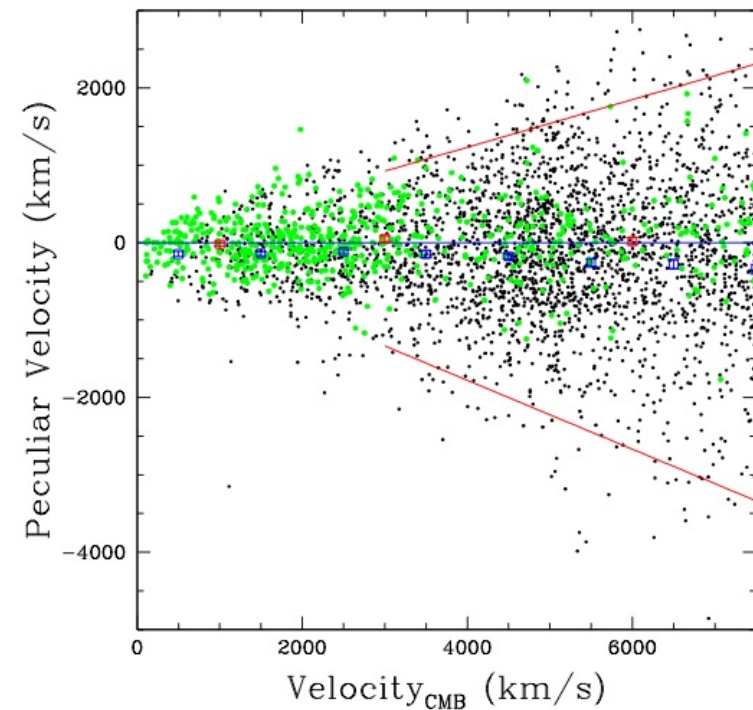
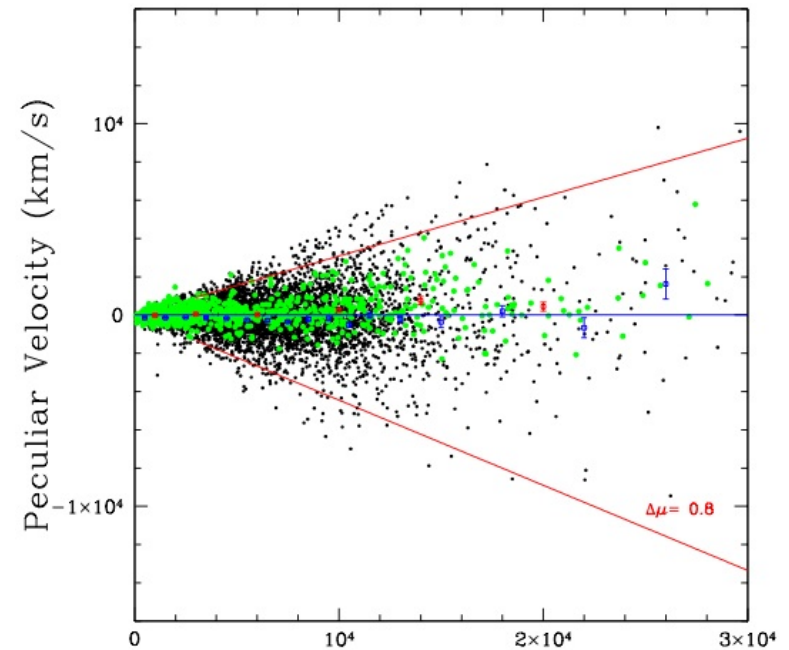
Peculiar Velocities

$$V_{\text{pec}} = V_{\text{obs}} - H_0 d$$

$$H_0 = 74.4 \text{ km/s/Mpc}$$



green: groups
black: singles



Bias

Malmquist selection bias (Teerikorpi, Sandage)



-2 galaxies at the same distance: the brighter one selected in preference to the fainter

Solution: take the regression with errors normal to luminosity (“inverse TF”)

Malmquist distribution bias (Lynden-Bell, Willick)

- Homogeneous case: more galaxies arrive at a given observed distance by being scattered inward by errors than scattered outward → more +ve V_{pec} then -ve at given observed distance



- Inhomogeneous case: galaxies scatter in distance away from high density regions toward low densities → spurious flows toward high density regions

Solution: analyze peculiar velocities at observed redshifts, not at observed distances

Distance error bias



- errors are symmetric in distance modulus (ie, the log of distance), hence not symmetric in distance → -ve V_{pec} systematically larger amplitude than +ve V_{pec}

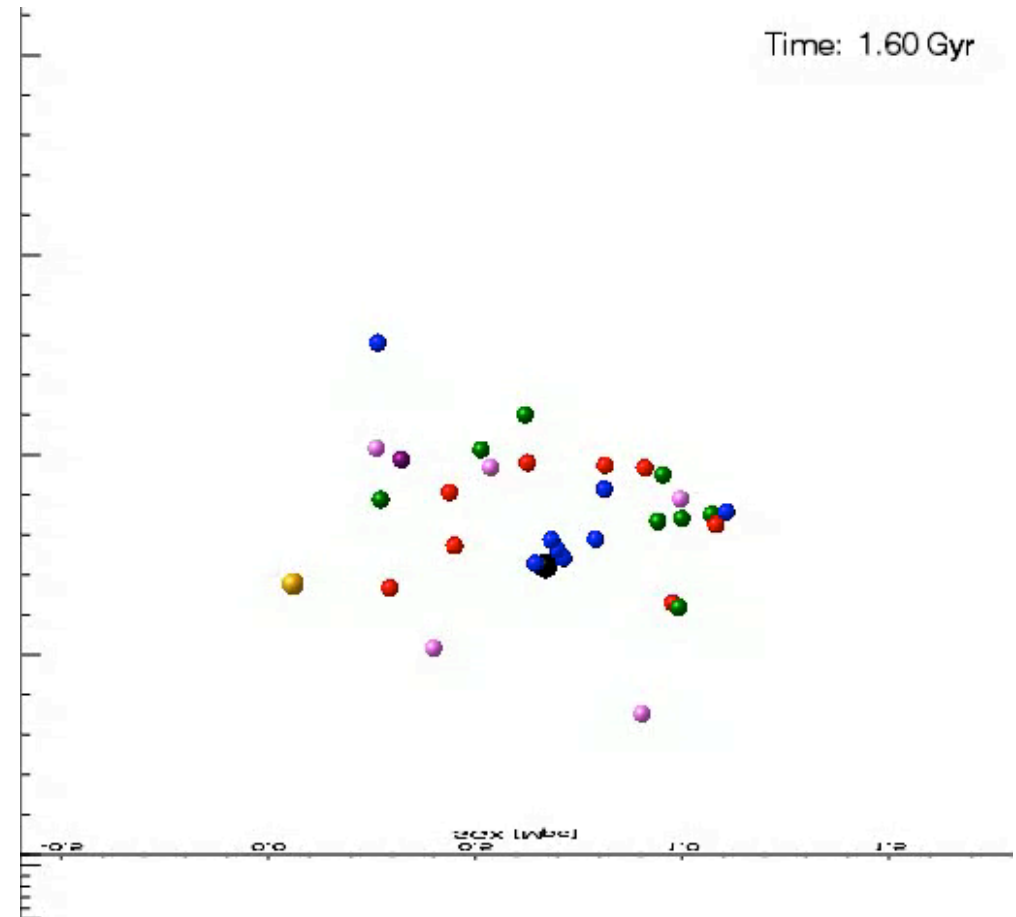
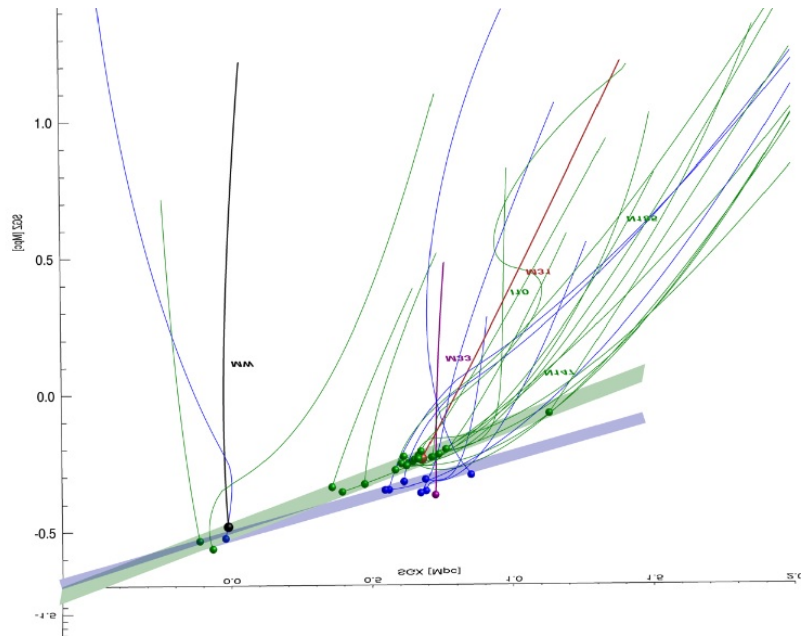
Peculiar Velocities & Models

1. Numerical Action reconstruction of orbits in high density non-linear regimes

Peebles & Tully 2013, ApJ, 778, 137

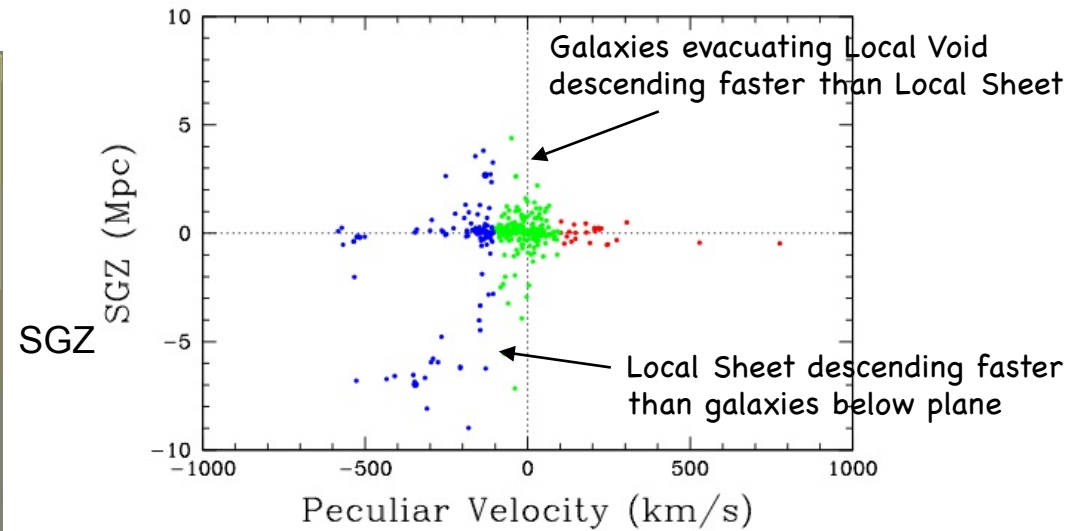
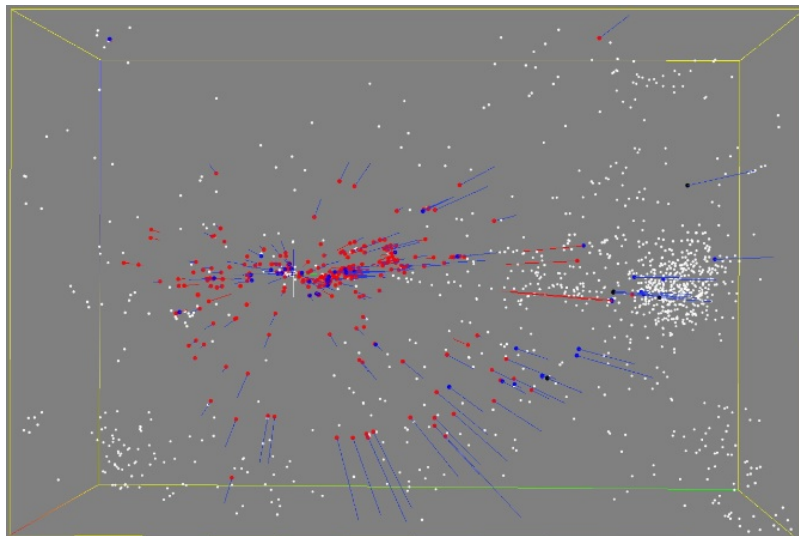
Shaya & Tully 2013, MNRAS, 436, 2096

