Galaxy Surveys and Databases

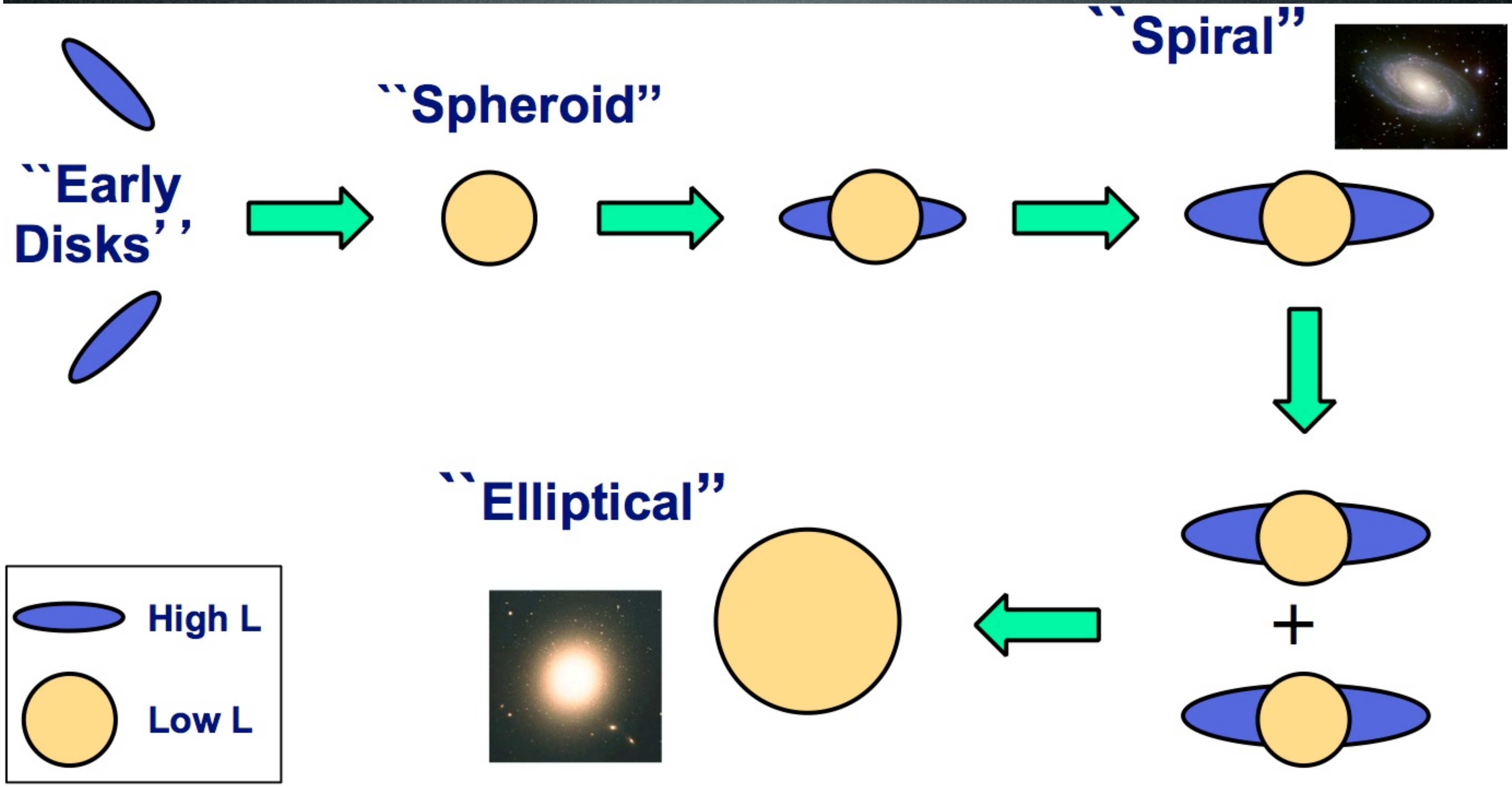
Luc Simard

Astronomy 505
Fall 2014

Outline

- Two galaxy surveys as examples: SINS and SLACS
- Using databases
- Paper discussion

Galaxy Formation through Hierarchical Assembly



Why are large surveys needed?

- Large statistical samples are required for comparison with stochastic, hierarchical galaxy assembly models
- Well-characterized errors and completeness limits
- Control samples can be defined
- The local and distant Universes can be compared
- Unique subsamples can be selected for follow-up studies

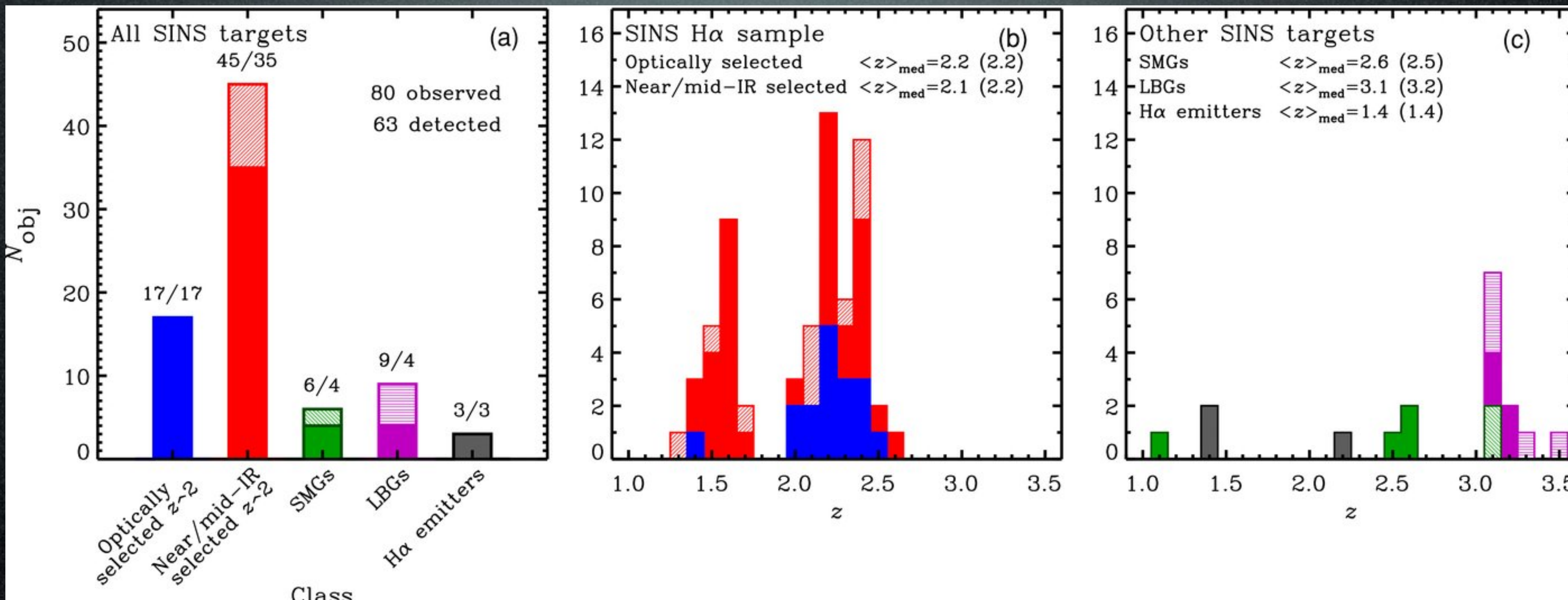
Why are databases needed?

- Galaxy samples are now reaching 100s millions of objects – The Large Synoptic Survey Telescope will push towards billions
- Each object may have a large number of measurements associated with it: fluxes, sizes, axial ratios, orientation, asymmetries
- Measurements may be multi-wavelength
- Benefits of a database:
  - Able to store very large samples
  - Flexible queries for subsample definition
  - Data curation: additions/deletions, updates, versioning
  - Can be interfaced with powerful data visualization tools

Spectroscopic Imaging survey in the Near-infrared with SINFONI (SINS)

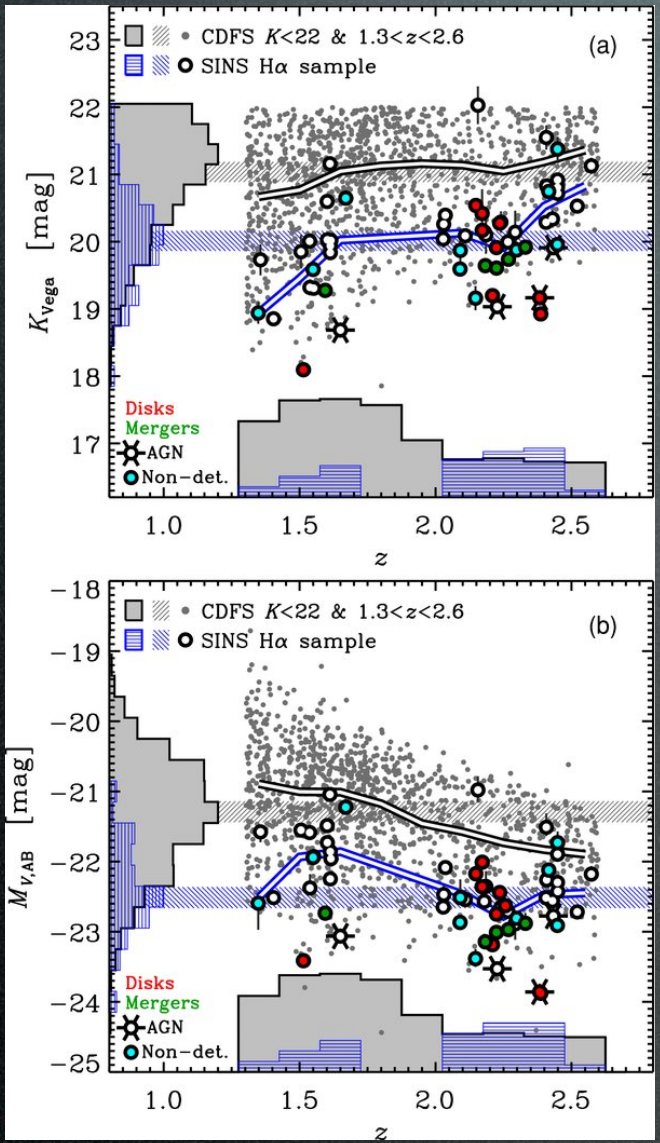
Forster-Schreiber, N. M. et al. 2009, Astrophysical Journal, 706, 1364
(+ many other papers in SINS series)

SINS – Distribution of the SINS galaxies as a function of class and redshift



- Main selection criteria:
  - Integrated emission line flux
  - Sky line avoidance
  - Visibility
- 80 galaxies observed, 63 of which were detected

SINS – Redshift and Magnitude Distribution

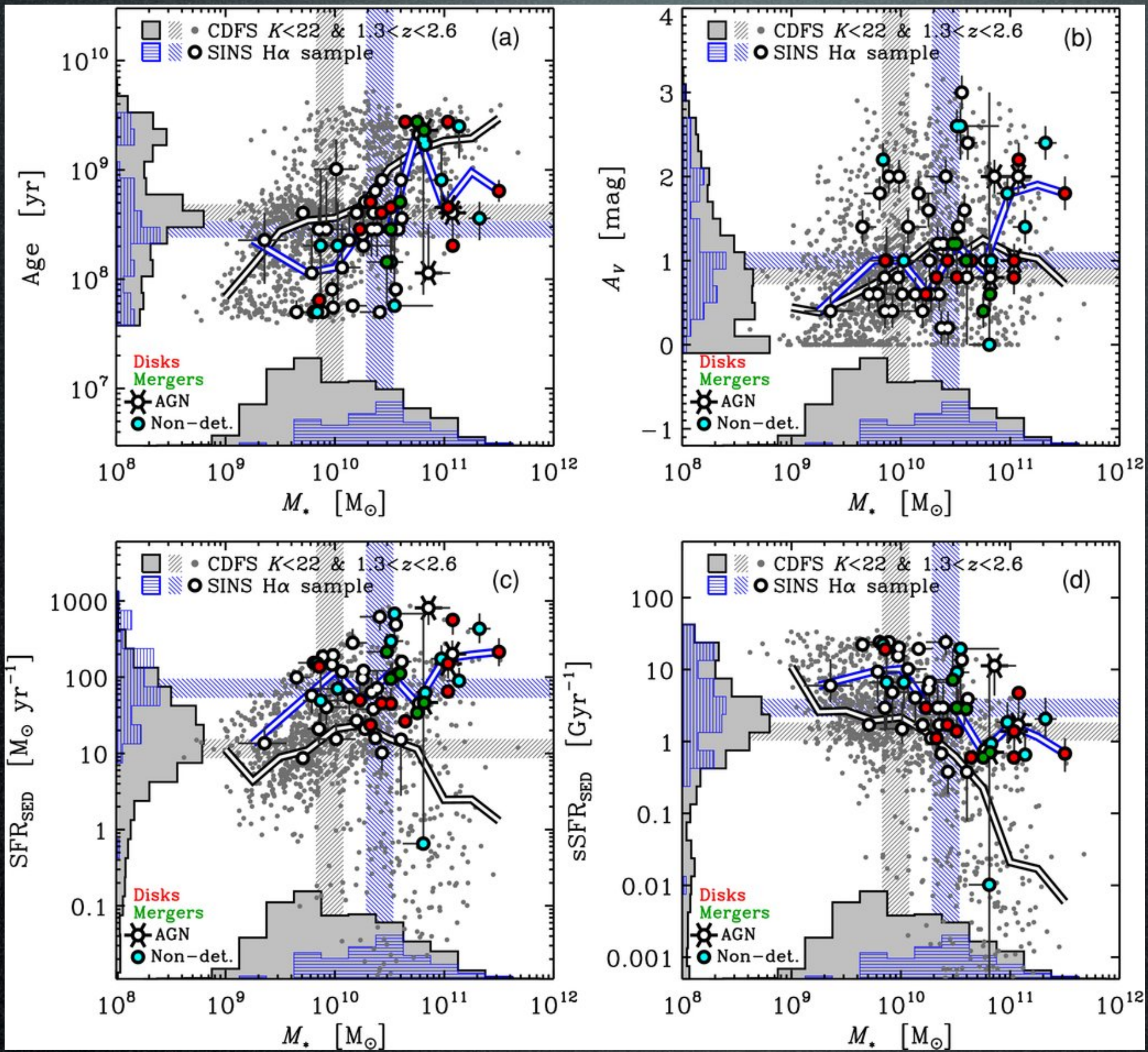


Note how biased the SINS H-alpha sample is in K-band compared to K-band selected galaxies

This bias is unavoidable because strong emission line is required for detection → star-forming galaxies