The origin of planes of satellites in the Local Group from evacuation of Local Void



Evacuation of Local Void & Virgo Infall

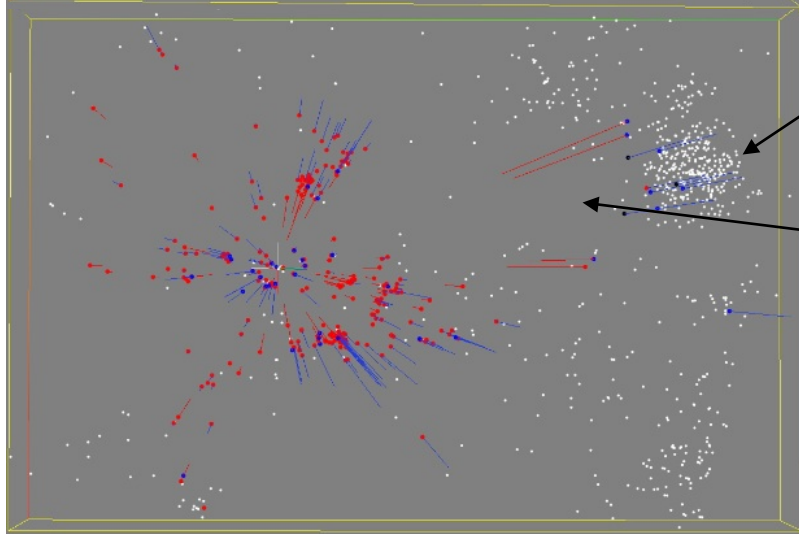
SGY



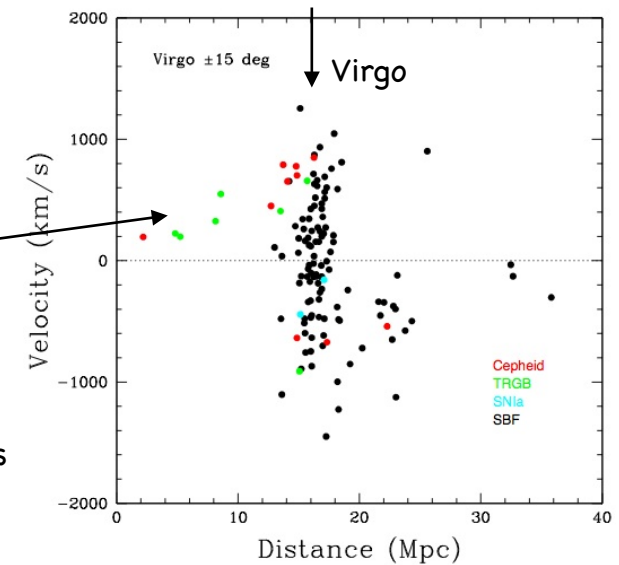
Virgo

Virgo infall

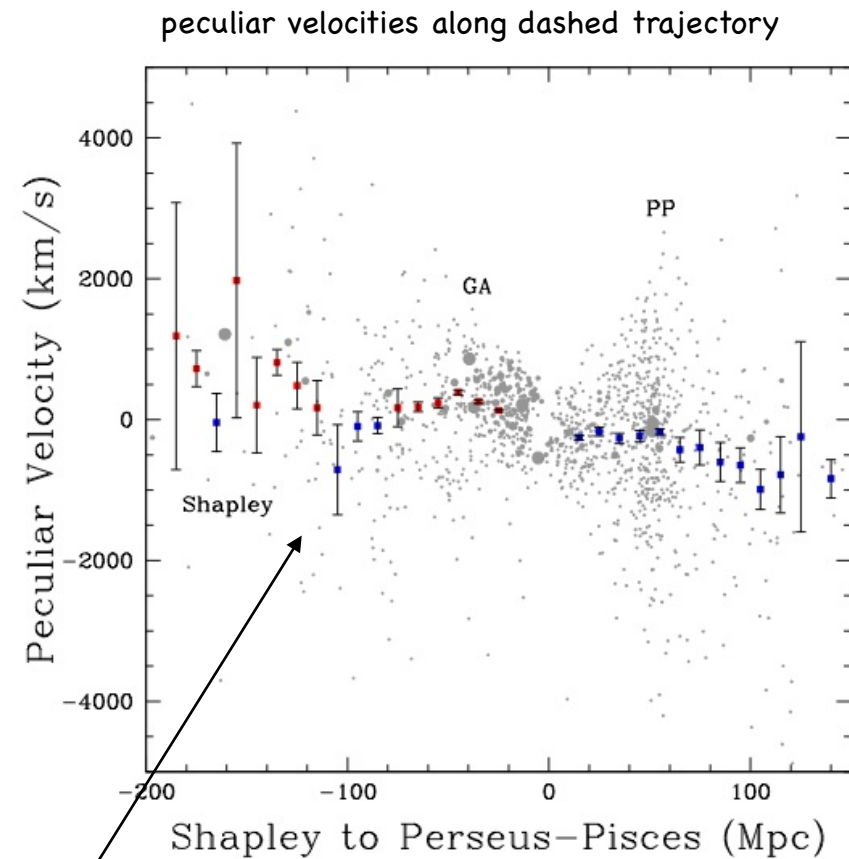
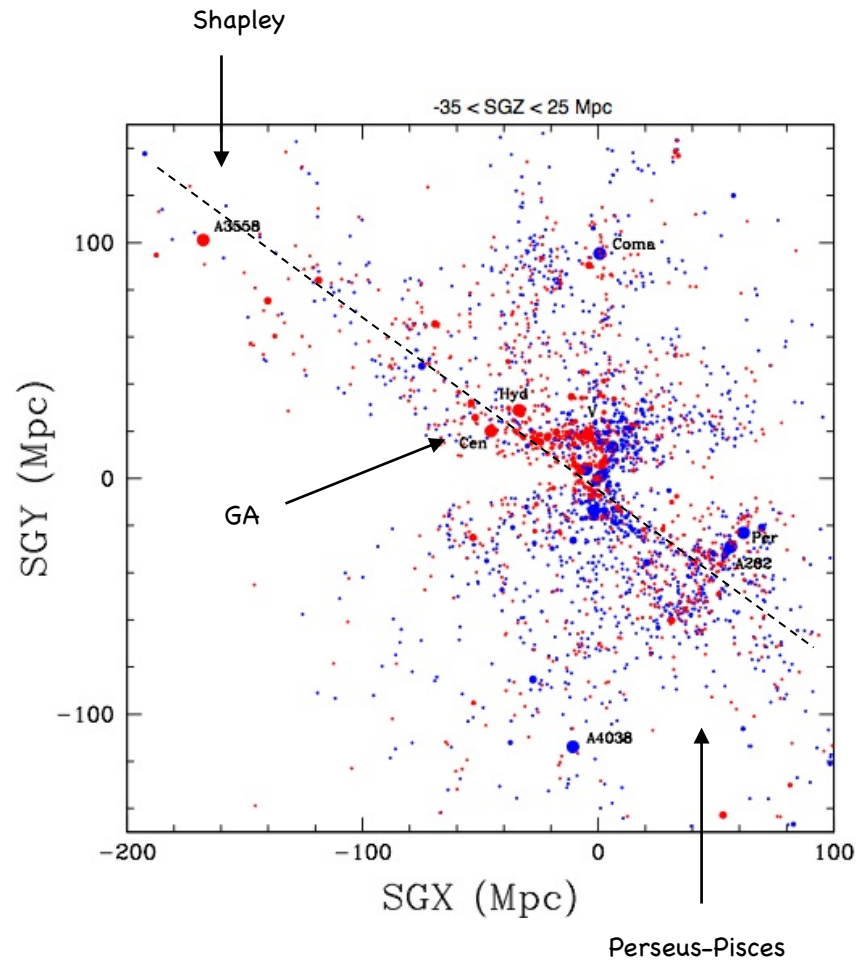
SGX



Virgo mass
 $8 \times 10^{14} M_{\odot}$



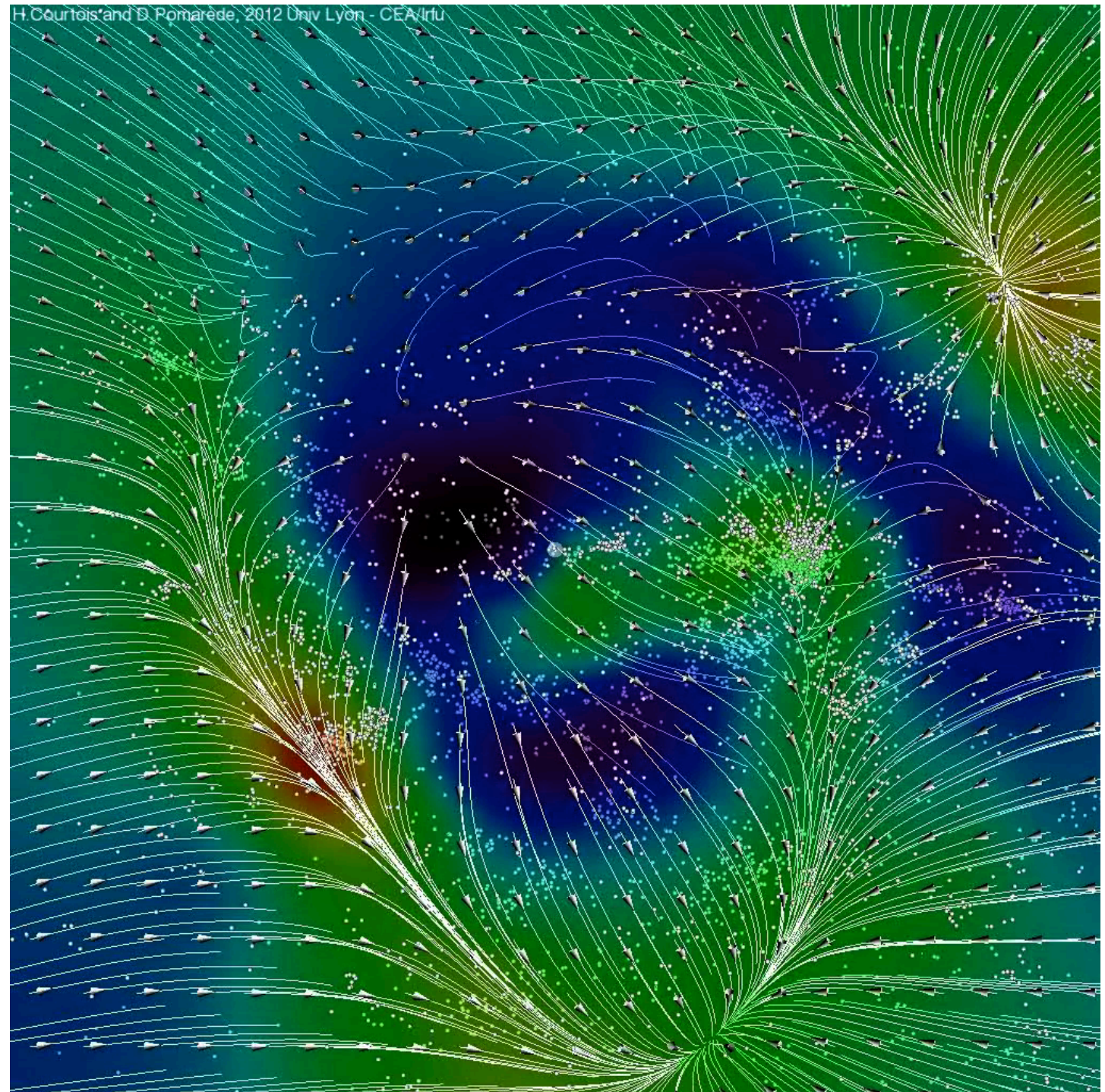
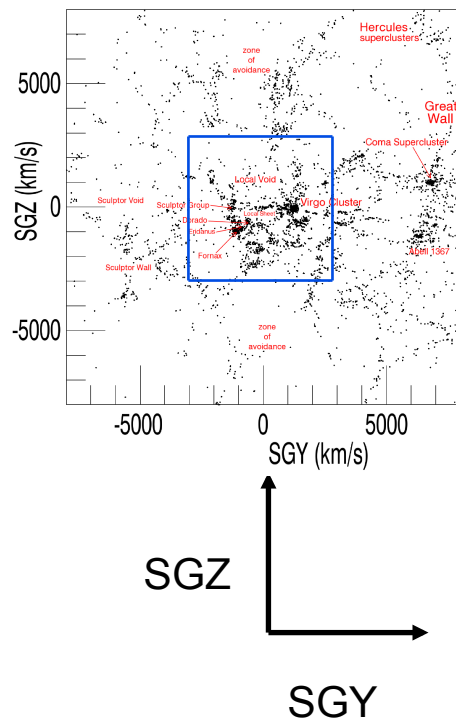
Flows on Large Scales



backside infall into Great Attractor?