Gaps in redshift distribution come from sky line avoidance

SINS - Properties derived from SED modelling



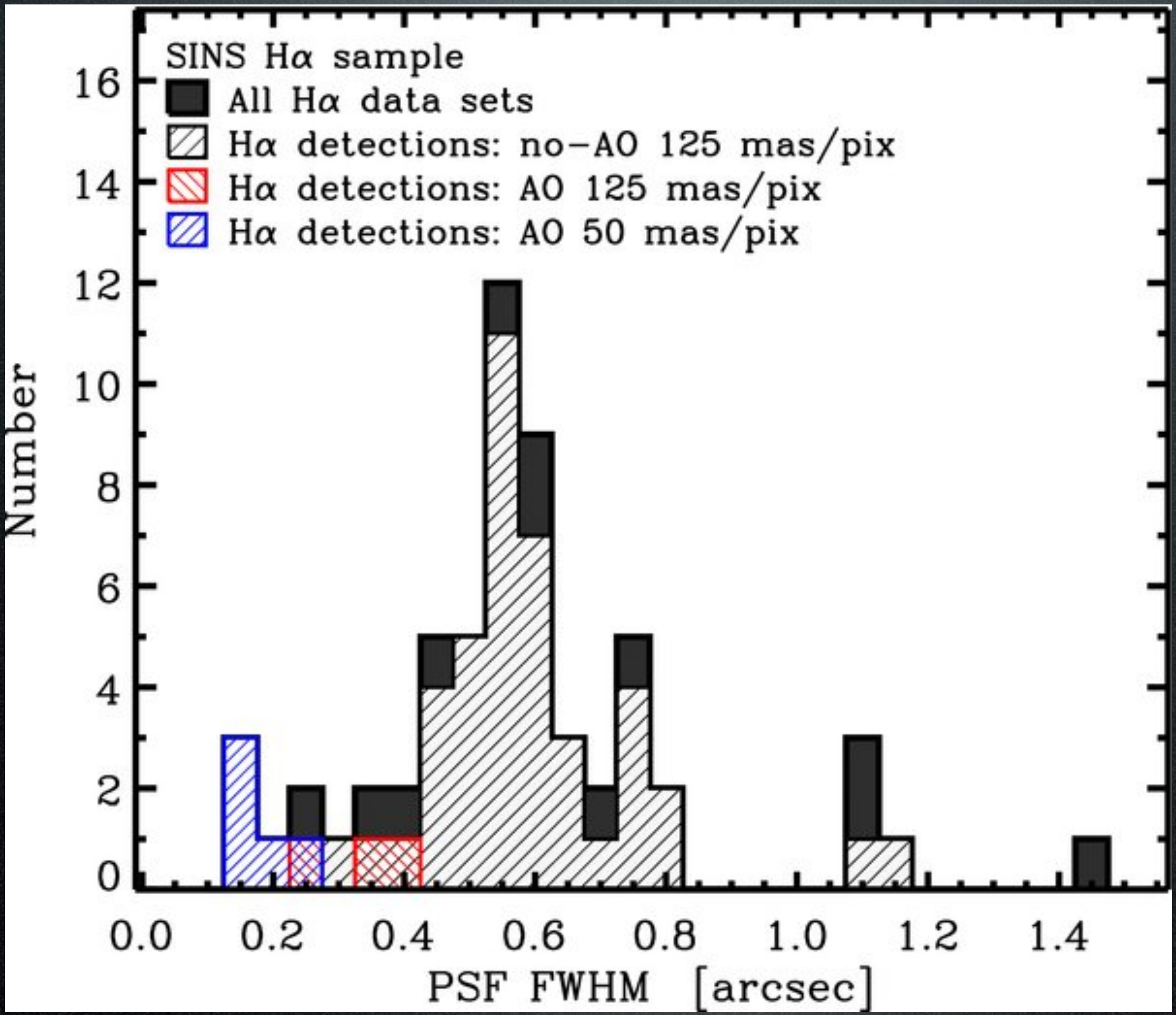
SINS – Observational Parameters

Table 5. Summary of the SINFONI Observations

Source	z_{sp}[a]	Band	Scale[b] (mas)	Mode	t_{int}[c] (s)	PSF FWHM[d]	Run ID[e]
Q1307-BM1163	1.4105	*H*	125	Seeing-limited	14400	0.″61	Mar 05
		J	125	Seeing-limited	7200	0.″77	Mar 05
Q1623-BX376	2.4085	*K*	125	Seeing-limited	15600	0.″49	Mar 05, Apr 05
Q1623-BX447	2.1481	*K*	125	Seeing-limited	14400	0.″56	Mar 06, Aug 06
		H	125	Seeing-limited	1800	0.″83	Apr 07
Q1623-BX455	2.4074	*K*	125	Seeing-limited	12000	0.″57	Mar 05
Q1623-BX502	2.1550	*K*	50	NGS/LGS-AO	22800	0.″24	Apr 05, Mar 08, Apr 08
Q1623-BX528	2.2682	*K*	125	Seeing-limited	24300	0.″63	Jul 04, (Aug 05), Mar 07
Q1623-BX543	2.5211	*K*	125	Seeing-limited	8400	···	Mar 06
Q1623-BX599	2.3304	*K*	125	Seeing-limited	5400	···	Jul 04
Q1623-BX663	2.4333	*K*	125	NGS-AO	26400	0.″39	Jul 04, (Mar 07), Apr 07

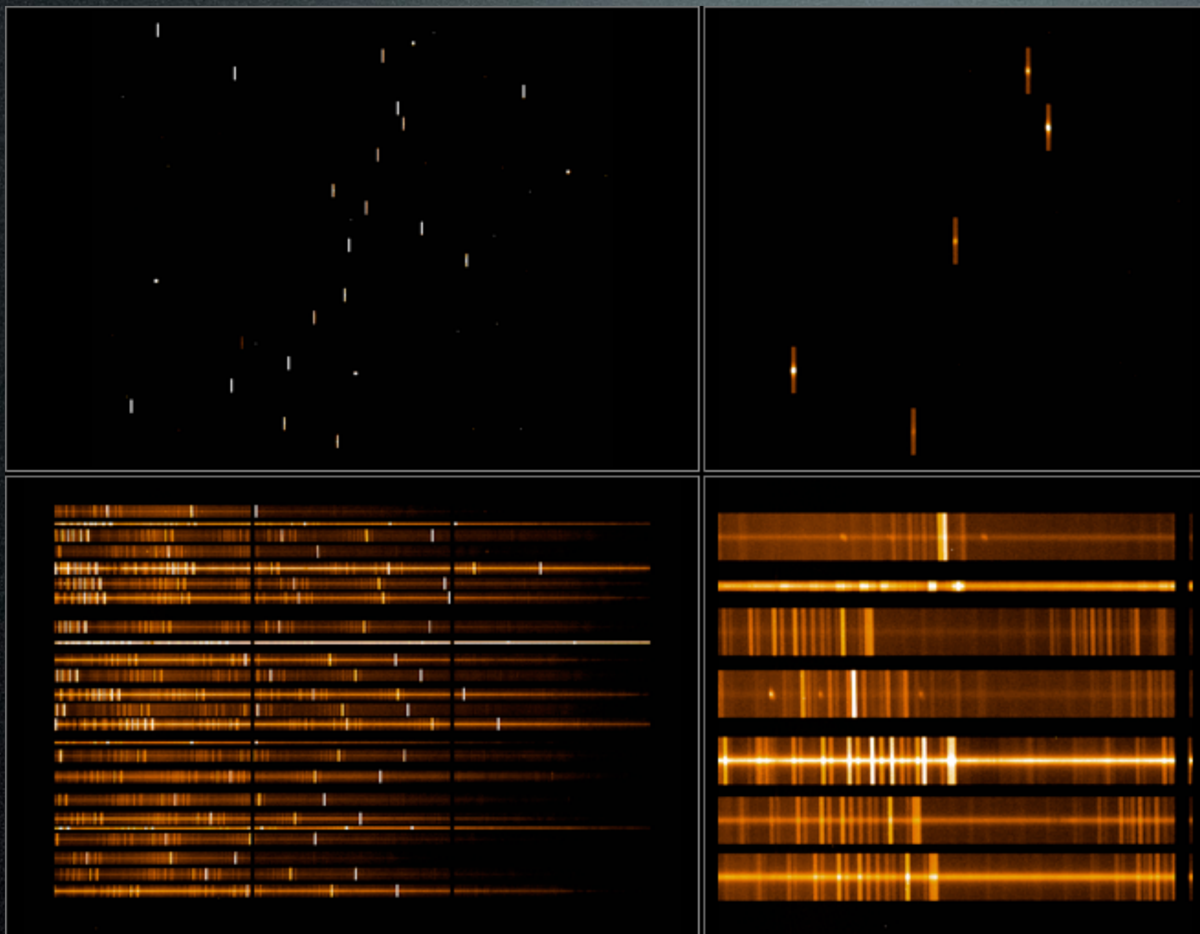
Note the observing modes, i.e., seeing-limited versus AO and the integration times!

SINS – Distribution of the Point-Spread-Function FWHMs



The PSF is critically important for SINS due to an effect called "beam smearing"

Multi-Object Spectroscopy



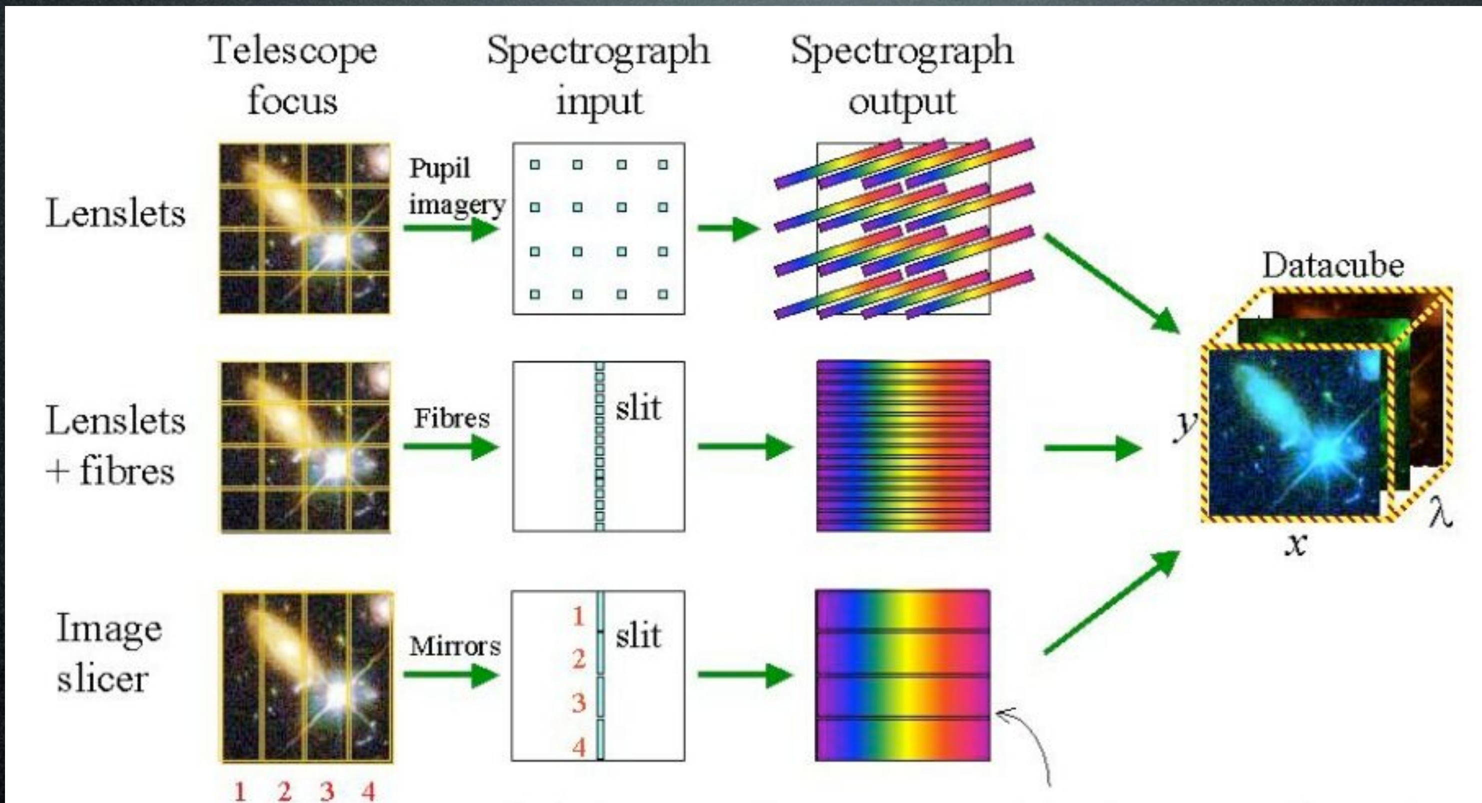
Direct exposure through mask

Diffraction grating is in – light is now dispersed

Note how different “slitlets” have different wavelength zeropoints

MOS observations can now achieve several hundreds of spectral in a single exposure through the use of band-limiting filters

Integral Field Units (IFUs)



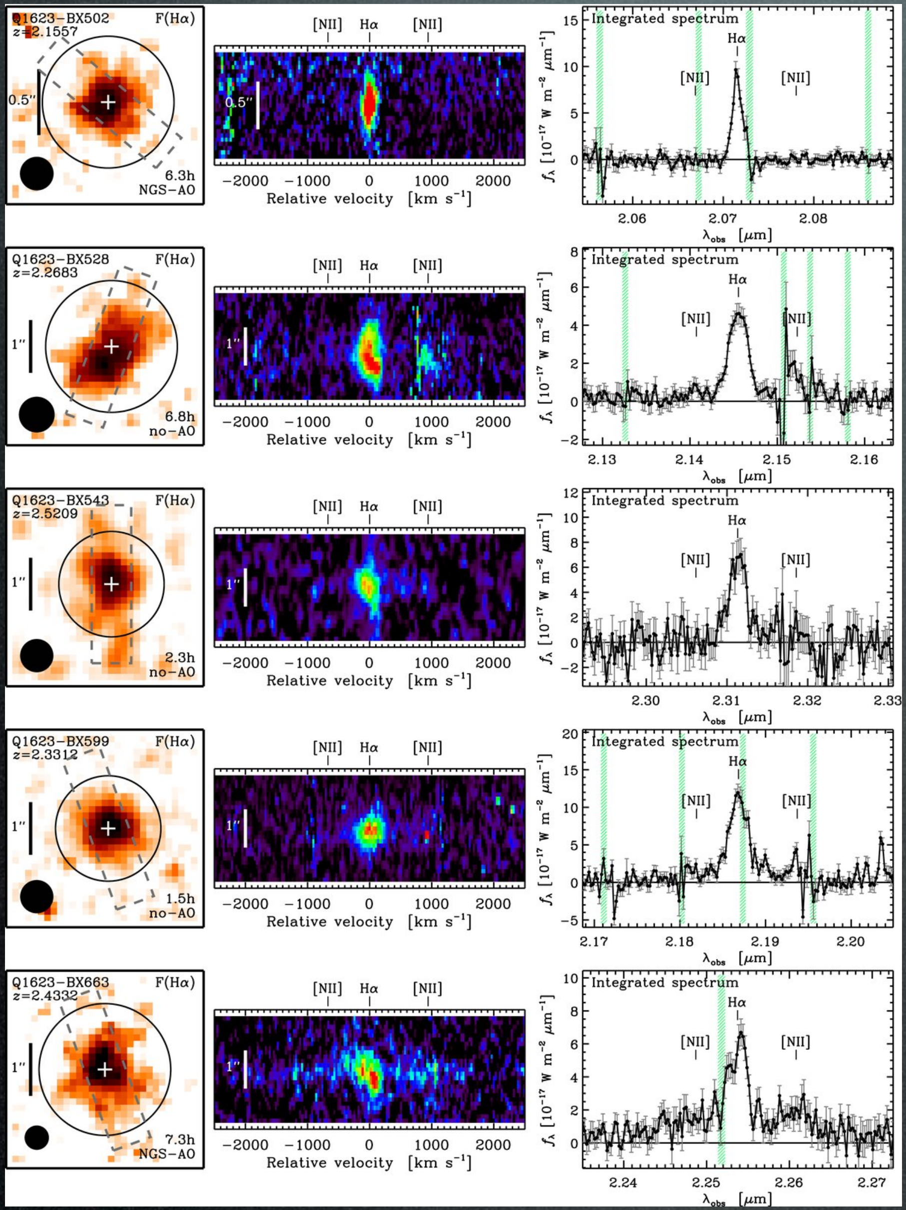
Lenslets provide good spatial sampling, but spectrum packing on detector is a problem

Fibers+lenslets offer flexibility in building "pseudoslit", but fibers have problems

Image slicer IFUs offer best usage of detector "real estate"

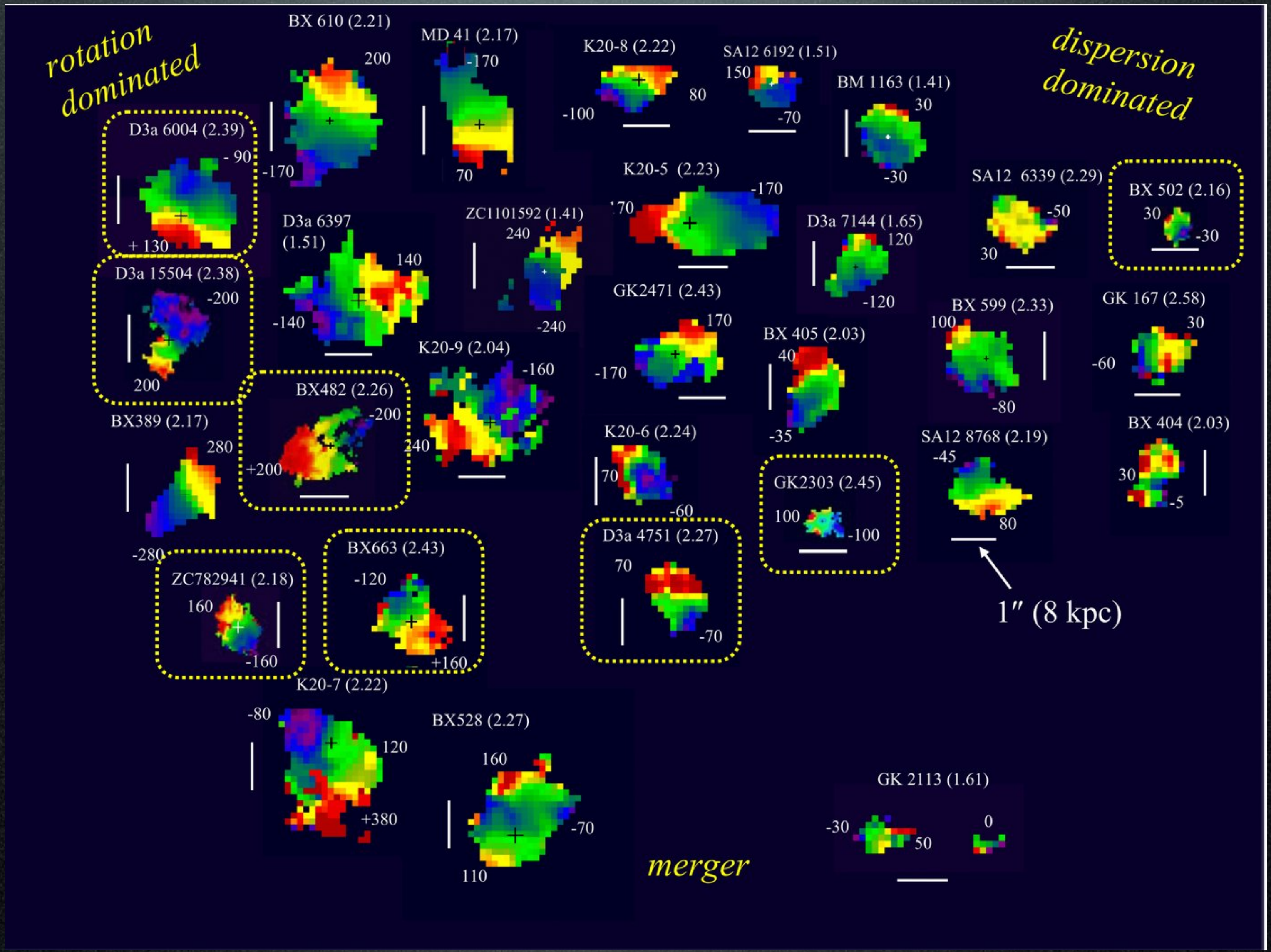
IFU data reduction can be quite complicated!

SINS - IFU Data



IFU datacubes were converted to "synthetic slit" spectra here

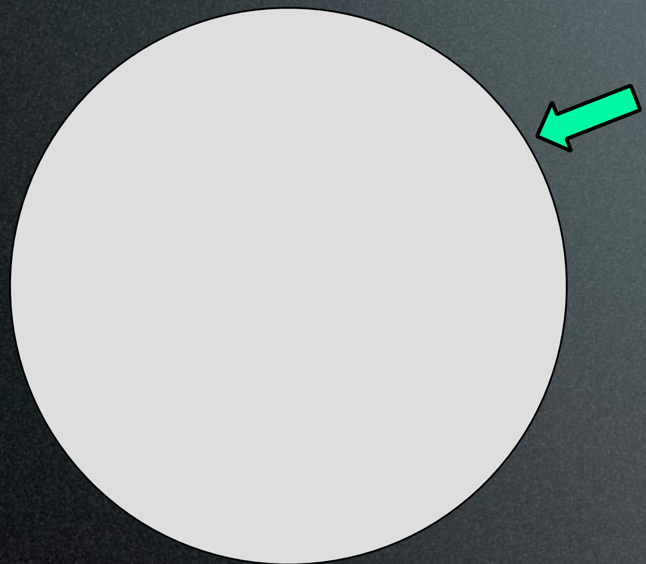
SINS – Internal Velocity Fields



Scaling Relations

- Galaxies have a fundamental set of physical properties:
    - Mass
    - Size
    - Angular momentum
- These physical properties translate into the following observables:
    - Luminosity or mass-to-light ratio
    - Internal velocity – rotation and/or dispersion
    - Size – Half-light radius (R_{hl} or R_e), disk scale length (R_d or h)
- Basic questions: What are the underlying relations (if any) among galaxy properties and what do they tell us about galaxy formation?

Galaxy Formation: A "Back of the envelope model"



Consider a dark matter halo of mass M, total energy E and angular momentum J

$$\rho(r) = \frac{V_c^2}{4\pi G r^2}$$

$$r_{200} = \frac{V_c}{10H(z)}$$

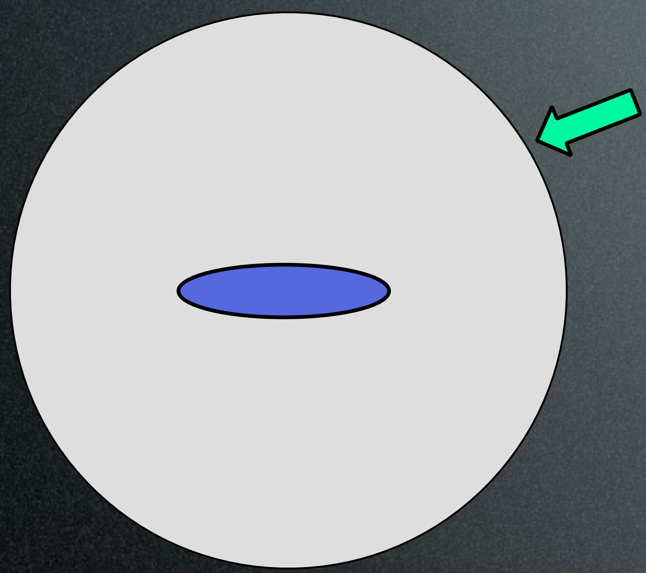
$$M = \frac{V_c^2 r_{200}}{G} = \frac{V_c^3}{10GH(z)}$$

$$\lambda = J|E|^{1/2}G^{-1}M^{-5/2}$$

r_{200} is the radius within which the mean mass density is 200 ρ_{crit} where ρ_{crit} is the critical density at redshift

The quantity λ is called the "spin parameter"

Galaxy Formation: A "Back of the envelope model"



Now add a visible disk with

Surface density:

$$\Sigma(R) = \Sigma_0 \exp(-R/R_d)$$

Total mass:

$$M_d = 2\pi\Sigma_0 R_d^2 \equiv m_d M$$

Total angular Momentum:

$$J_d = 2 M_d R_d V_c \equiv j_d J$$

Galaxy Formation: A "Back of the envelope model"

$$R_{\rm d} = \frac{1}{\sqrt{2}}\left(\frac{j_{\rm d}}{m_{\rm d}}\right)\lambda r_{200}$$

$$\approx 8.8 h^{-1}\,{\rm kpc}\left(\frac{\lambda}{0.05}\right)\left(\frac{V_{\rm c}}{250\,{\rm km\,s^{-1}}}\right)\left[\frac{H}{H_0}\right]^{-1}\left(\frac{j_{\rm d}}{m_{\rm d}}\right)$$

Assuming that all disks have the same mass-to-light ratio, we get:

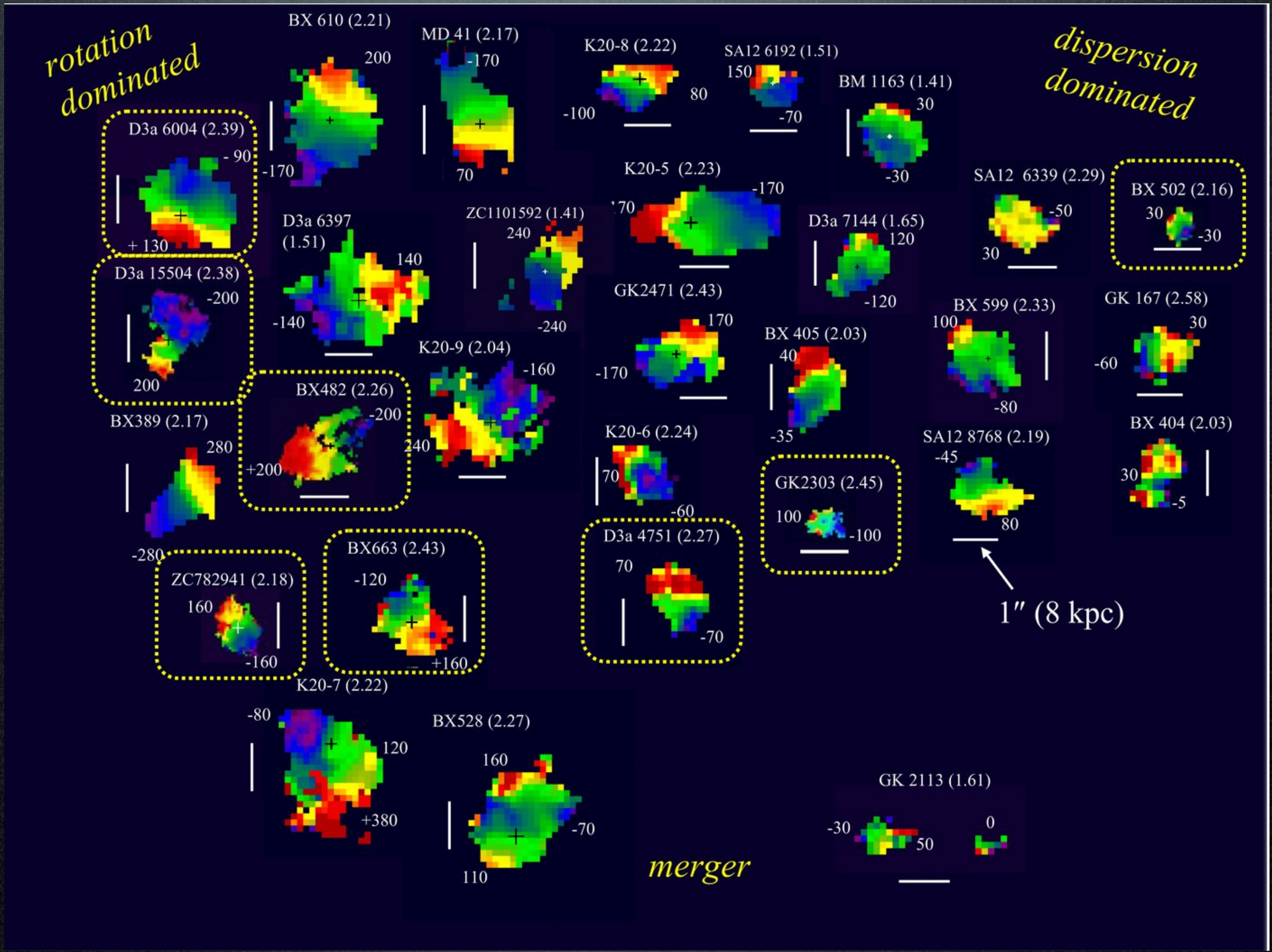
$$R_d \simeq 8.8 h^{-1}{\rm kpc}\left(\frac{\lambda}{0.05}\right)\left(\frac{L_d}{A}\right)^{1/2}\left(\frac{H(z)}{H_0}\right)^{-1}\left(\frac{j_d}{m_d}\right)$$

where

$$A = 1.7\times 10^{11} h^{-1} L_\odot \Upsilon_d^{-1}(m_d/0.05)(H(z)/H_0)^{-1}$$