Wiener Filter reconstructions of
3D velocity fields and density
maps. Results from
cosmicflows-1

Courtois, Pomarede, Hoffman
2013, AJ, 146, 69
Expulsion from the Local Void.



Wiener Filter with Constrained Realizations

- Estimate Bayesian probability that data fits prior model that structure emerged from initial Gaussian fluctuations.
- Model assumes Λ CDM WMAP power spectrum.
- Wiener filter schematic: $P_k/(P_k + \sigma^2)$ where P_k is power spectrum and σ is error $\Rightarrow$ 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 $\Rightarrow$ 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.

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Properties of peculiar velocities in the linear regime

- Scale of non-linearity for velocity field is a few Mpc (10x larger for density field)
- Coherent tidal flows => information on structure well beyond domain of direct observations
- Decomposition of divergent (local) and tidal components:
$$\text{Div}V = -H_0 \Omega^{0.55} \delta$$
- Local flows about arbitrary centers and with arbitrary radius can be studied by setting densities to null field outside selected radius; tidal flows are residuals from local flows
- V-web: order 3 eigenvalues of shear tensor $\lambda_1 > \lambda_2 > \lambda_3$
 - knot: 3 above threshold;
 - filament: 2 above threshold;
 - sheet: 1 above threshold;
 - void: 0 above threshold

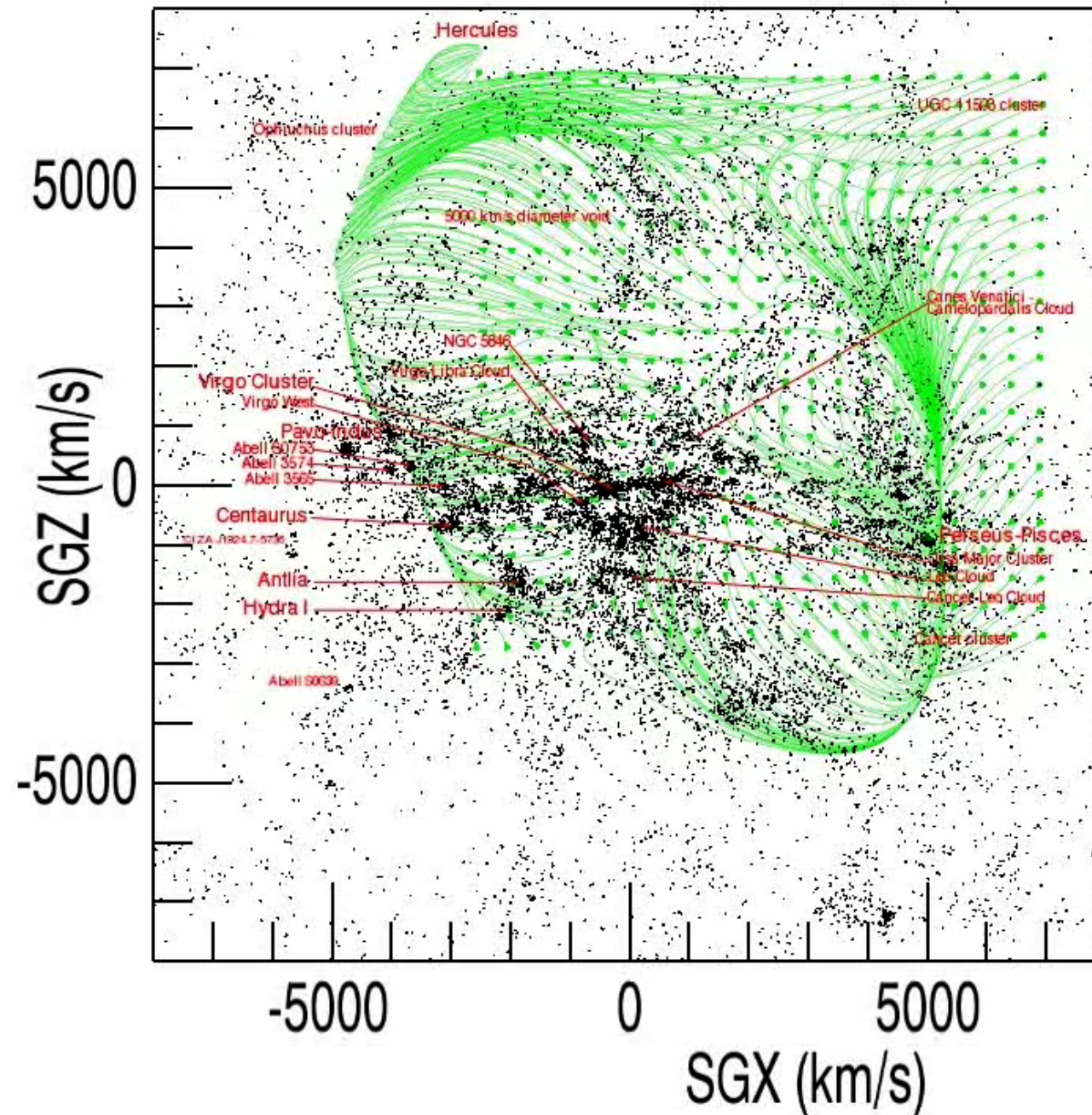
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 - void: 0 above threshold

Properties of peculiar velocities in the linear regime

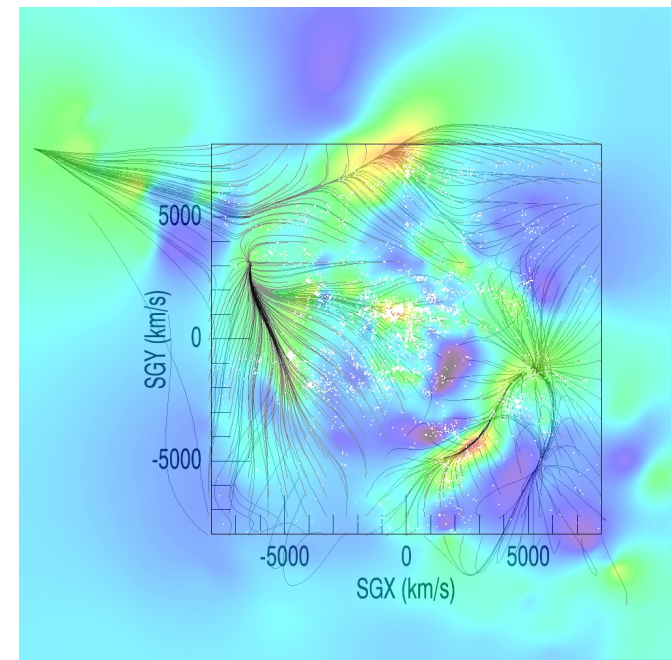
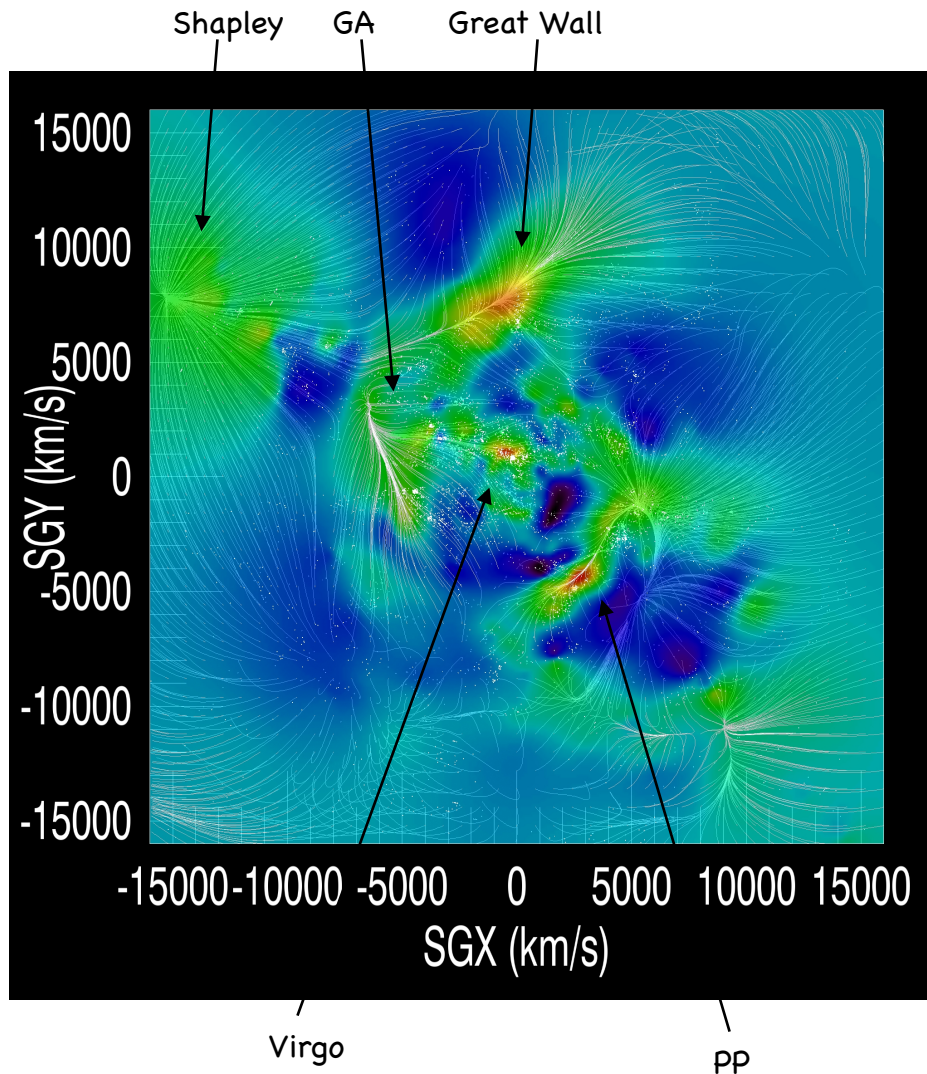
- Scale of non-linearity for velocity field is a few Mpc (10x larger for density field)
- Coherent tidal flows => information on structure well beyond domain of direct observations
- Decomposition of divergent (local) and tidal components:
$$\text{Div}V = -H_0 \Omega^{0.55} \delta$$
- Local flows about arbitrary centers and with arbitrary radius can be studied by setting densities to null field outside selected radius; tidal flows are residuals from local flows
- V-web: order 3 eigenvalues of shear tensor $\lambda_1 > \lambda_2 > \lambda_3$
 - knot: 3 above threshold;
 - filament: 2 above threshold;
 - sheet: 1 above threshold;
 - void: 0 above threshold