$$\Upsilon_d \equiv M_d/L_d$$

SINS – Internal Velocity Fields

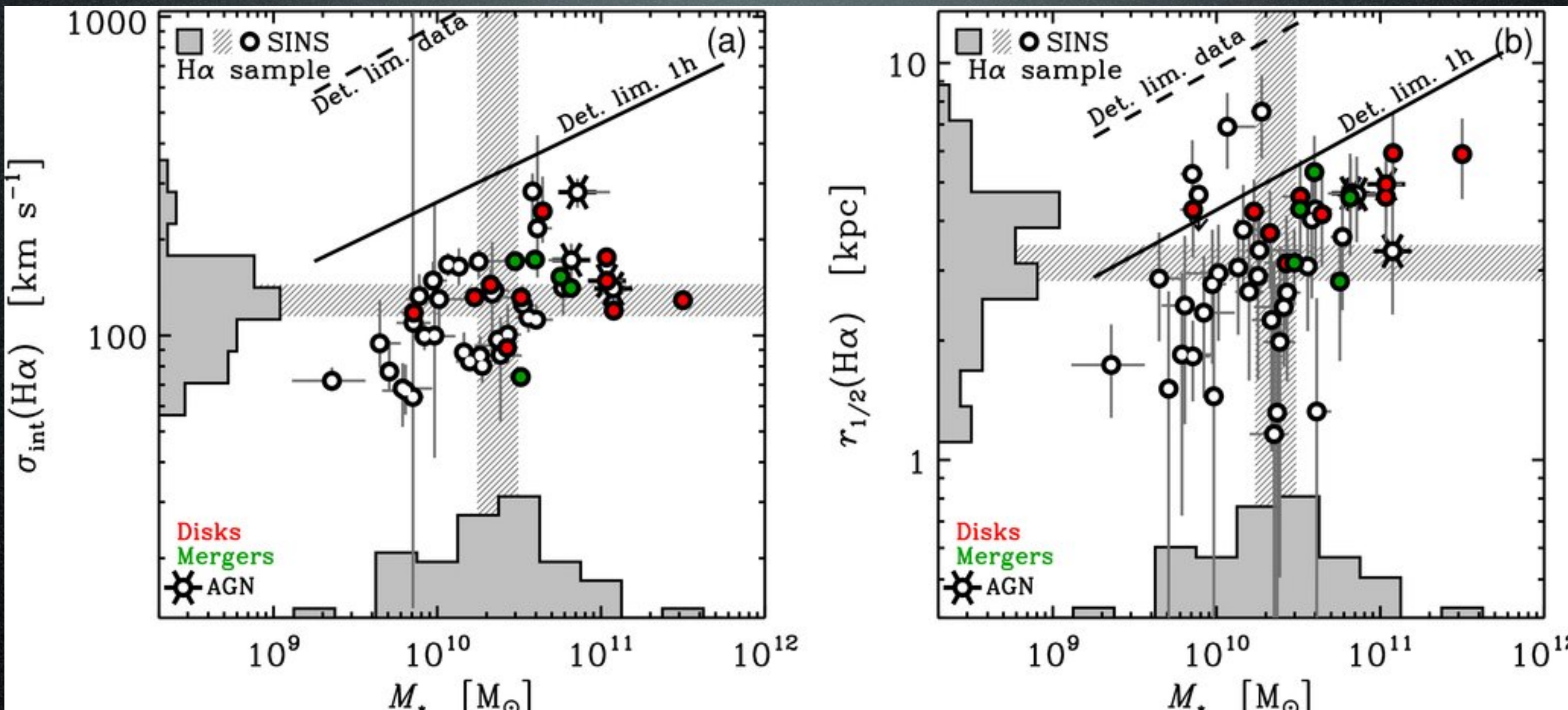


SINS – H-Alpha Properties of the Sample

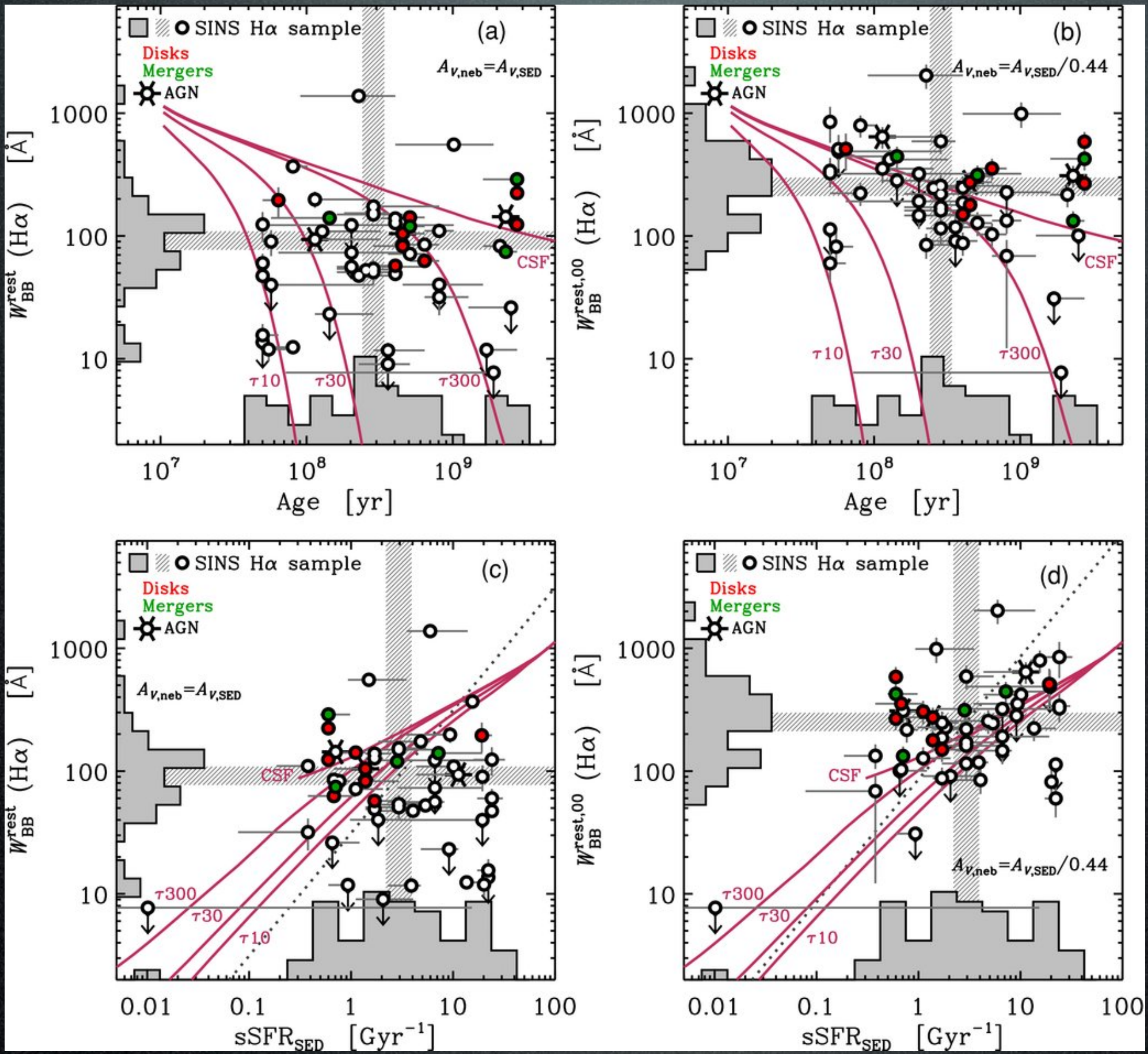
Table 6. Hα Properties of the SINS Hα Sample

Source	r_{aper}[a] (arcsec)	$z_{H\alpha}$[b]	F(Hα)[b] (10^{-17} erg s^{-1} cm^{-2})	σ_{int}(Hα)[b] (km s^{-1})	$r_{1/2}$(Hα)[c] (kpc)	FWHM(Hα)[d] (kpc)	f_{BB}(Hα)[e]
Q1307-BM1163	1.00	1.4104	64.2 ± 1.7	153^{+6}_{-5}	2.4 ± 1.1	6.5 ± 2.2	...
Q1623-BX376	1.00	2.4088	$8.5^{+0.8}_{-0.6}$	99^{+11}_{-9}	2.4 ± 0.9	4.6 ± 1.8	0.15
Q1623-BX447	1.00	2.1473	$10.2^{+1.0}_{-0.9}$	144 ± 17	3.7 ± 1.0	10.0 ± 2.4	0.12
Q1623-BX455	1.00	2.4072	$10.5^{+1.5}_{-1.2}$	130 ± 28	3.0 ± 1.0	7.5 ± 2.1	0.36
Q1623-BX502	0.50	2.1556	$12.3^{+0.7}_{-0.6}$	72^{+7}_{-5}	1.7 ± 0.5	4.3 ± 1.0	0.57
Q1623-BX528	1.25	2.2683	11.4 ± 0.4	141 ± 8	4.6 ± 1.3	11.7 ± 2.9	0.07
Q1623-BX543	1.00	2.5209	$19.5^{+1.3}_{-1.4}$	149^{+22}_{-23}	2.8 ± 1.0	8.6 ± 2.3	0.28
Q1623-BX599	1.00	2.3313	$30.6^{+0.9}_{-0.8}$	153 ± 9	2.8 ± 1.0	4.7 ± 2.1	0.23
Q1623-BX663	1.25	2.4332	16.7 ± 0.9	172 ± 22	4.7 ± 1.1	11.0 ± 2.4	0.13
SSA22a-MD41	1.25	2.1704	14.4 ± 0.6	118^{+6}_{-7}	4.3 ± 1.0	10.8 ± 2.4	0.19
Q2343-BX389	1.25	2.1733	21.0 ± 1.0	245^{+70}_{-50}	4.2 ± 1.1	13.3 ± 3.0	0.18
Q2343-BX513	1.00	2.1080	$12.5^{+1.8}_{-1.3}$	101^{+24}_{-19}	2.6 ± 1.1	6.6 ± 2.1	0.09
Q2343-BX610	1.25	2.2103	$30.5^{+1.3}_{-1.1}$	176^{+10}_{-11}	4.6 ± 1.0	10.9 ± 2.4	0.11
Q2346-BX404	0.75	2.0284	10.6 ± 0.3	97^{+4}_{-3}	1.3 ± 1.5	3.8 ± 2.3	0.07
Q2346-BX405	1.00	2.0298	12.5 ± 0.4	83^{+5}_{-3}	2.7 ± 1.1	7.3 ± 2.2	0.10

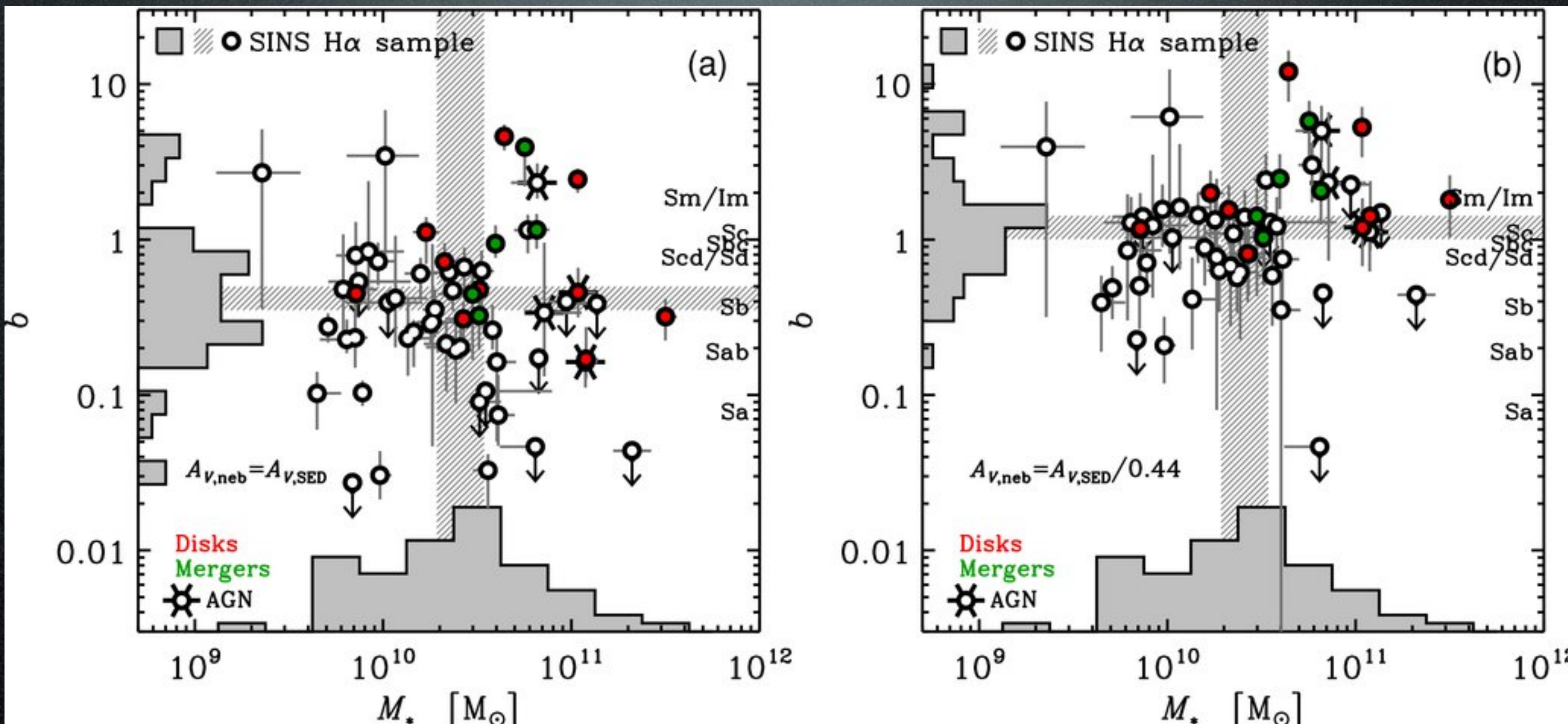
SINS - Velocity dispersions and Sizes



SINS – Star Formation History Models



SINS – Birth Parameter



The birth parameter *b* is the ratio of current to past-averaged star-formation

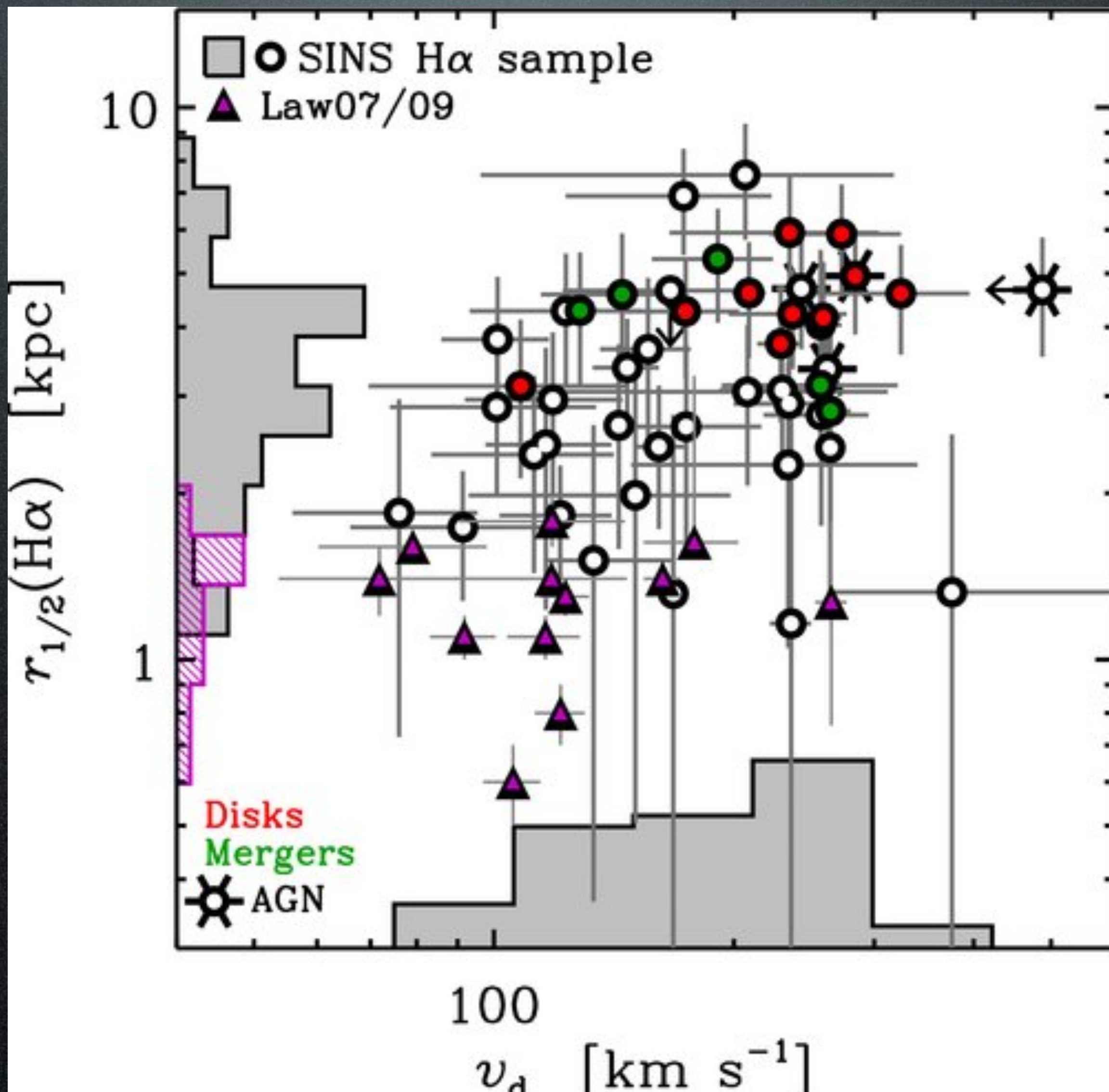
SINS – Dynamical Properties and Mass Estimates

Table 9
Dynamical Properties and Mass Estimates of the SINS Hα Sample

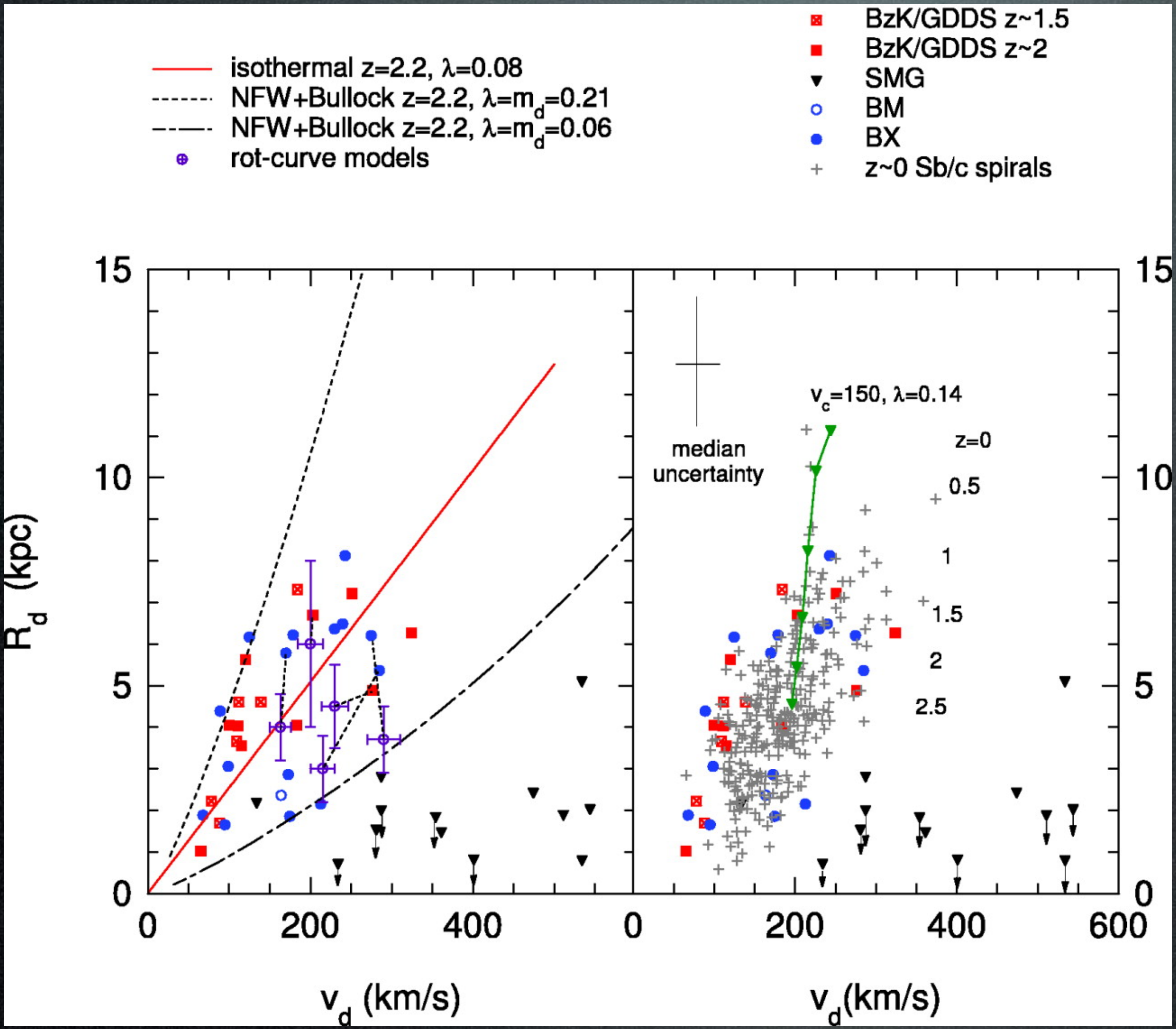
Source	Method[a]	Kinemetry[b]	$v_{obs}/2$[c] (km s^{-1})	$v_{obs}/(2\sigma_{int})$[d]	v_{rot}/σ_0[e]	v_d[f] (km s^{-1})	M^0_{gas}[g] ($10^{10}\,M_\odot$)	M^{00}_{gas}[g] ($10^{10}\,M_\odot$)	M_{dyn}[h] ($10^{10}\,M_\odot$)
Q1307 – BM1163	Velocity width	...	60 ± 18	0.39 ± 0.12	...	264^{+10}_{-9}	...	...	8.8 ± 4.1
Q1623 – BX376	Velocity gradient + width	...	60 ± 18	0.60 ± 0.19	...	112 ± 29	0.64 ± 0.22	0.80 ± 0.30	1.4 ± 0.6
Q1623 – BX447	Kinematic modeling	Disk	100 ± 30	0.69 ± 0.22	...	229 ± 15	1.1 ± 0.3	1.6 ± 0.5	12 ± 1
Q1623 – BX455	Velocity gradient + width	...	55 ± 17	0.42 ± 0.16	...	119 ± 27	0.95 ± 0.28	1.3 ± 0.5	2.7 ± 1.1
Q1623 – BX502	Velocity gradient + width	...	45 ± 14	$0.62^{+0.19}_{-0.20}$	0.8 ± 0.2	91^{+26}_{-25}	$0.52^{+0.13}_{-0.12}$	$0.65^{+0.20}_{-0.19}$	0.85 ± 0.36
Q1623 – BX528	Velocity gradient + width	Merger	67 ± 20	$0.48^{+0.14}_{-0.15}$	...	145 ± 30	1.3 ± 0.3	1.8 ± 0.6	6.0 ± 2.1
Q1623 – BX543	Velocity width	...	55 ± 17	0.37 ± 0.12	...	257^{+38}_{-39}	1.5 ± 0.5	2.3 ± 0.9	$9.5^{+4.0}_{-4.1}$
Q1623 – BX599	Velocity width	Merger	49 ± 15	0.32 ± 0.10	...	264^{+16}_{-15}	1.5 ± 0.5	1.9 ± 0.7	10 ± 4

Notes.
[a] Method used to derive the circular velocity v_d and dynamical mass M_{dyn} estimates as explained in Section 9.5. In brief, "Kinematic modeling": from full kinematic modeling of the velocity field and velocity dispersion map (Genzel et al. 2008; Cresci et al. 2009). "Velocity gradient + width": for sources with rotation-dominated kinematics, the values adopted are averages obtained from estimates based on the observed velocity gradient and on the integrated velocity line width in the framework of rotating disks. "Velocity width": for sources with dispersion-dominated kinematics, we used virial isotropic estimates. Galaxies that are undetected in our SINFONI data or for which we cannot establish whether their kinematics are rotation- or dispersion-dominated due to poorer S/N are excluded.
[b] Classification based on quantitative analysis of the Hα kinematics through kinemetry (see Shapiro et al. 2008, and Section 9.1).
[c] The v_{obs} is the full observed difference between the maximum and minimum relative velocities from the Hα kinematics across the source, uncorrected for inclination.
[d] Ratio of half the observed velocity gradient to the source-integrated velocity dispersion (from Table 6), derived from the Hα kinematics and uncorrected for inclination. We treated galaxies with $v_{obs}/(2\sigma_{int}) > 0.4$ as rotation-dominated and those with $v_{obs}/(2\sigma_{int}) < 0.4$ as dispersion-dominated (see Section 9).
[e] Ratio of inclination-corrected circular velocity and intrinsic local velocity dispersion for the disks with kinematic modeling, corrected for inclination (Genzel et al. 2008; Cresci et al. 2009).
[f] Disk circular velocity (or equivalent $\sqrt{3}\sigma_{int}$ for objects with dispersion-dominated Hα kinematics) derived according to the method given in the second column and described in Section 9.5.
[g] Total gas masses estimated from the Hα star formation rate surface densities (within the Hα half-light radius $r_{1/2}$(Hα) from Table 6) through the Schmidt–Kennicutt relation as derived by Bouché et al. (2007). Two estimates are listed, depending on the extinction correction applied to the Hα line luminosities: M^0_{gas} uses SFR^0(Hα) derived using the best-fit extinction $A_{V,SED}$ from the SED modeling (Table 3) and the Calzetti et al. (2000) reddening law, and M^0_{gas} uses SFR^{00}(Hα) assuming extra attenuation toward the H II regions with $A_{V,neb} = A_{V,SED}/0.44$.
[h] Total dynamical mass, derived according to the method given in the second column and described in Section 9.5.
[i] This source is classified as (minor) merger from its Hα kinematics, and a small faint close companion is also seen in Hα and continuum emission; the kinematic properties reported here are for the larger main disk component of the system.

SINS – Size versus Velocity



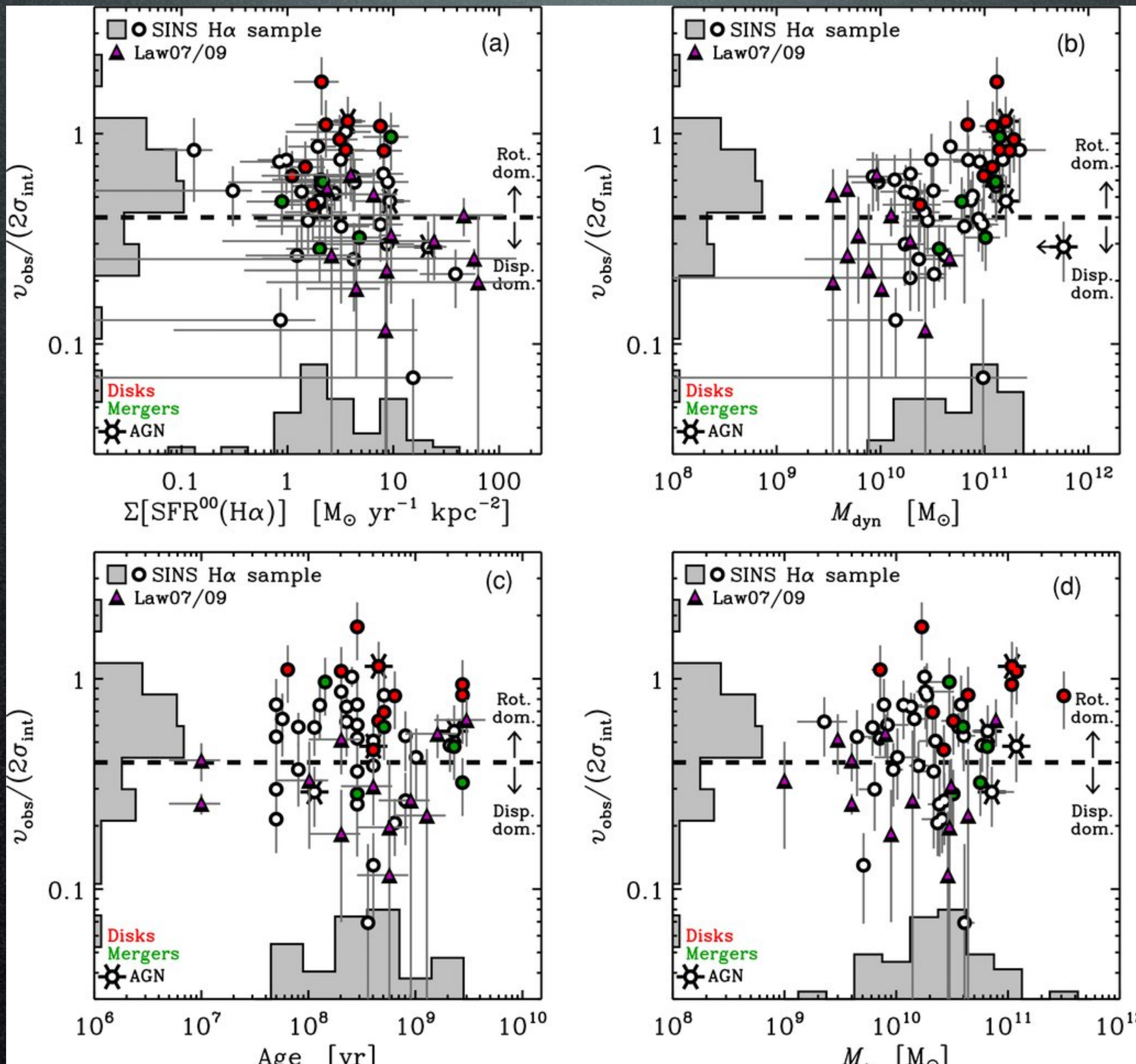
SINS – Size versus Velocity Comparison



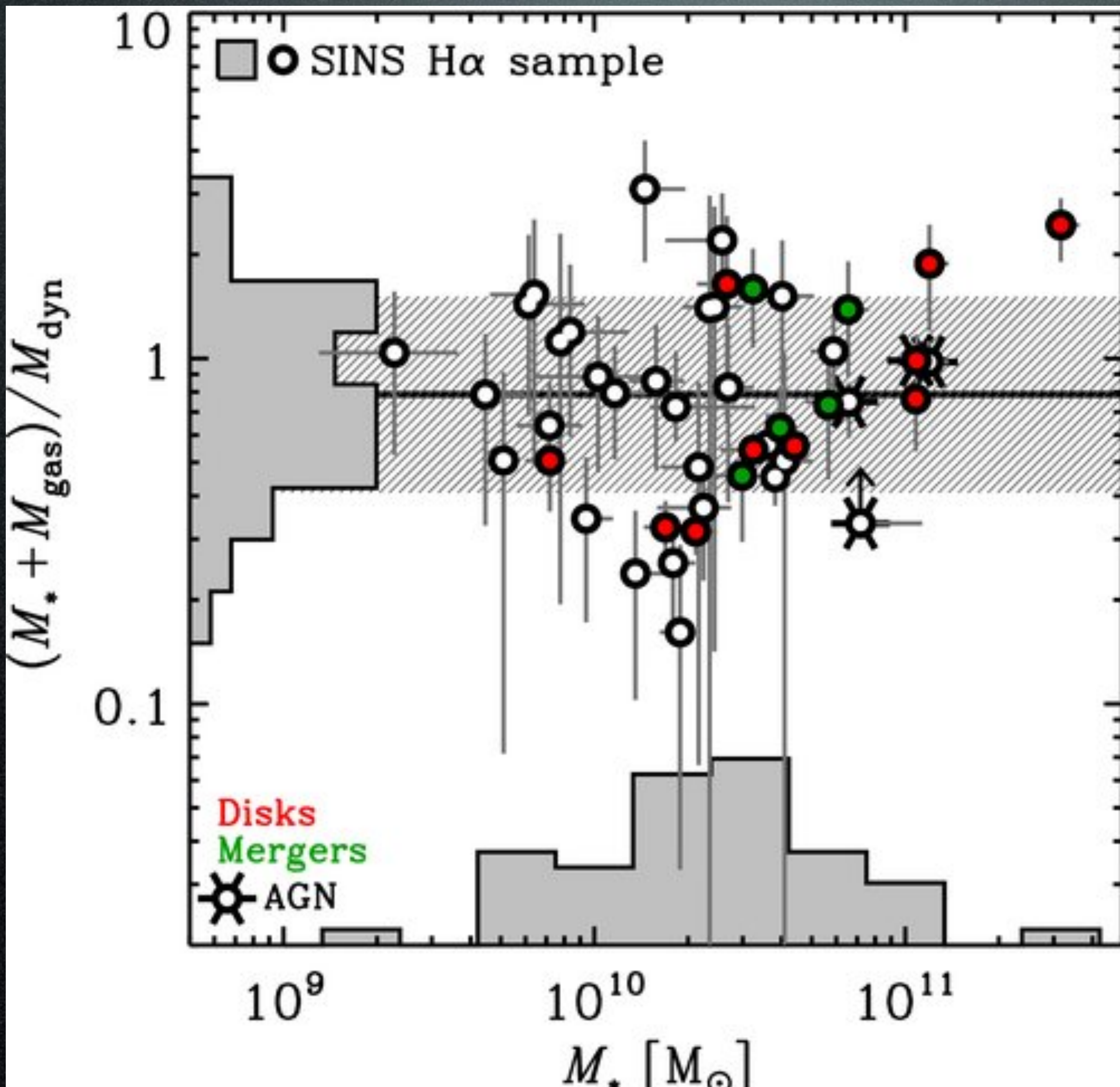
No evolution in size-velocity relation with redshift

Bouche et al. 2007, Astrophysical Journal, 671, 303

SINS – Rotation- or Dispersion-Dominated?