Preliminary Wiener Filter result from Cosmicflows-2



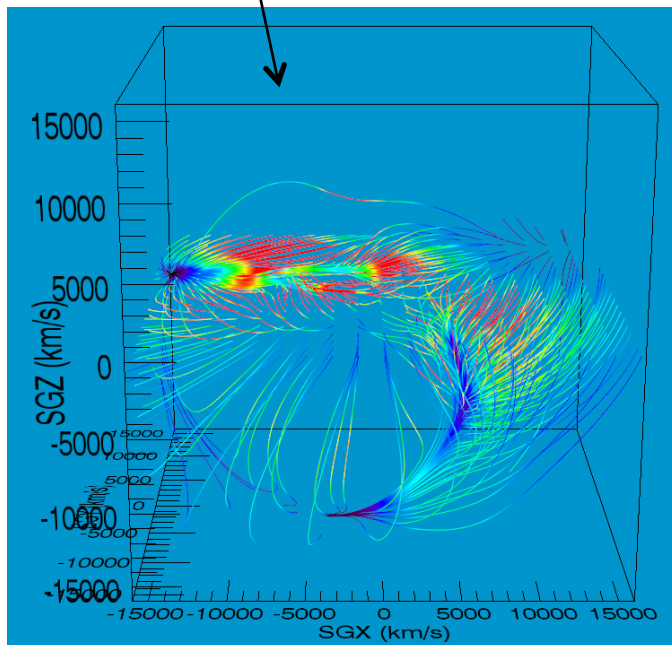
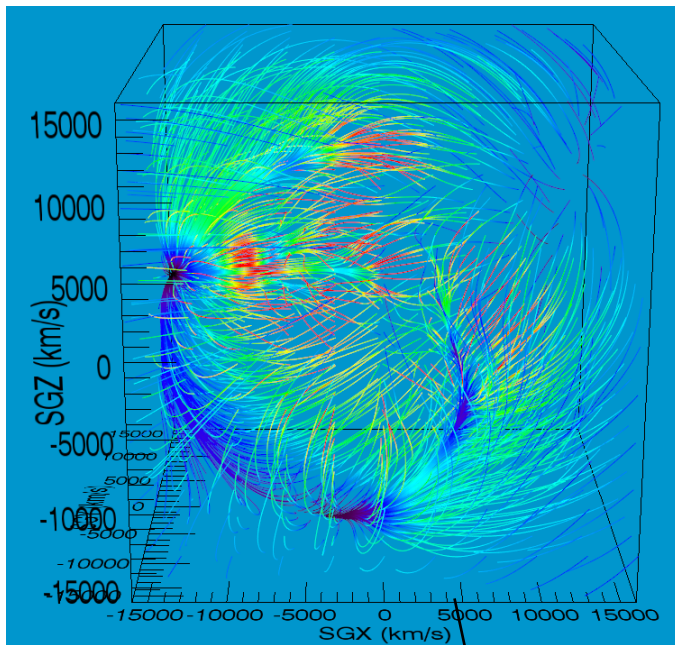
Wiener Filter Reconstructions with Cosmicflows-2

3D velocities and density map computed from CF2 peculiar velocities

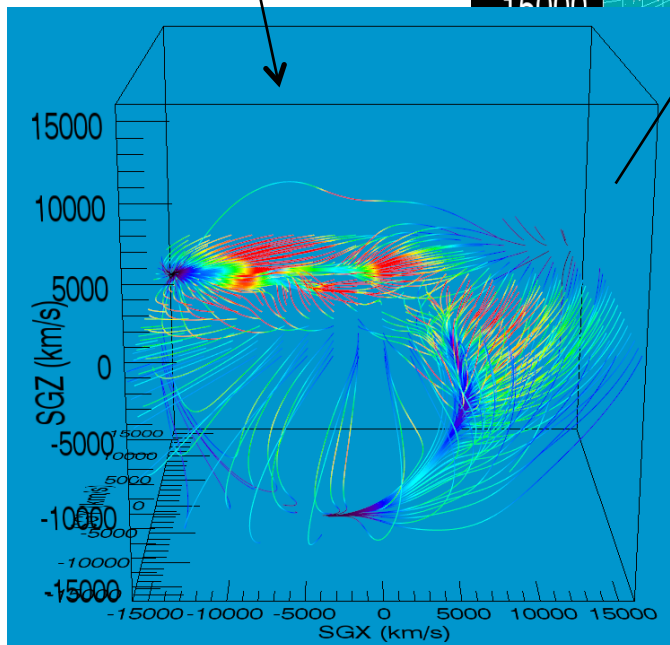
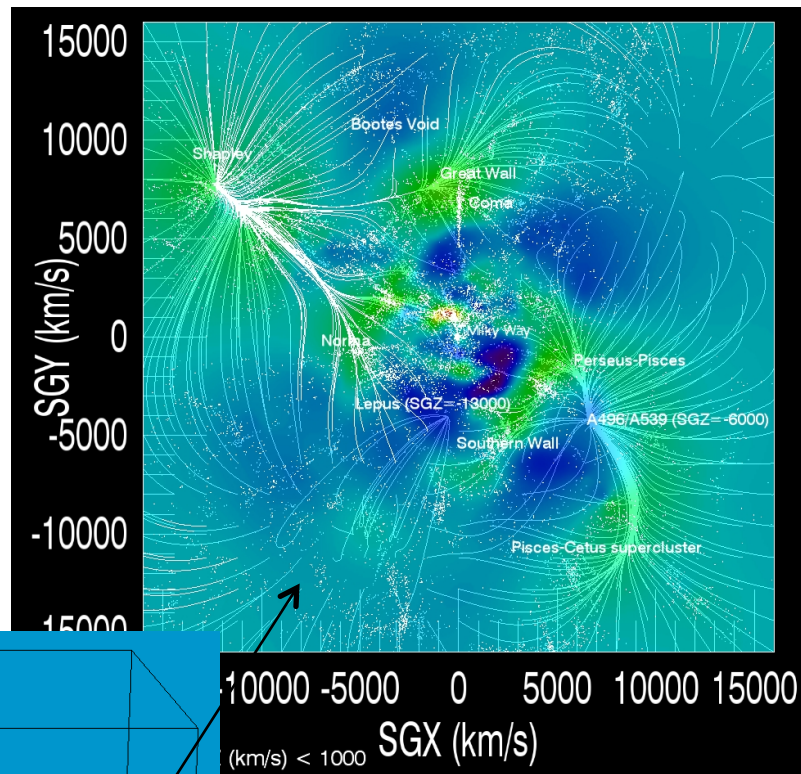
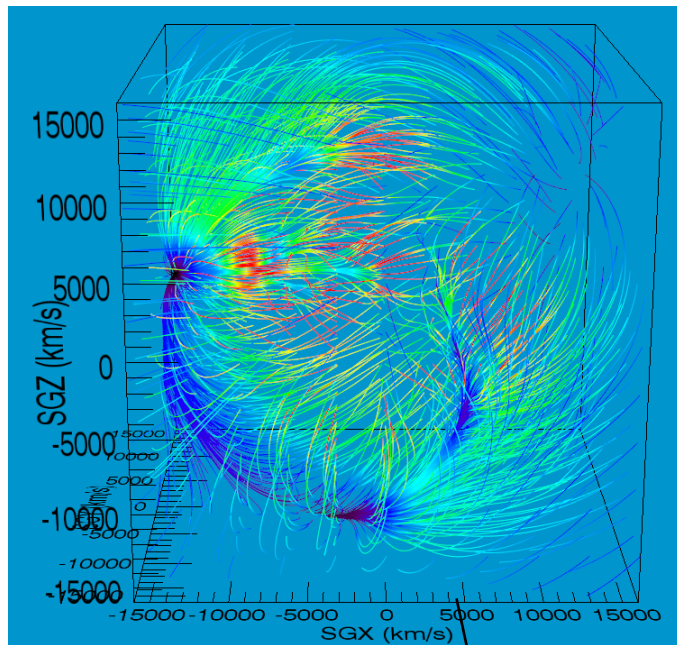


Hoffman, Pomarede, Courtois

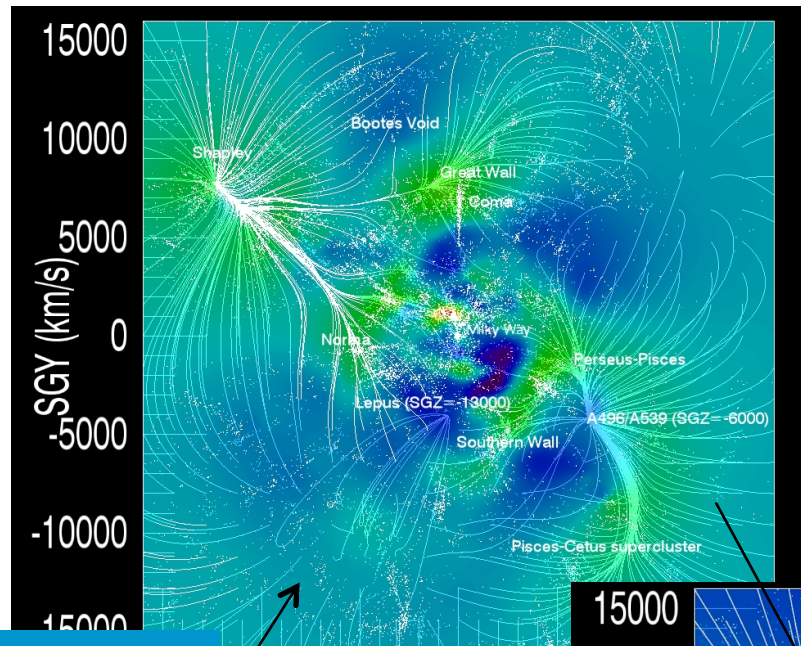
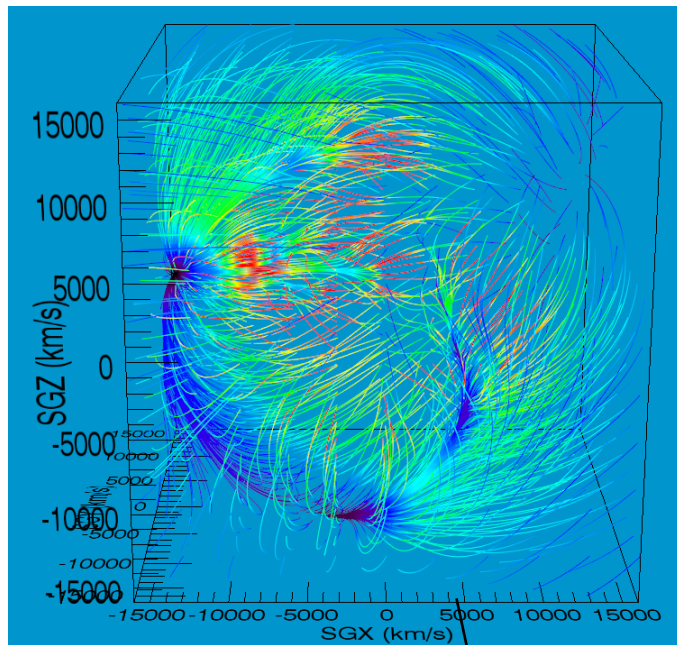
Flow Dissection