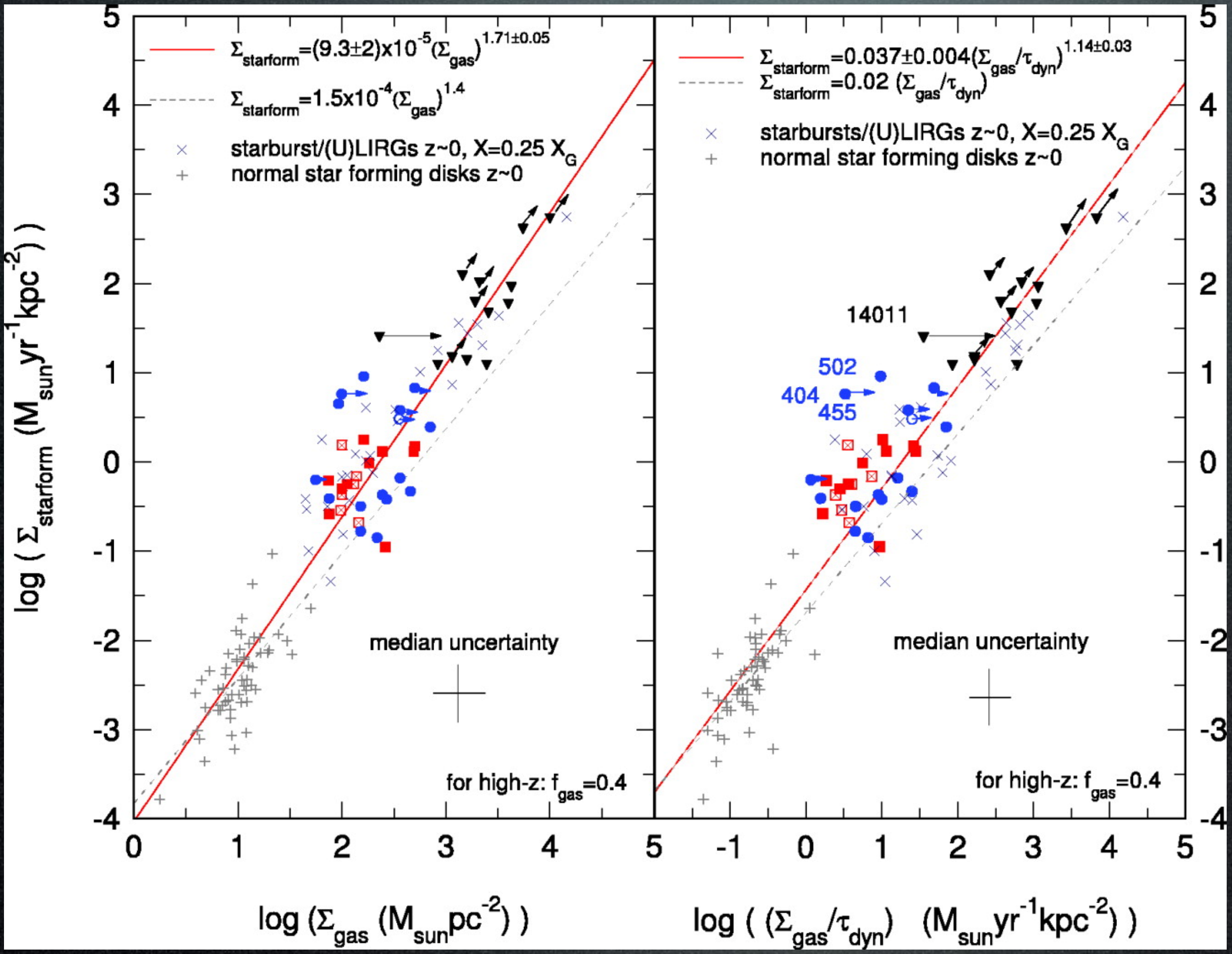


SINS - Baryonic Mass Fractions



Dark matter contribution within a radius of ≈ 10 kpc is ≈ 20-30%

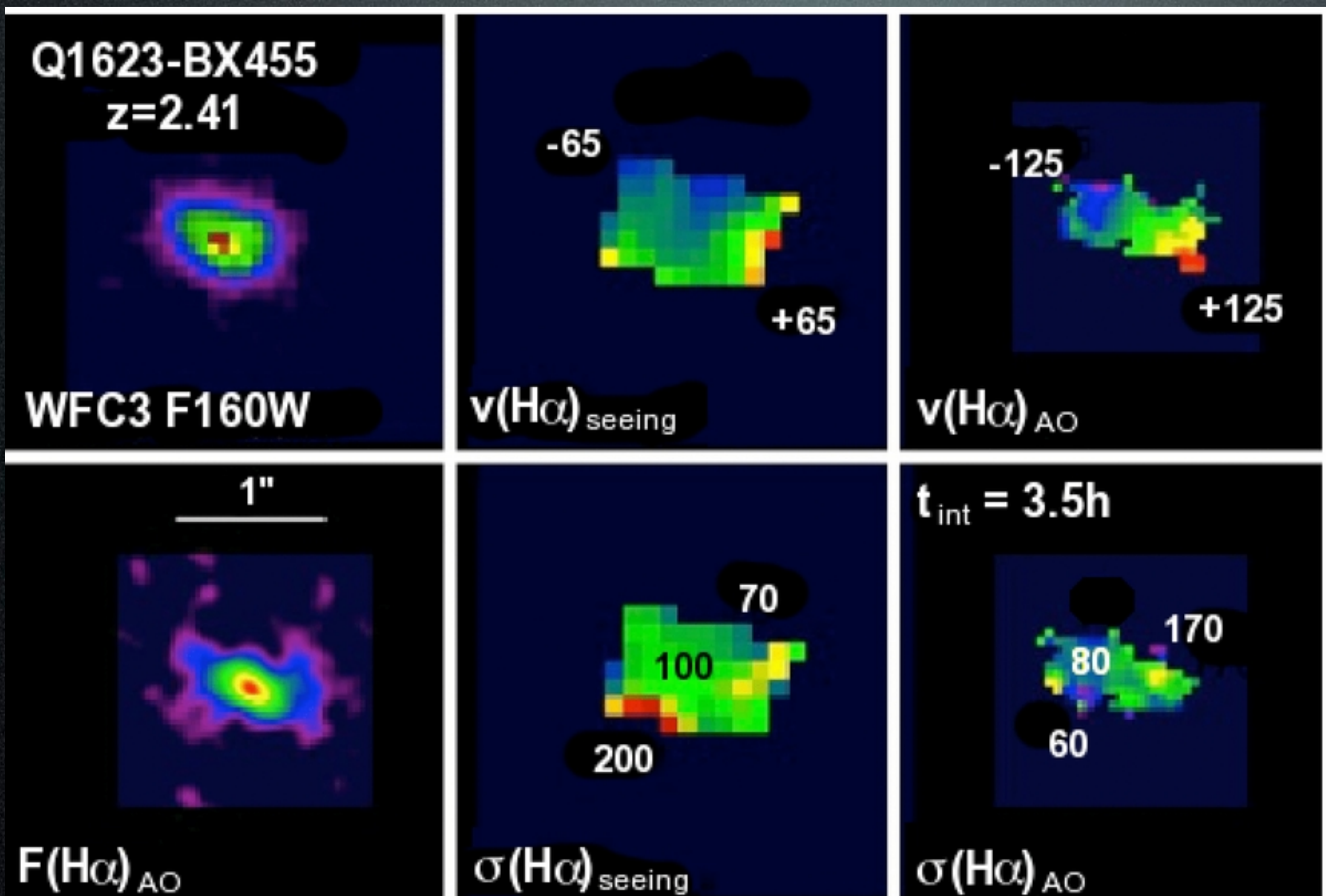
SINS - Local versus High-Redshift Star Formation



Same Schmidt-Kennicutt relation at low and high redshift!

Bouche et al. 2007, Astrophysical Journal, 671, 303

SINS: Seeing-limited vs Adaptive Optics Observations



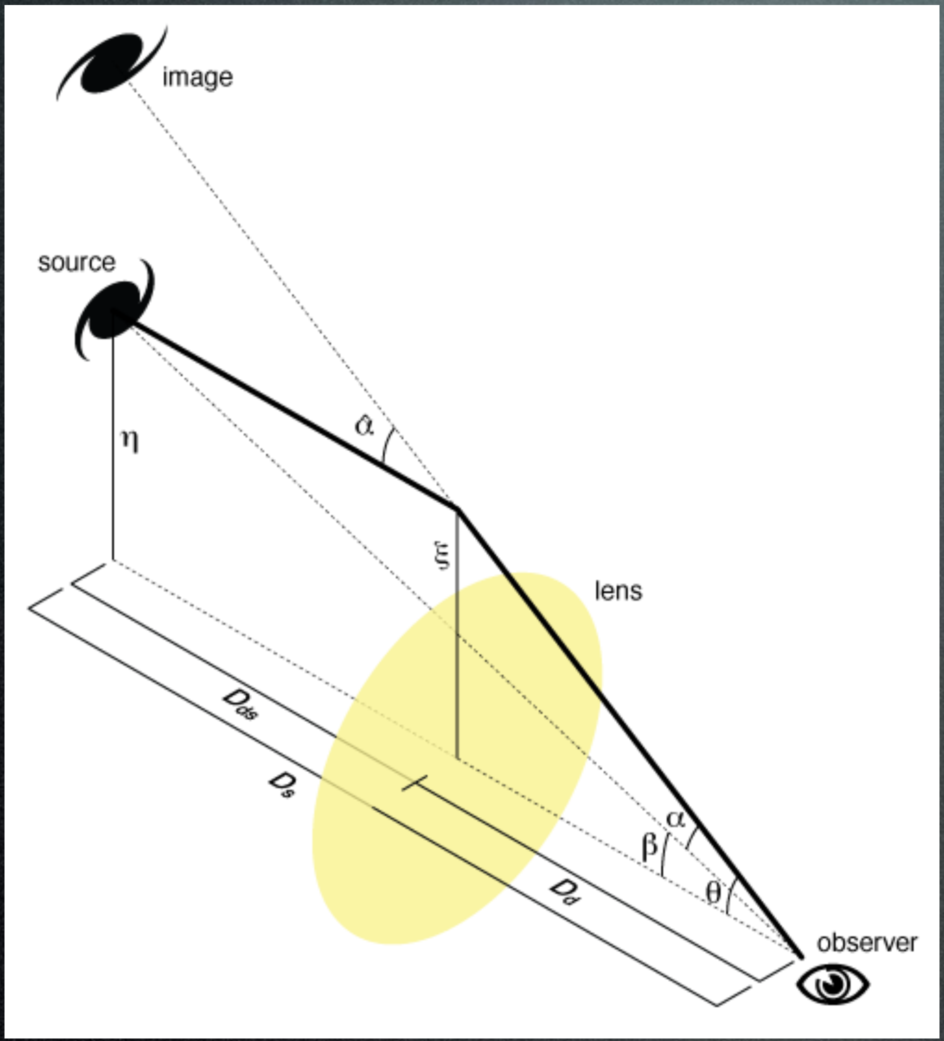
Rotation seen in AO observations is smeared out by the PSF, and it looks like a large velocity dispersion

Newman et al. 2013, Astrophysical Journal, 767, 104

Sloan Lens ACS (SLACS) Survey

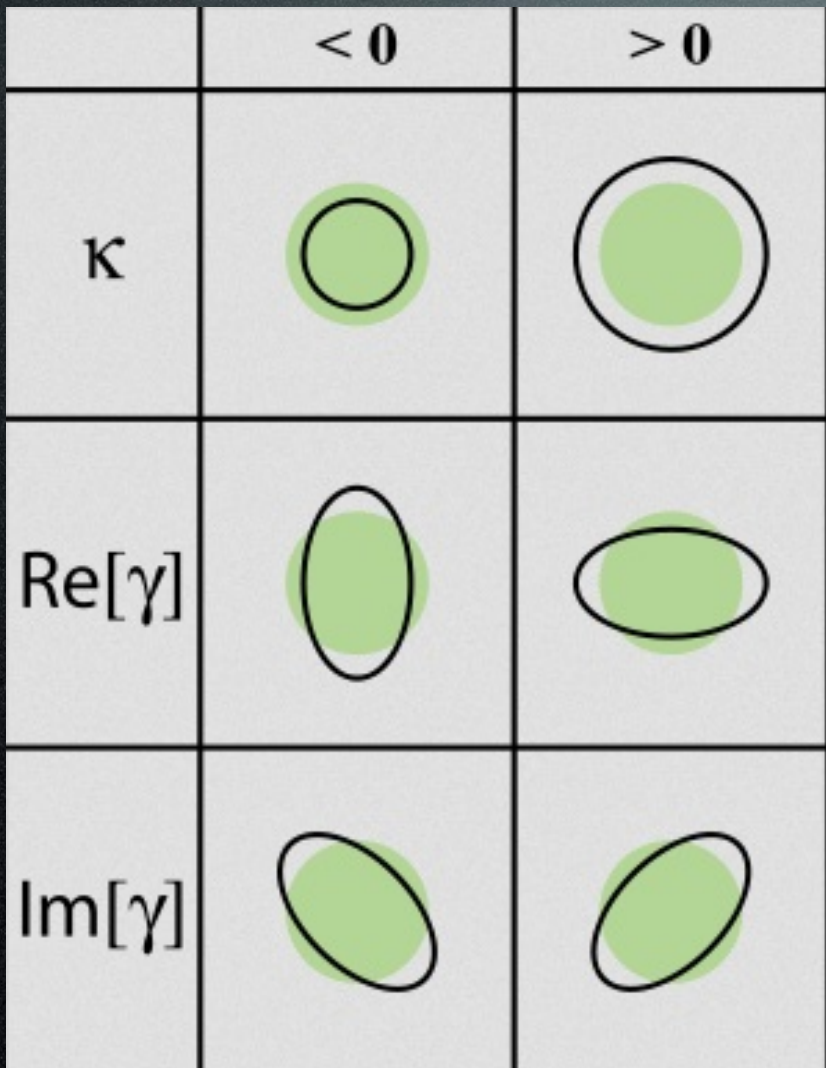
Bolton, A. S. et al. 2006, Astrophysical Journal, 703, 724
(+ many other papers in SLACS series)

Why SLACS? A: Gravitational Lensing



A background source on the axis going through the lensing galaxy and the observer will produce a ring

Gravitational Lensing – Convergence and Shear



The Jacobian between the unlensed and lensed coordinate systems can be decomposed into two terms called "Convergence" (κ) and "Shear"(γ)

The term involving the convergence magnifies the image while conserving surface brightness

Lensing measured the total projected mass surface density independent of mass-to-light ratios, gas dynamics, S/N ratios, etc. etc.

Lensing is achromatic

Gravitational Lensing - Singular Isothermal Ellipsoid (SIE)

$$\kappa(x,y) = \frac{b_{SIE}\sqrt{q_{SIE}}}{2\sqrt{q_{SIE}^2 x^2 + y^2}}$$

Mass model describing the projected mass distribution (i.e., convergence) of the lensing galaxy

$$q_{SIE} = (b/a)_\kappa$$

q_{SIE} = 1 is the classical Singular Isothermal Sphere (SIS)

$$b_{SIE} = 4\pi \frac{\sigma_{SIE}^2}{c^2} \frac{D_{LS}}{D_{OS}}$$

This quantity is called the "Angular Einstein Radius"

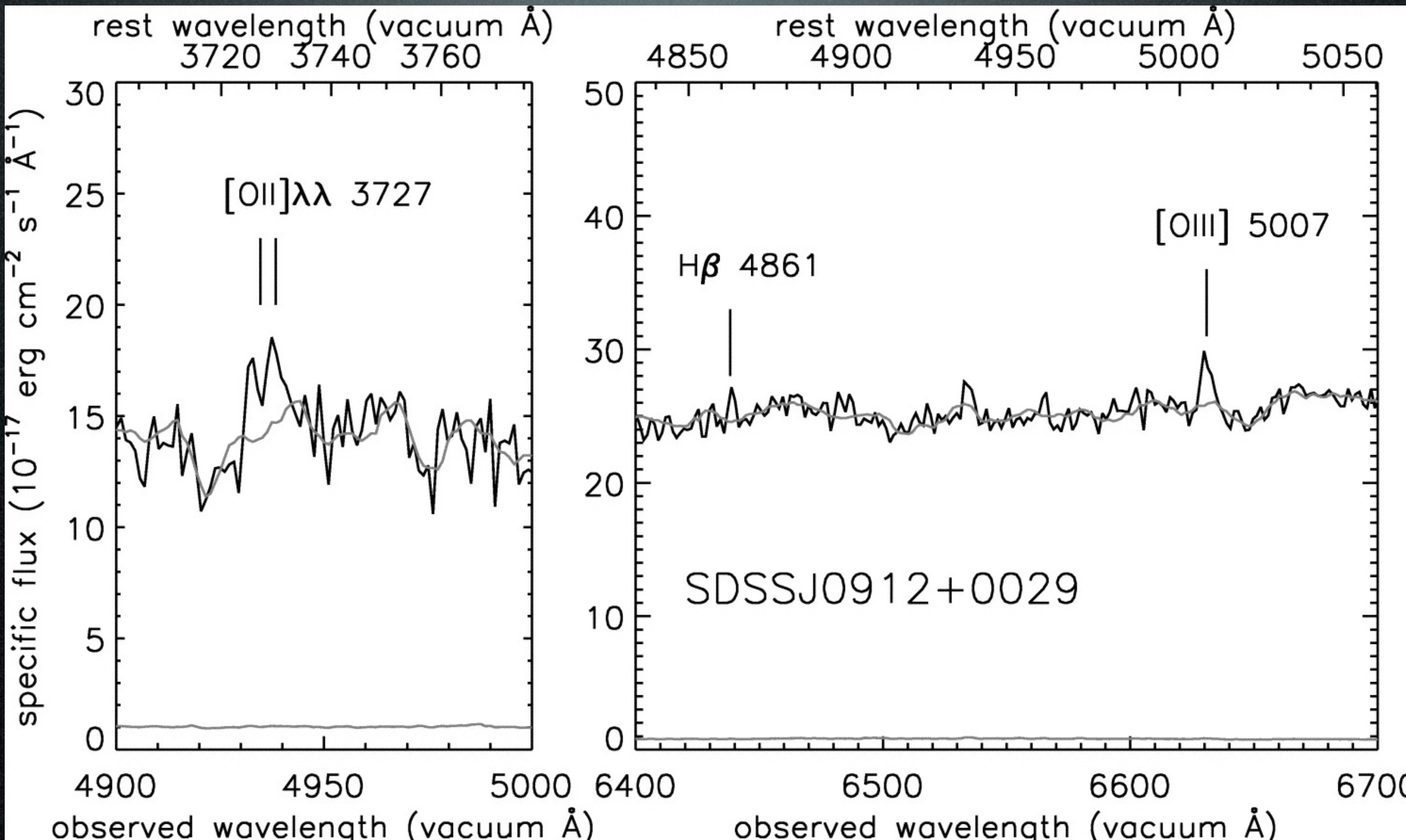
σ_{SIE} is NOT the same as the stellar velocity dispersion!

$$M_{200} \simeq \frac{2(\sigma_{SIE})^2 R_{200}}{G}$$

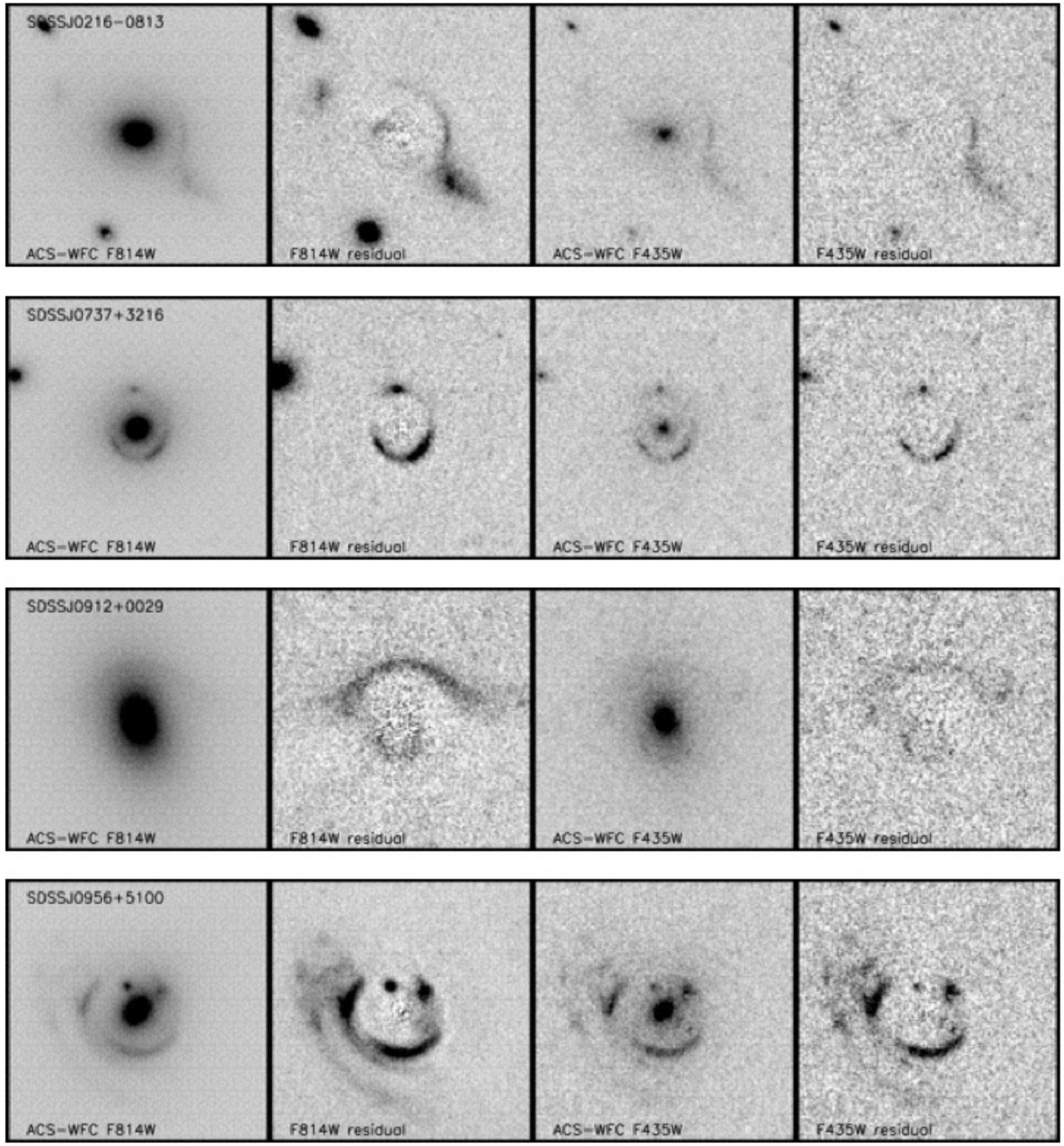
SLACS - Sample Selection

- Spectroscopically observed early-type galaxies from the Sloan Digital Sky Survey galaxies:
  - Early-types are expected to be “efficient” lenses
  - Well-behaved absorption-dominated spectra
  - Secure redshifts
- Subtract best-fit principal-component templates from observed SDSS target galaxy spectra
- Scan residual spectra for nebular line emission
- Select lens candidates through detection of (at least) three emission lines ([OII]$\lambda\lambda$3728 + two of H$\beta\lambda$4863, [OIII] λ4960 and [OIII] λ5007) from a single background redshift