Flow Dissection

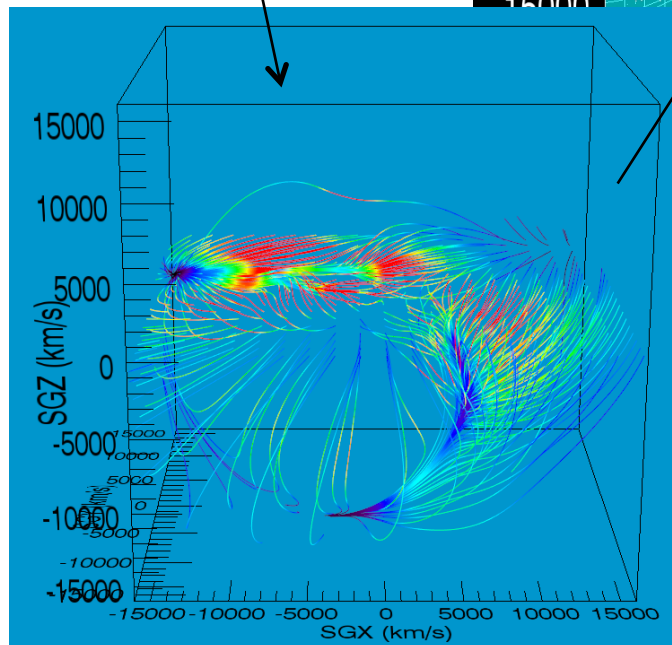


Flow Dissection

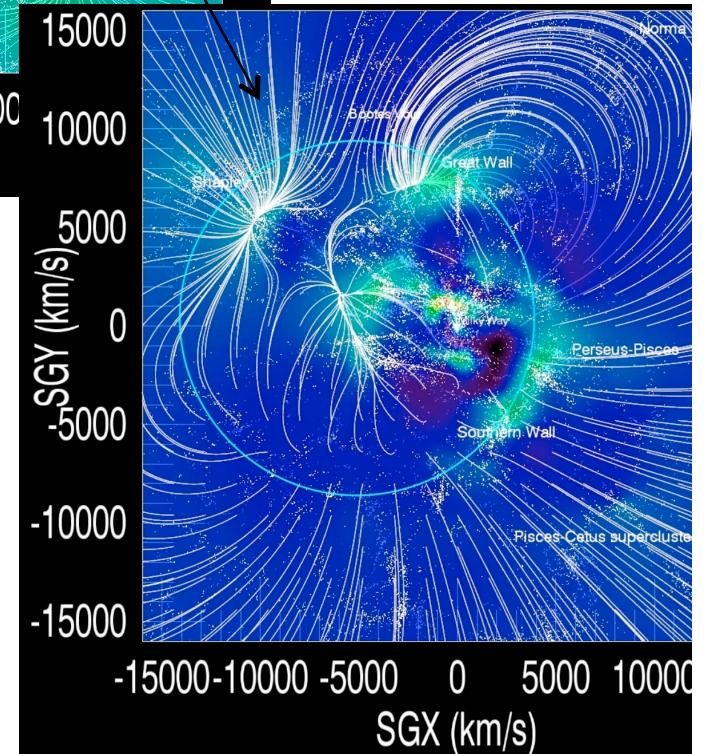


full flow

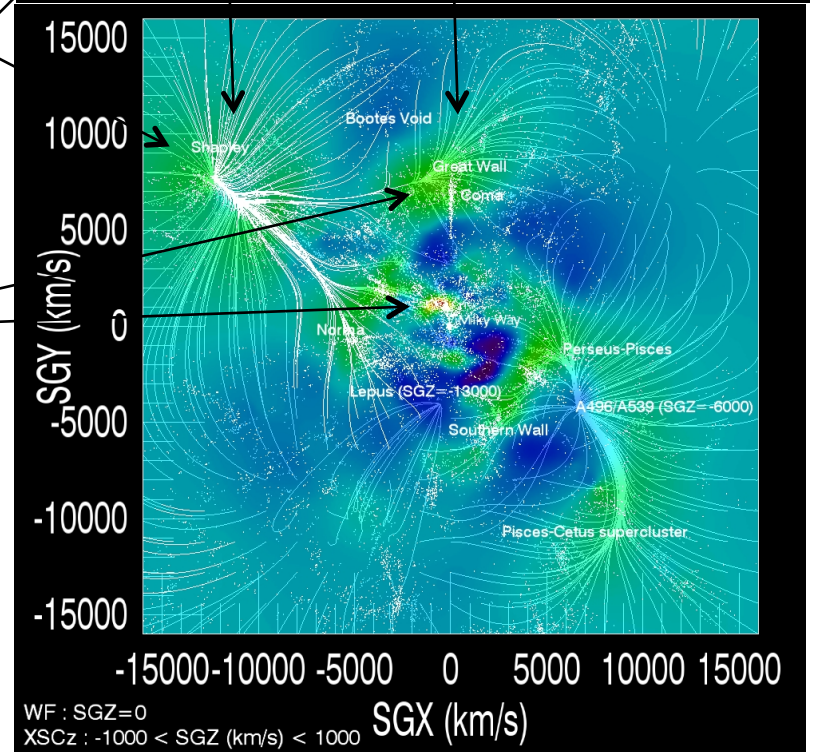
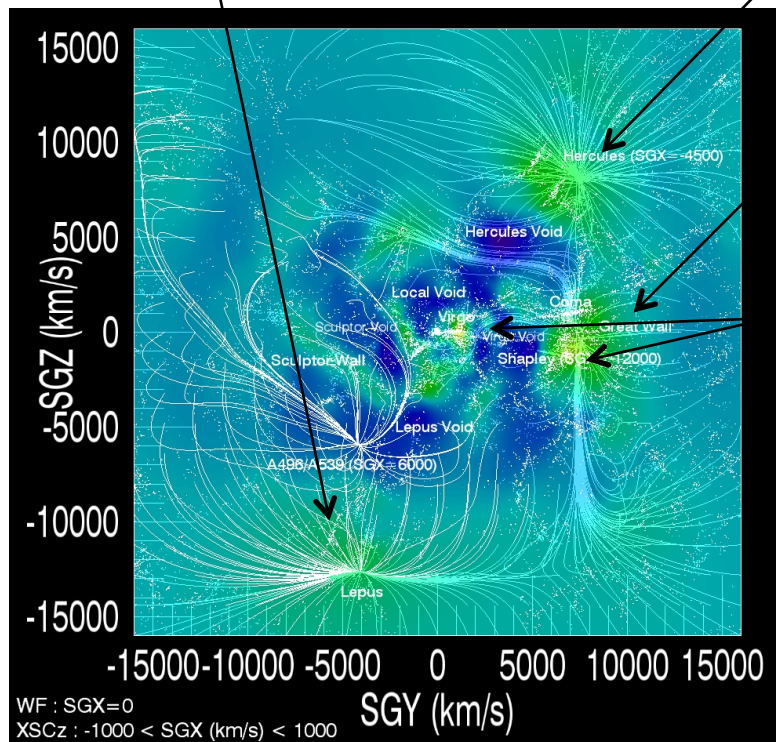
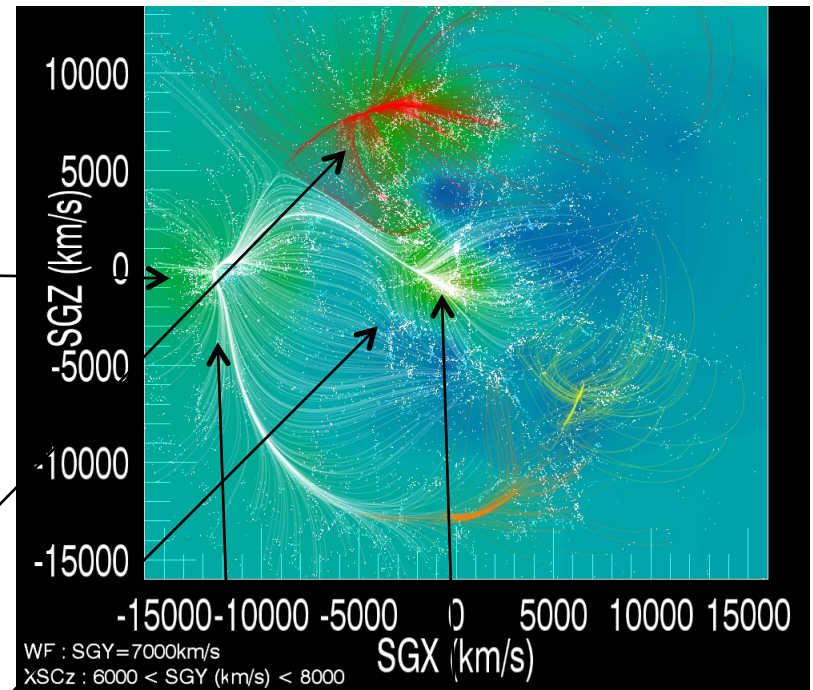
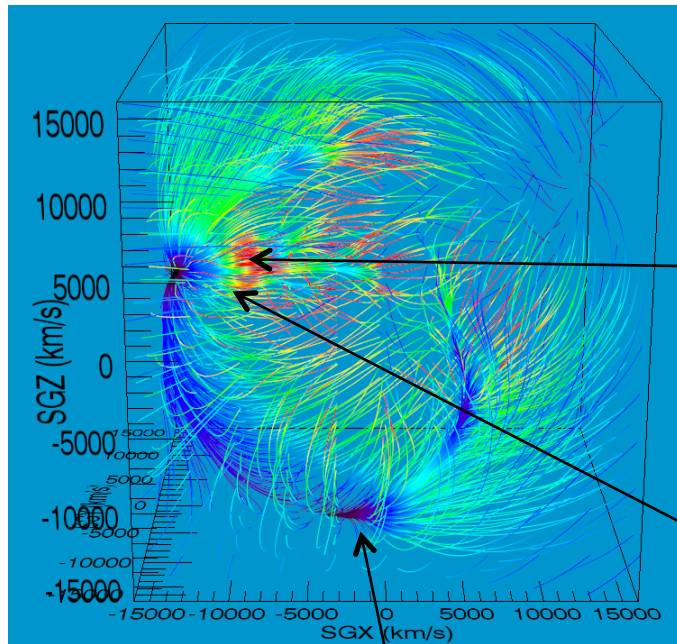
local (divergent) flow



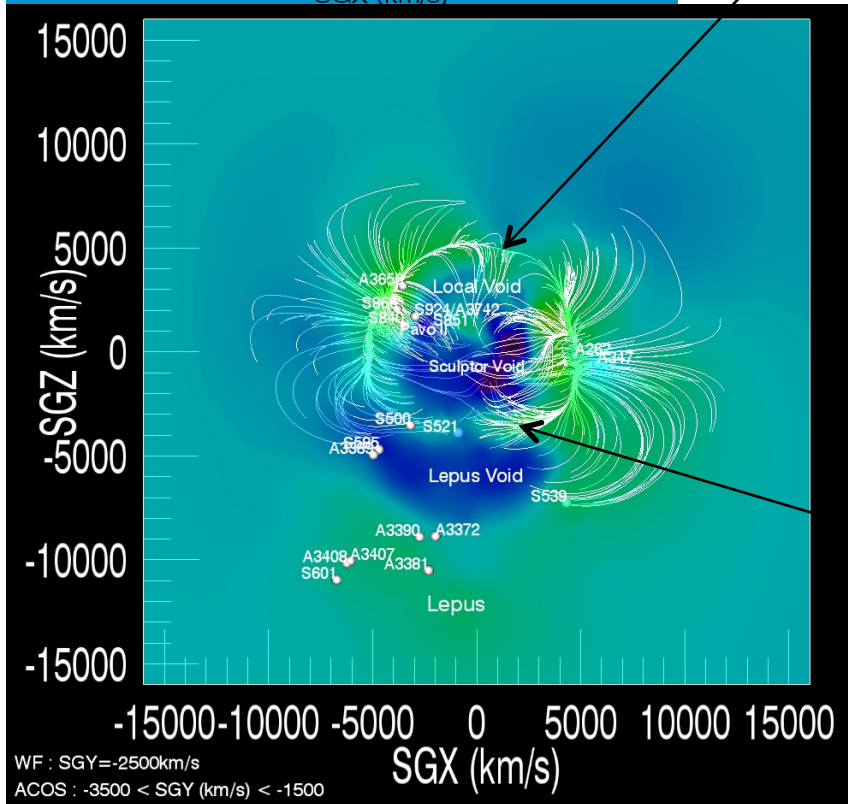
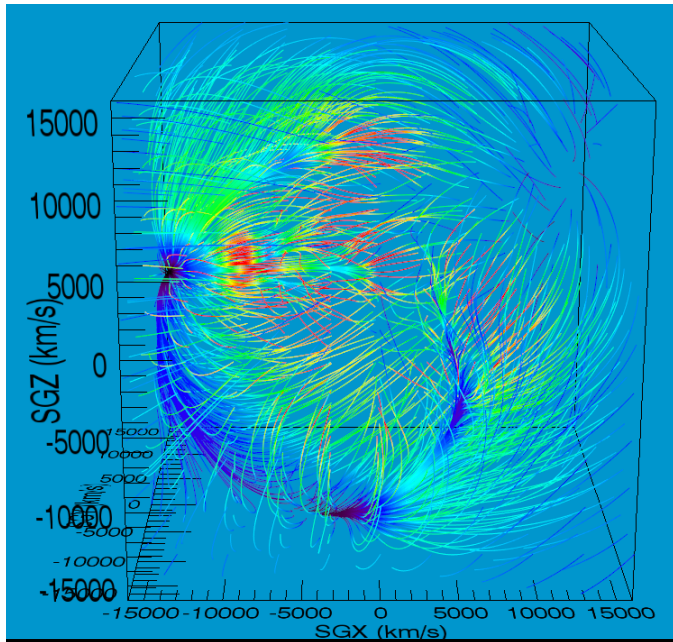
(km/s) < 1000
SGX (km/s)



slices

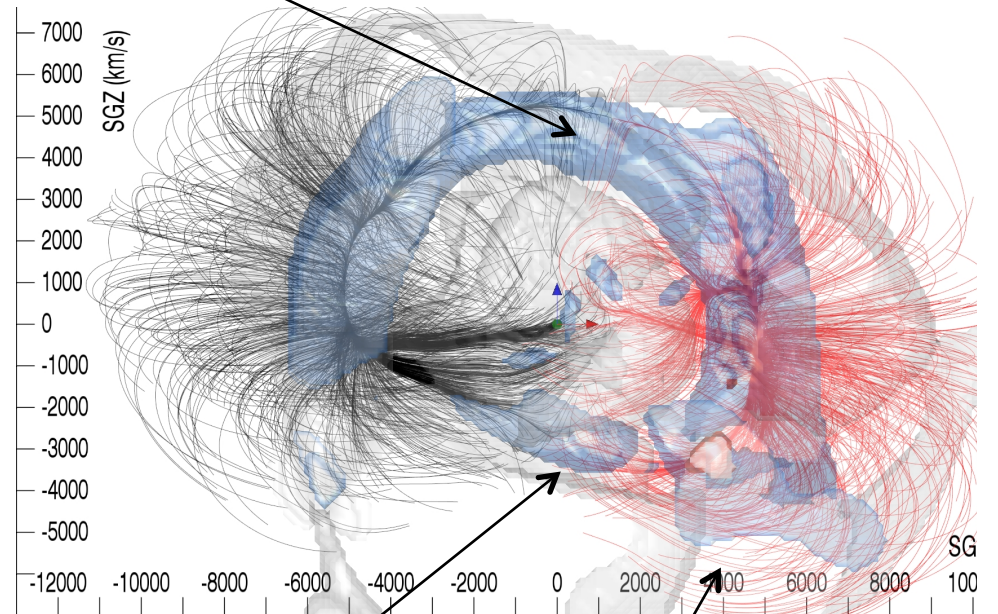


Watershed Connections



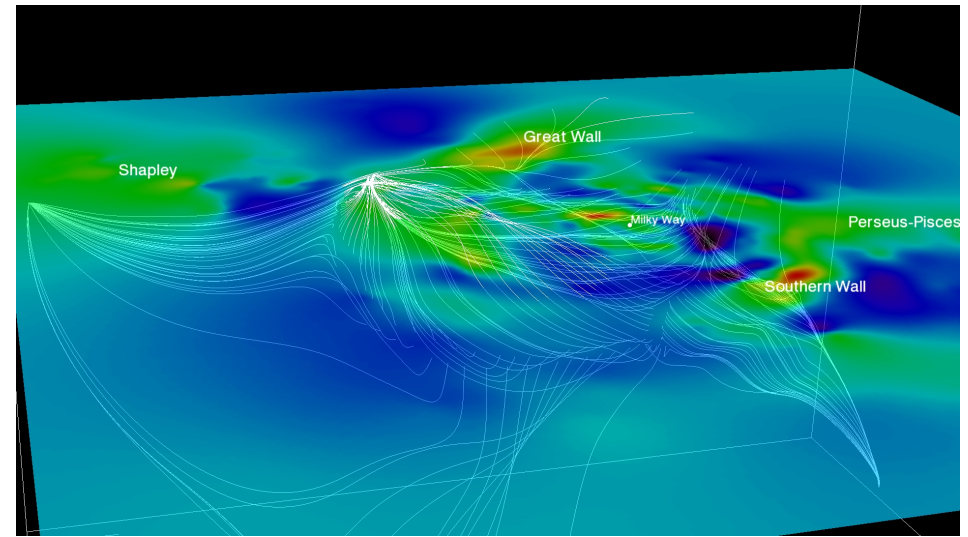
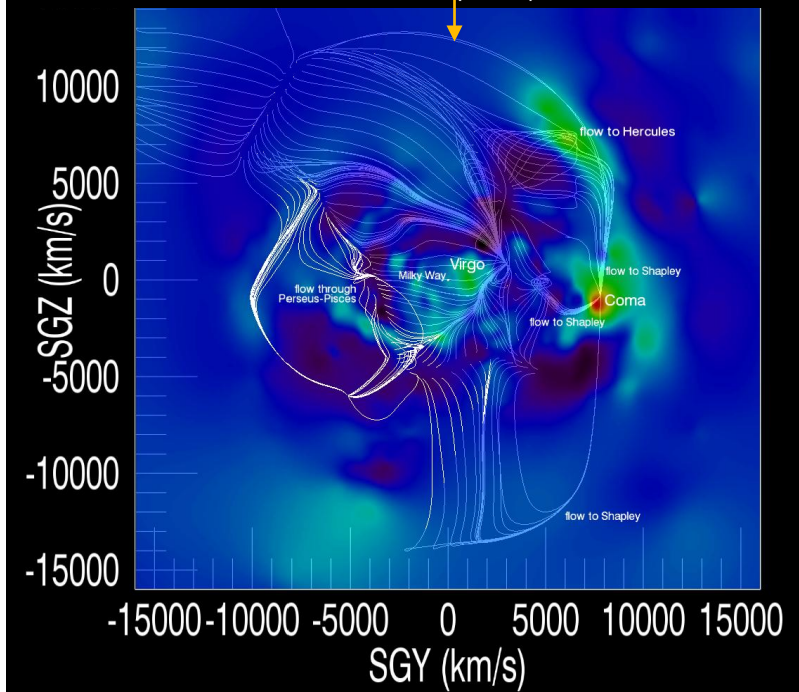
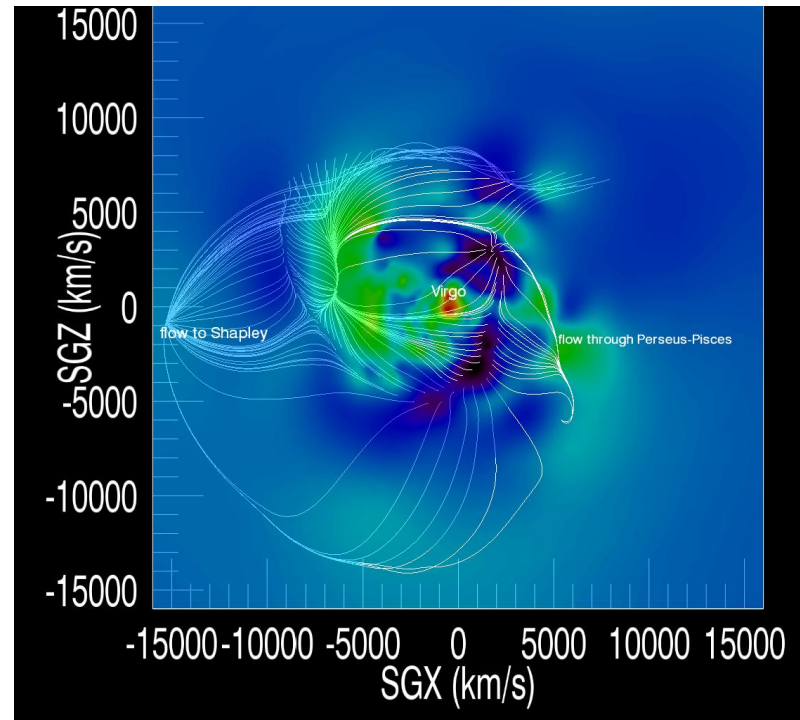
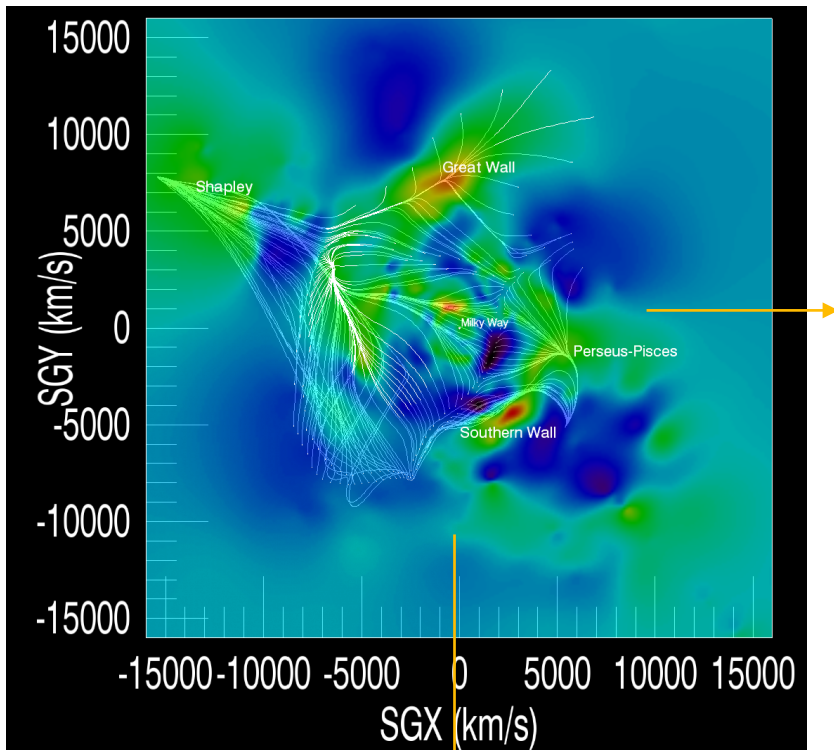
"Arch"

Laniakea

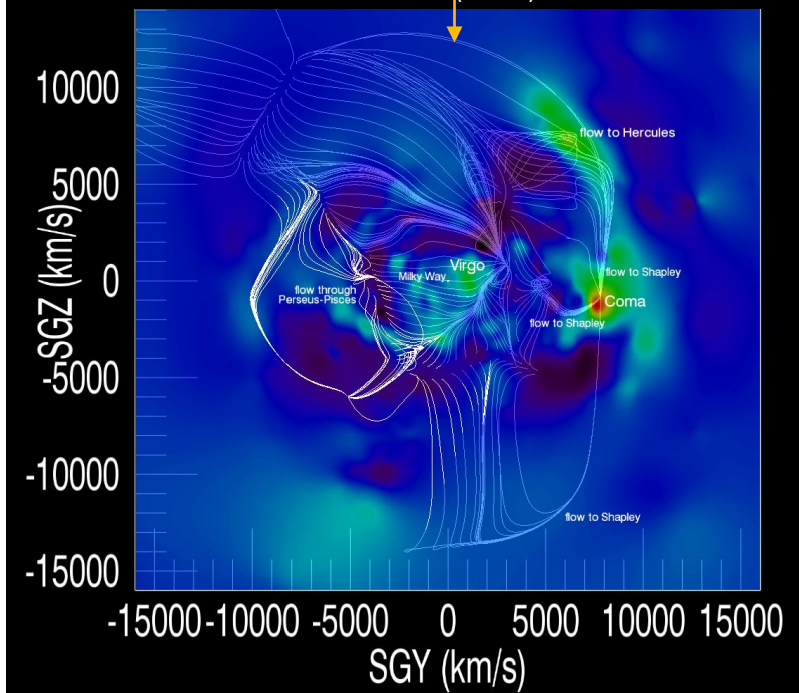
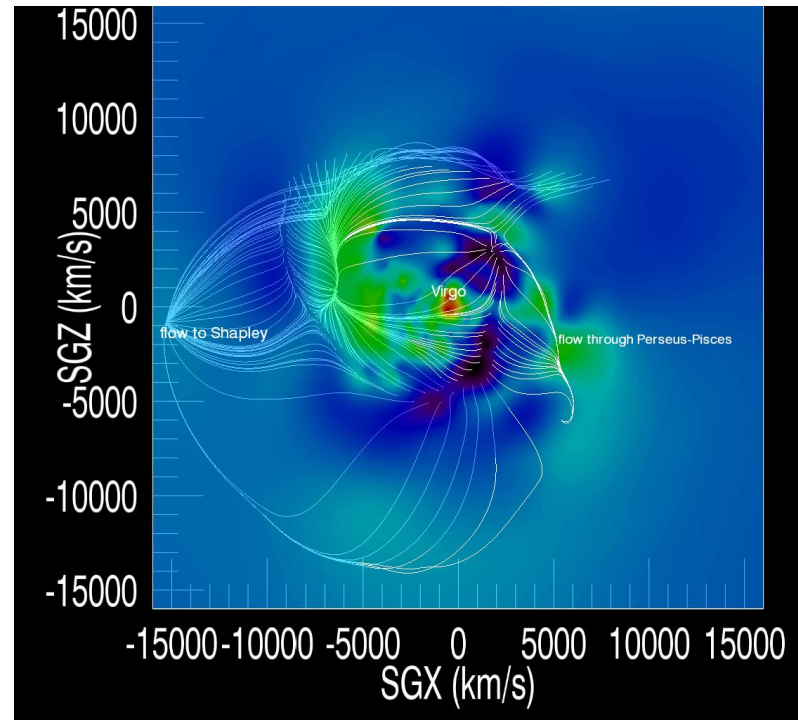
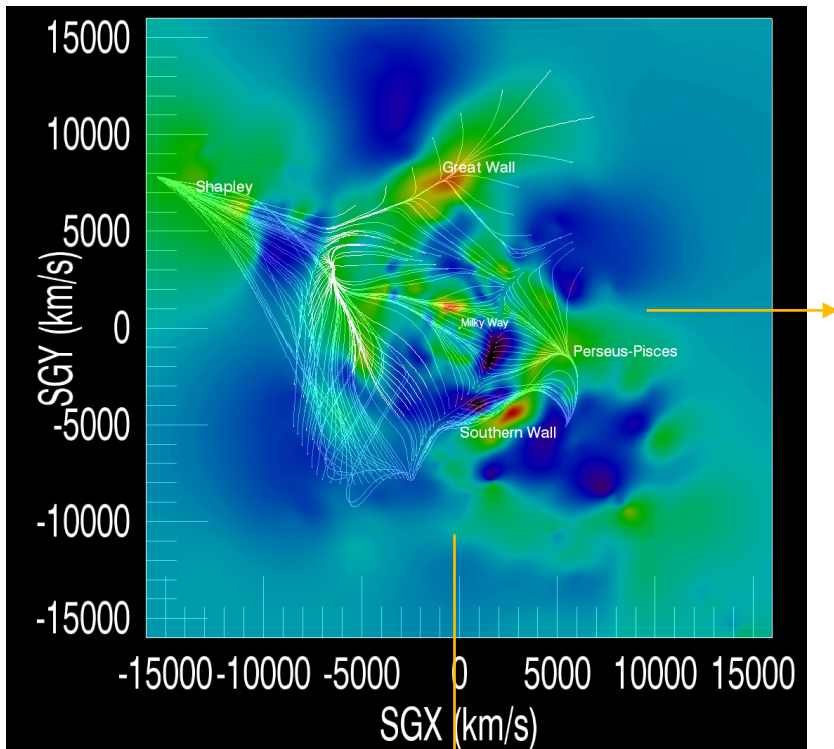


Perseus-Pisces

Antlia Wall Extension



WF: Orthogonal Views

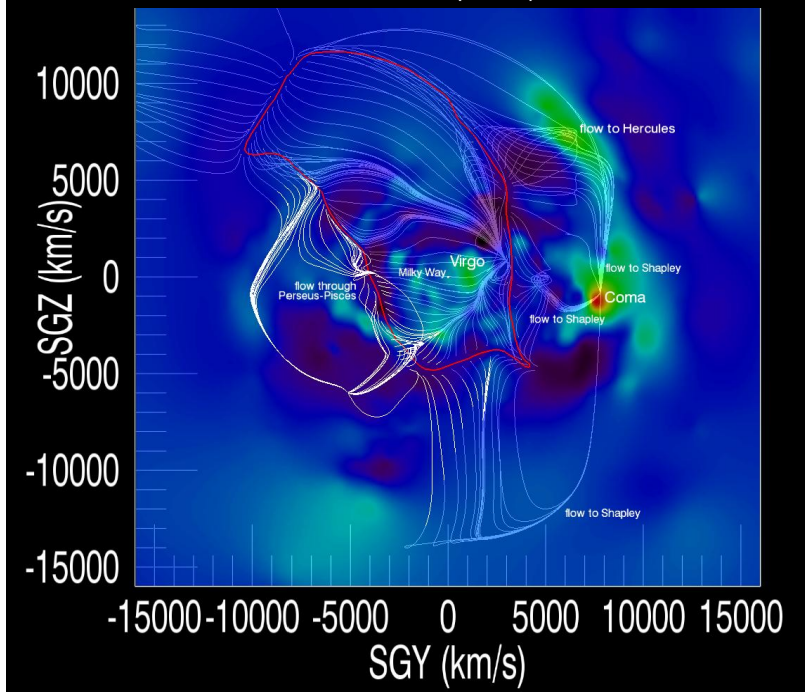
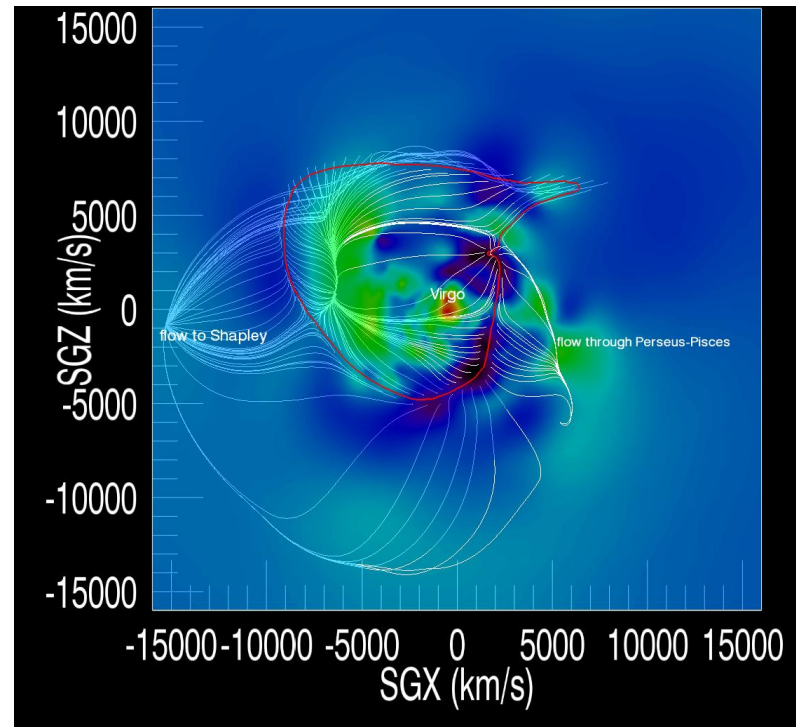
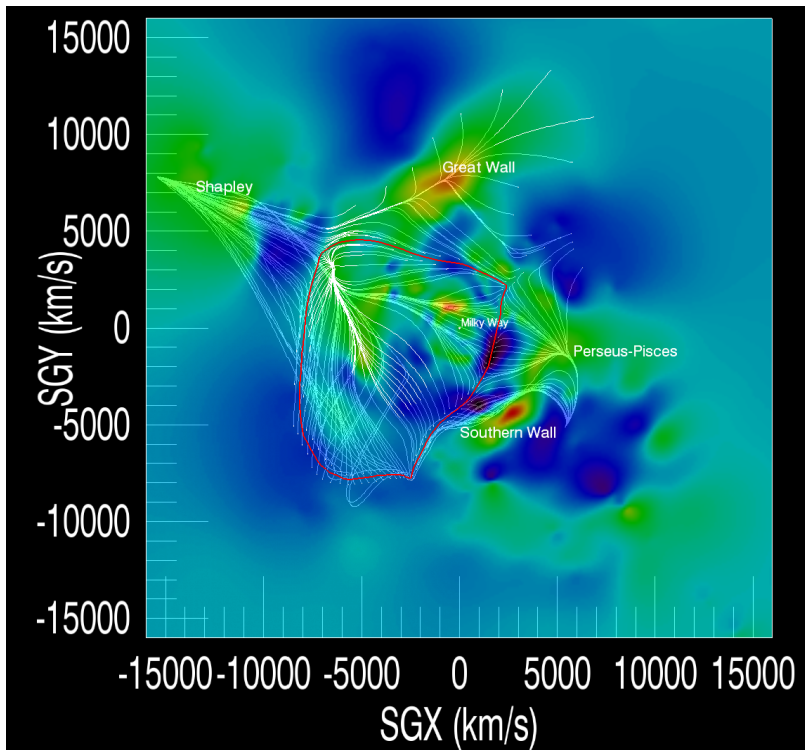


What is a supercluster?

Watershed analogy: divides most easily discerned by divergences in the flow of water

Our definition of a supercluster: a contiguous region of in-flowing velocity streams

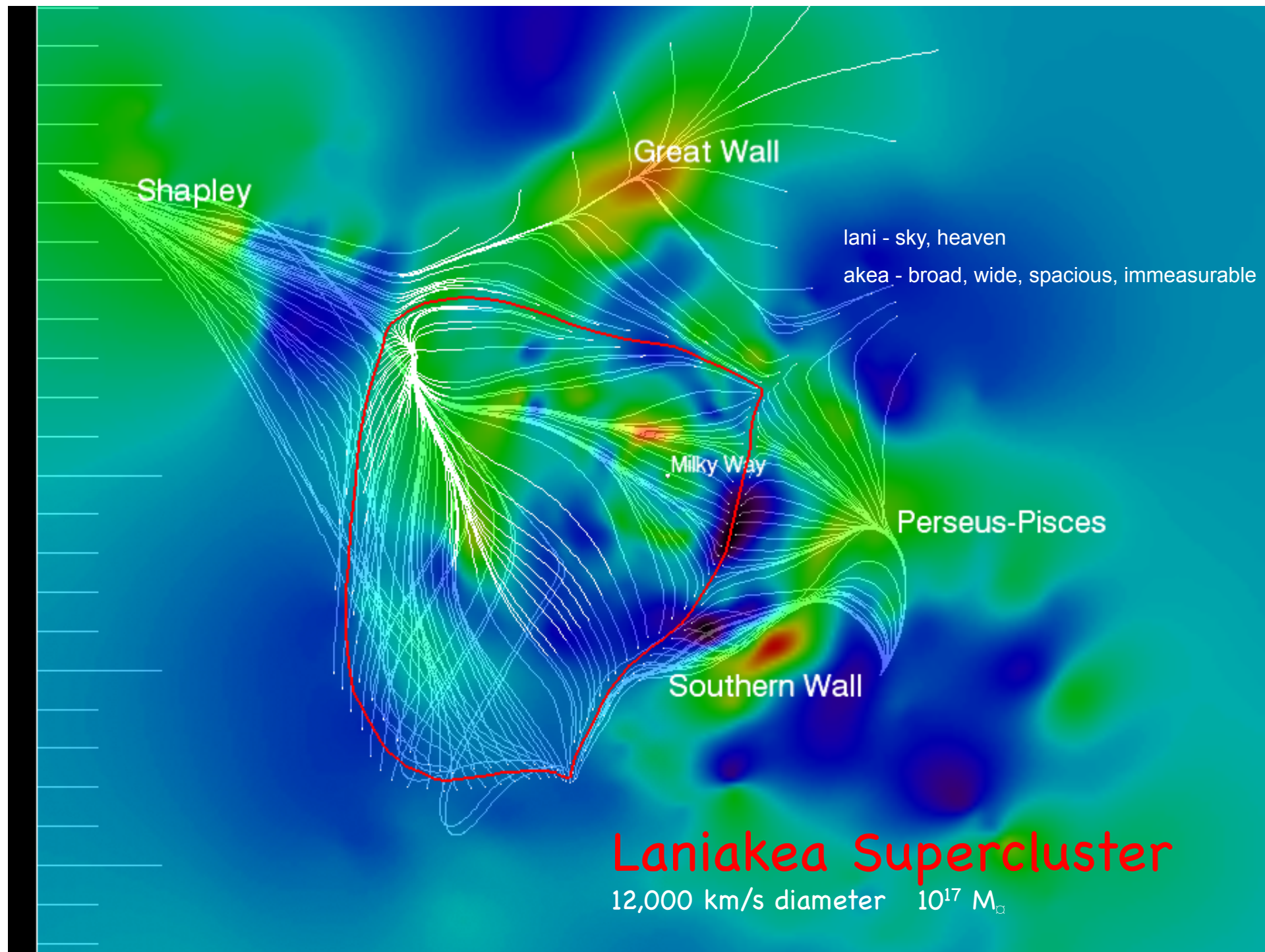
WF: Orthogonal Views

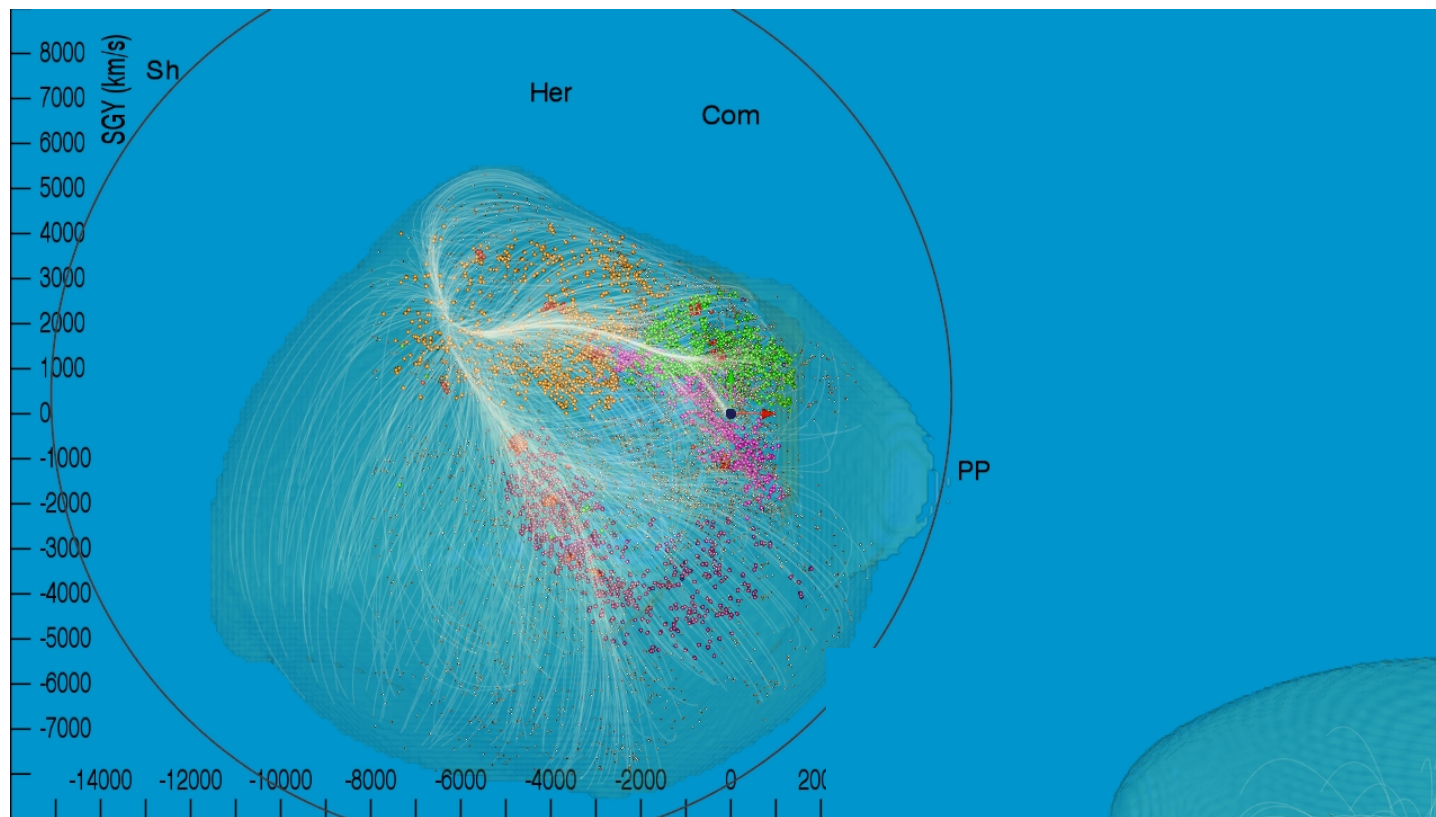


Red outlines separate region of inward flows from outward flows.

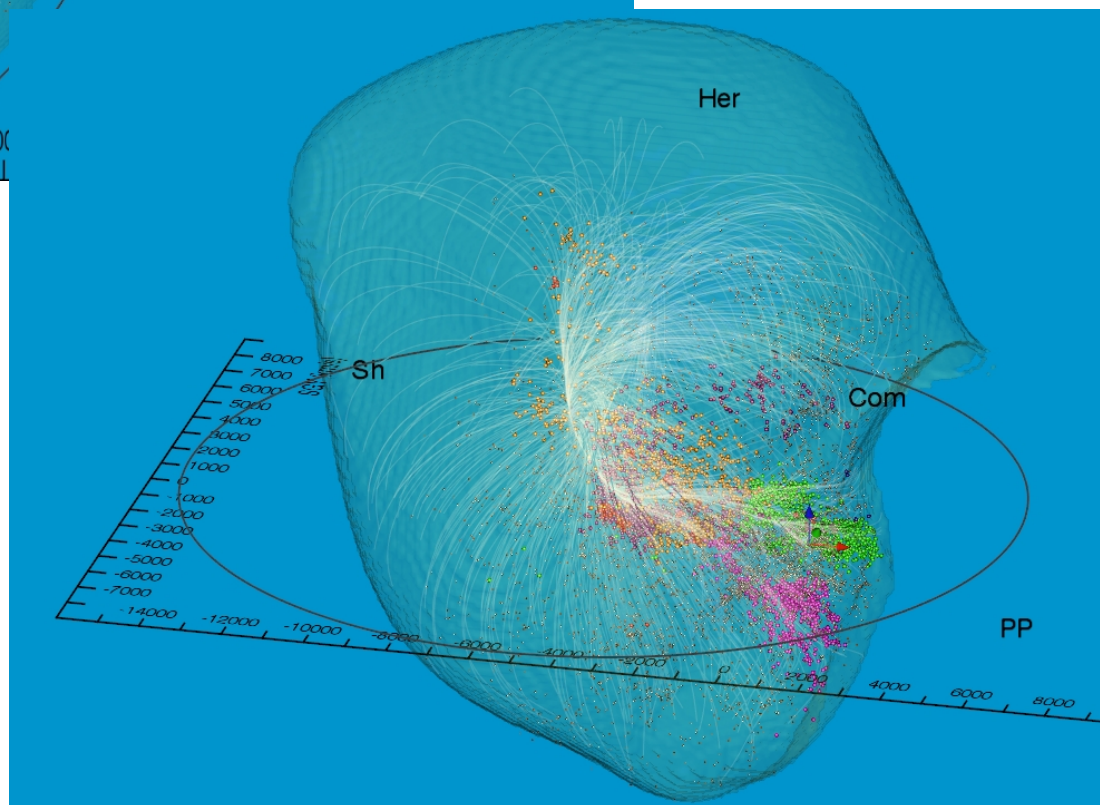
This kinematic information provides an optimal definition of a supercluster

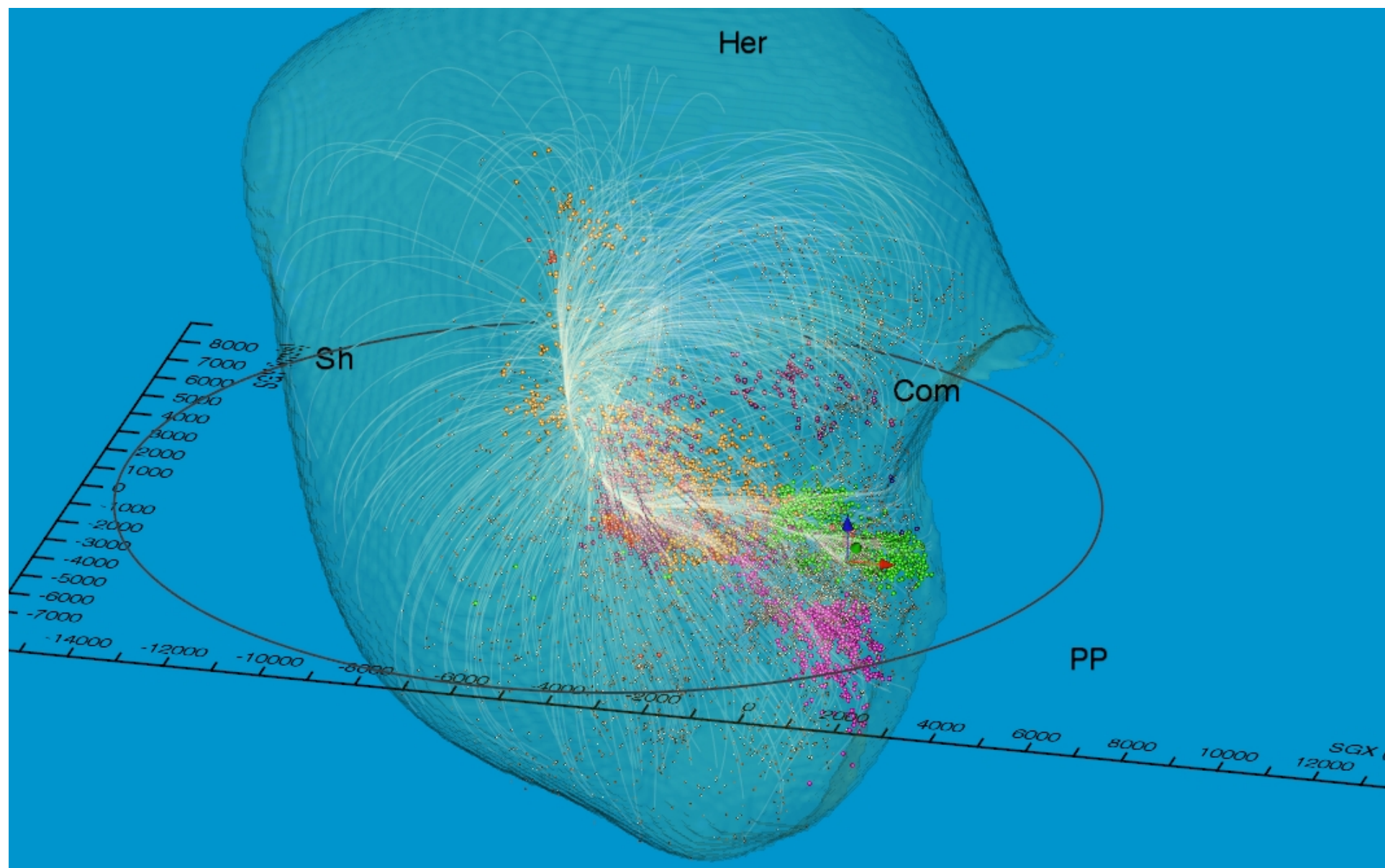
WF: Orthogonal Views





Laniakea





movie