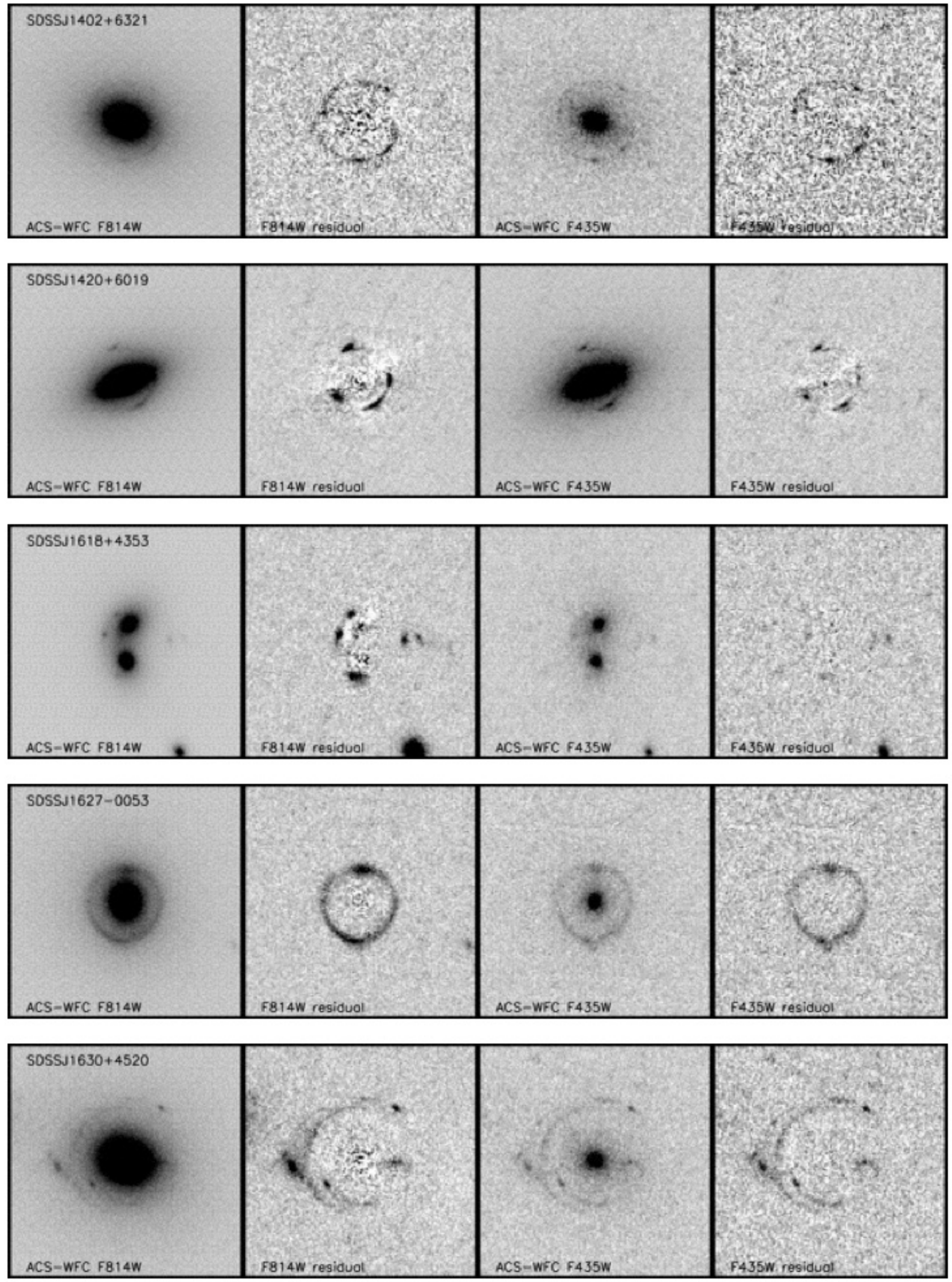
SLACS - Spectroscopic Lens Selection



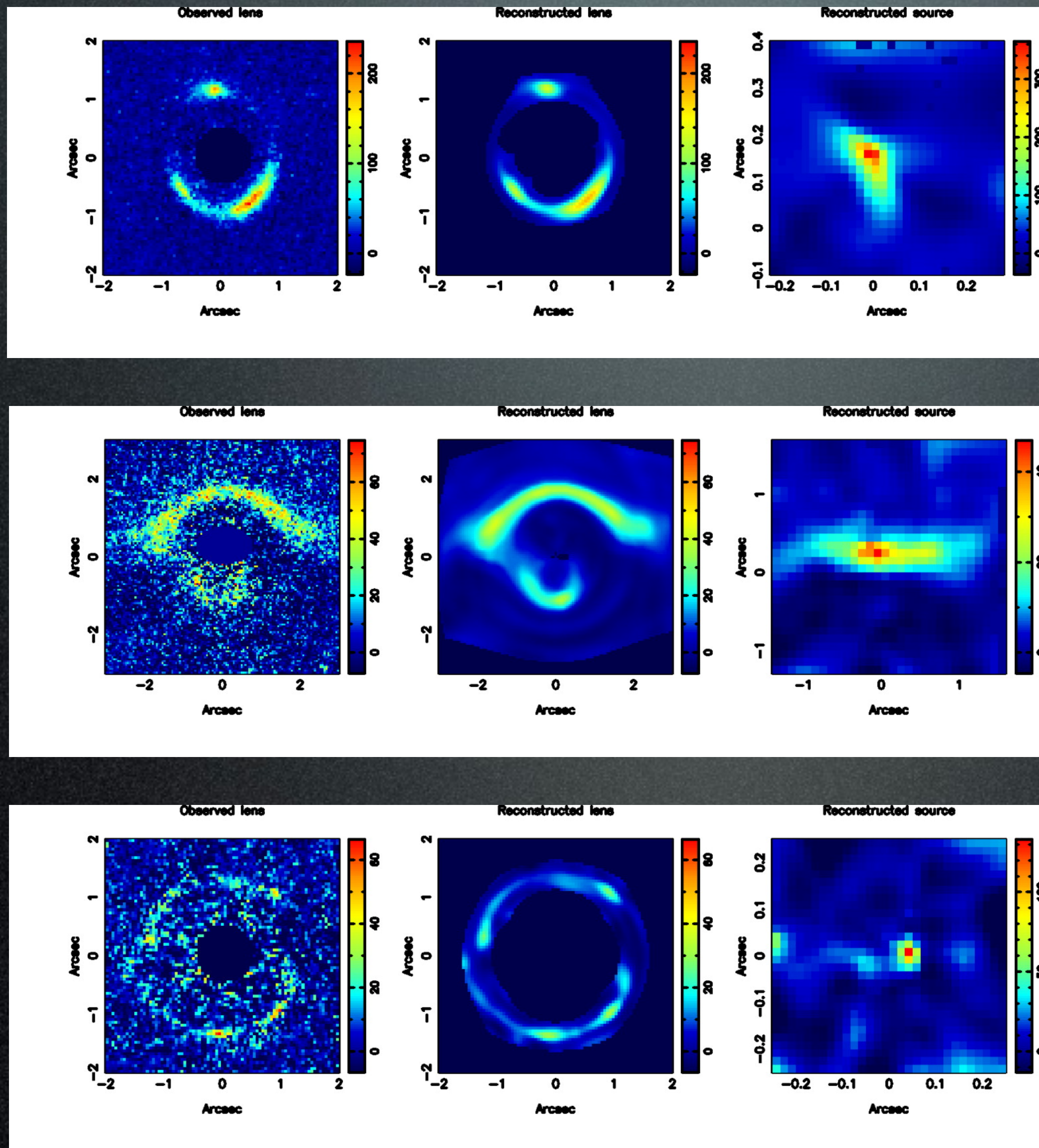
Some SLACS Lenses



And some more SLACS Lenses



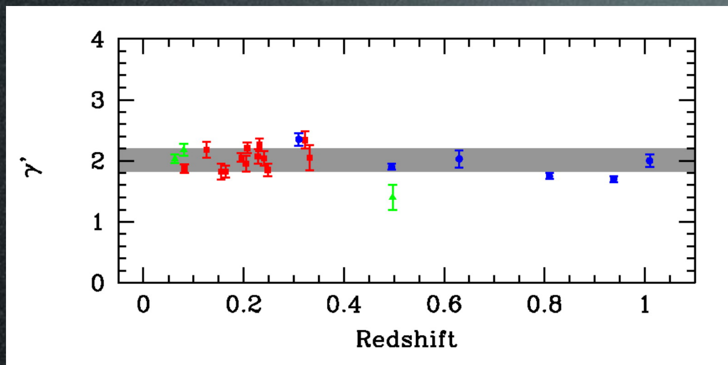
SLACS - Lens Modelling

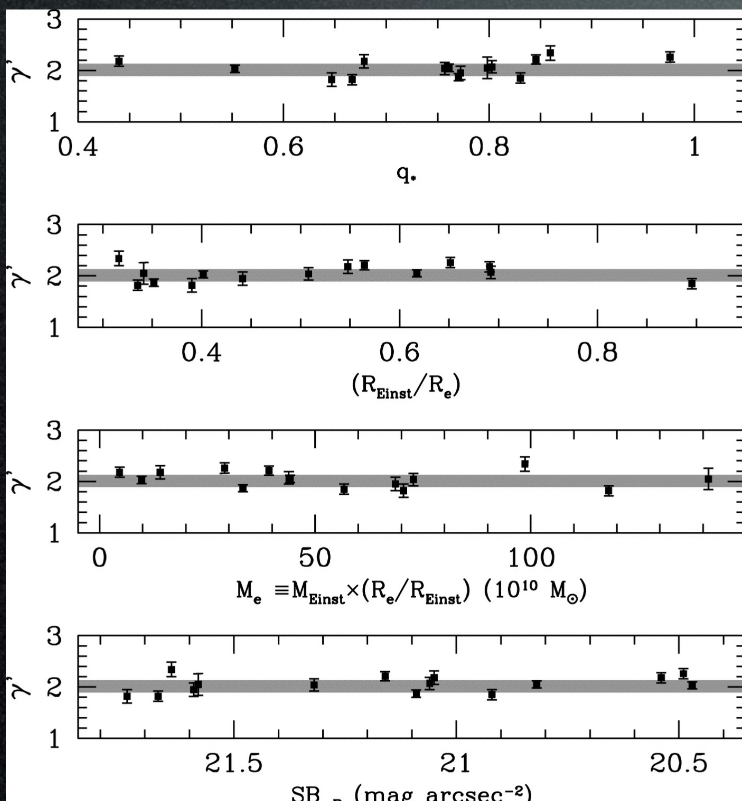


Assuming a SIE mass model

Koopmans et al. 2006, ApJ, 649, 599

SLACS – Inner Logarithmic Slope of Early-Type Galaxies





Early-type galaxies

Remarkable consistency of the inner logarithmic slope

$$\gamma' = -d\log\rho_{tot}/d\log r$$

as a function of many galaxy properties most notably redshift

Koopmans et al. 2006, ApJ, 649, 599

The Fundamental Plane of Galaxies

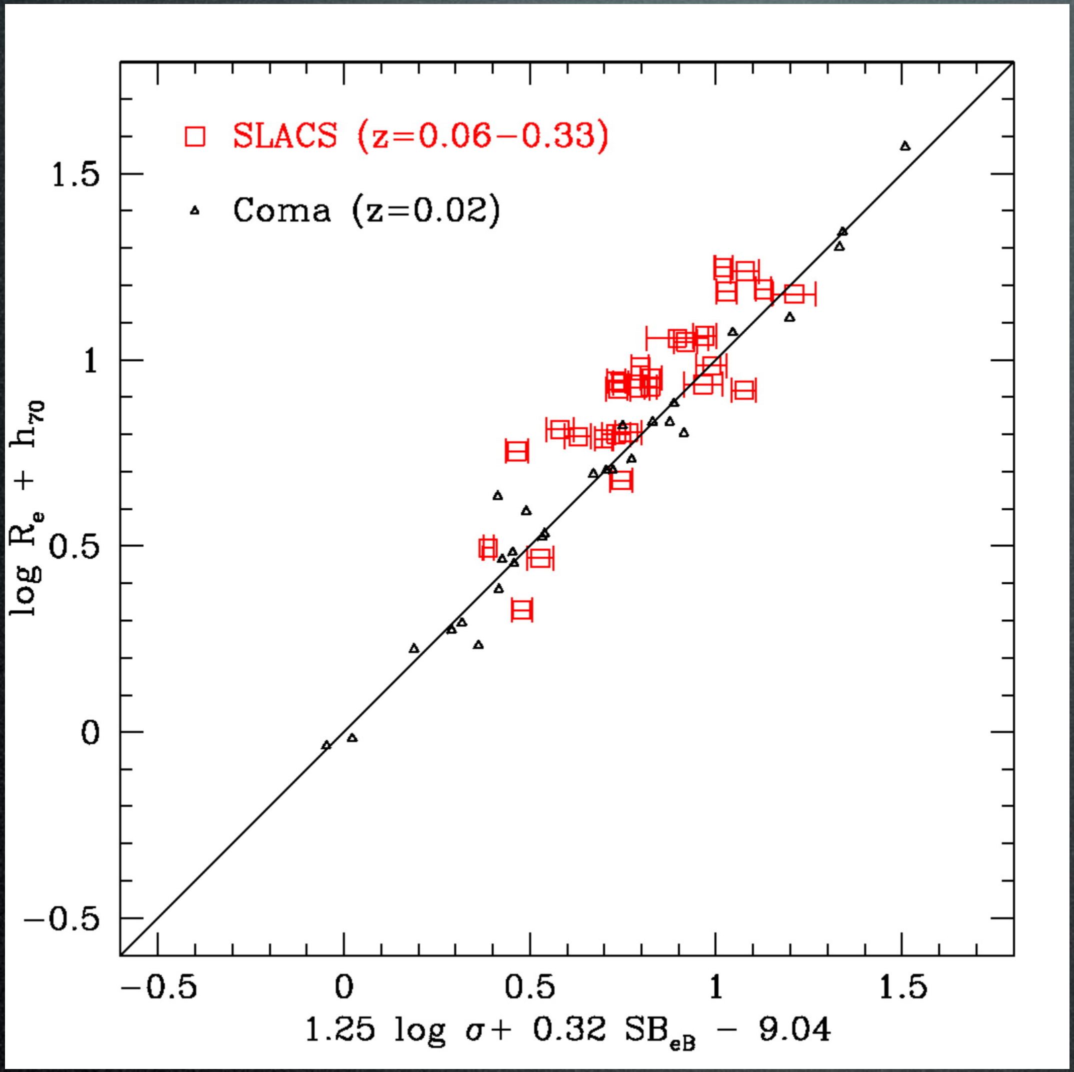
The fundamental plane (FP) of galaxies is defined as follows:

$$\log R_e = \alpha \log \sigma + \beta \mathrm{SB}_e + \gamma_{FP}$$

where α = 1.25, β = 0.32 and γ_{FP} = -9.04 in the B-band for Coma Cluster galaxies.

It is interesting to note that the prediction from the Virial Theorem are α = 2 and β = -1

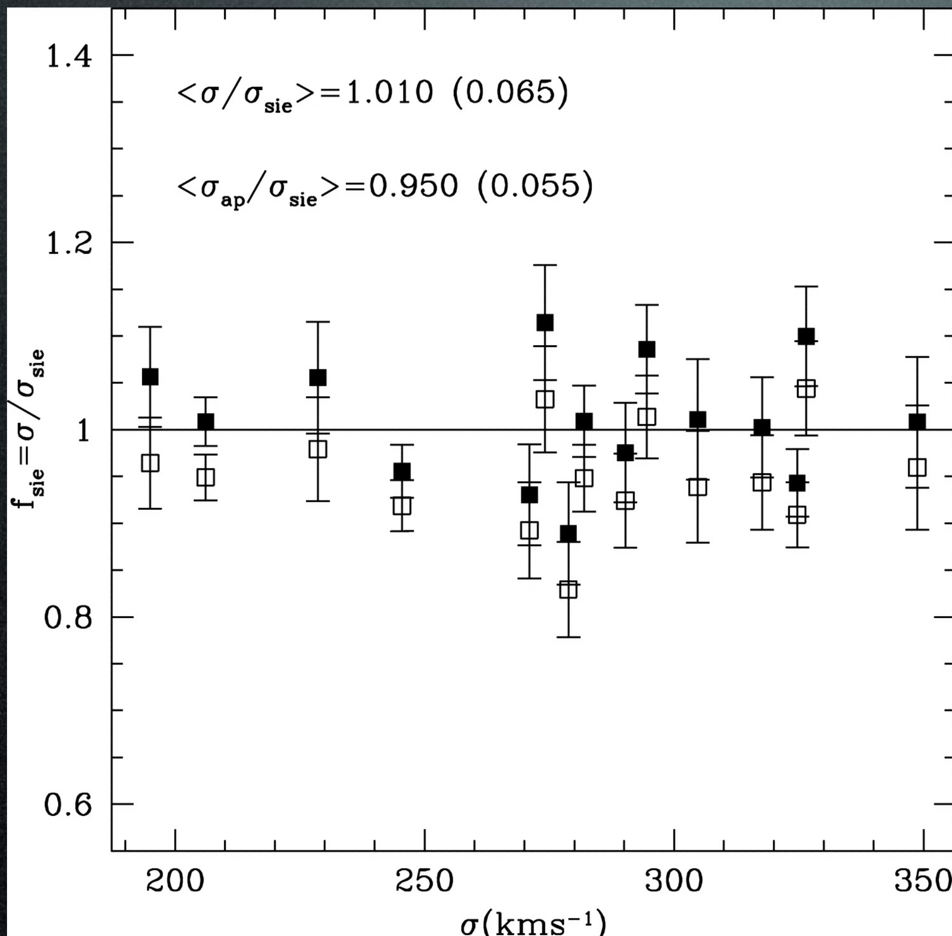
SLACS – The Fundamental Plane of Lens Galaxies



SLACS sample not corrected for evolution

Treu et al. 2006, ApJ, 640, 662

SLACS – A Bulge-Halo Conspiracy?

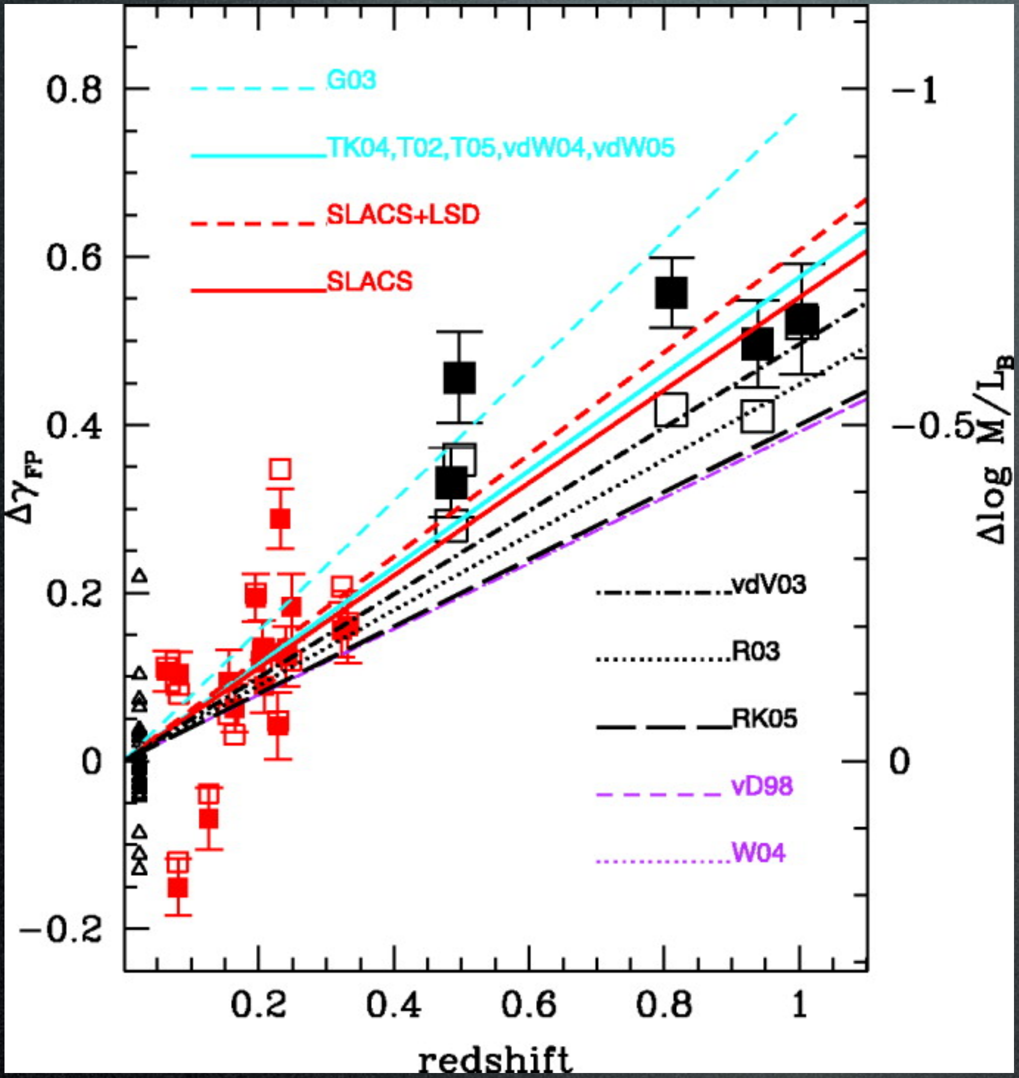


$f_{SIE} = 1$ implies that stellar and dark mass are coupled through an unexplained mechanism – a "bulge-halo conspiracy"

This is analogous to the well-known "disk-halo degeneracy" plaguing the rotation curve modelling of disk galaxies

Treu et al. 2006, ApJ, 640, 662

SLACS – The Evolution of the Fundamental Plane



If σ and R_e do not evolve with redshift, then for an individual galaxy i:

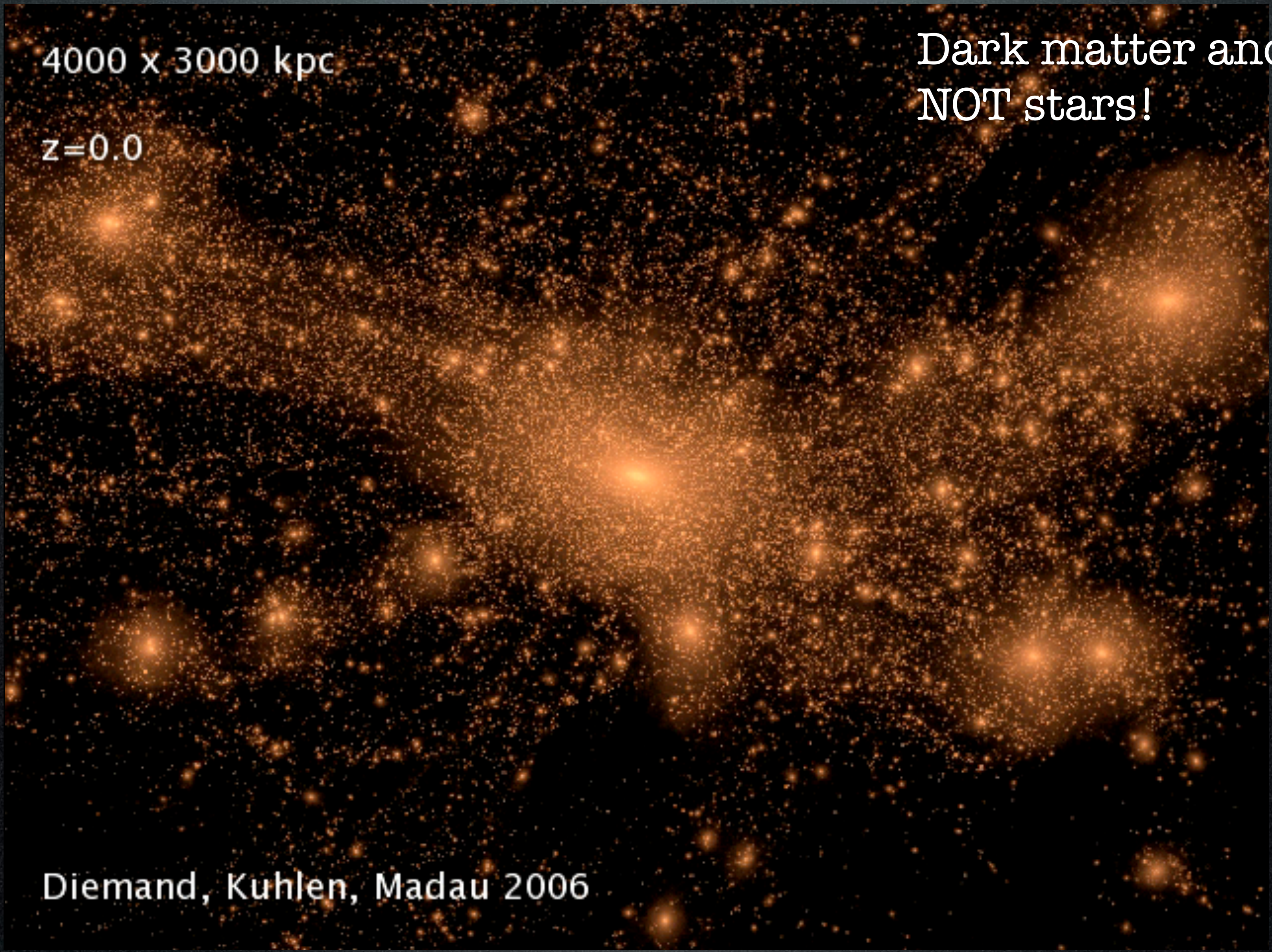
$$\Delta \log(M/L)^i = -\frac{\Delta\gamma^i_{FP}}{2.5\beta}$$

where $\Delta\gamma^i_{FP} \equiv \gamma^i_{FP} - \gamma_{FP}$

Lens and unlensed galaxies exhibit same amount of galaxies consistent with the passive evolution of an old stellar population formed at $z \approx 2$

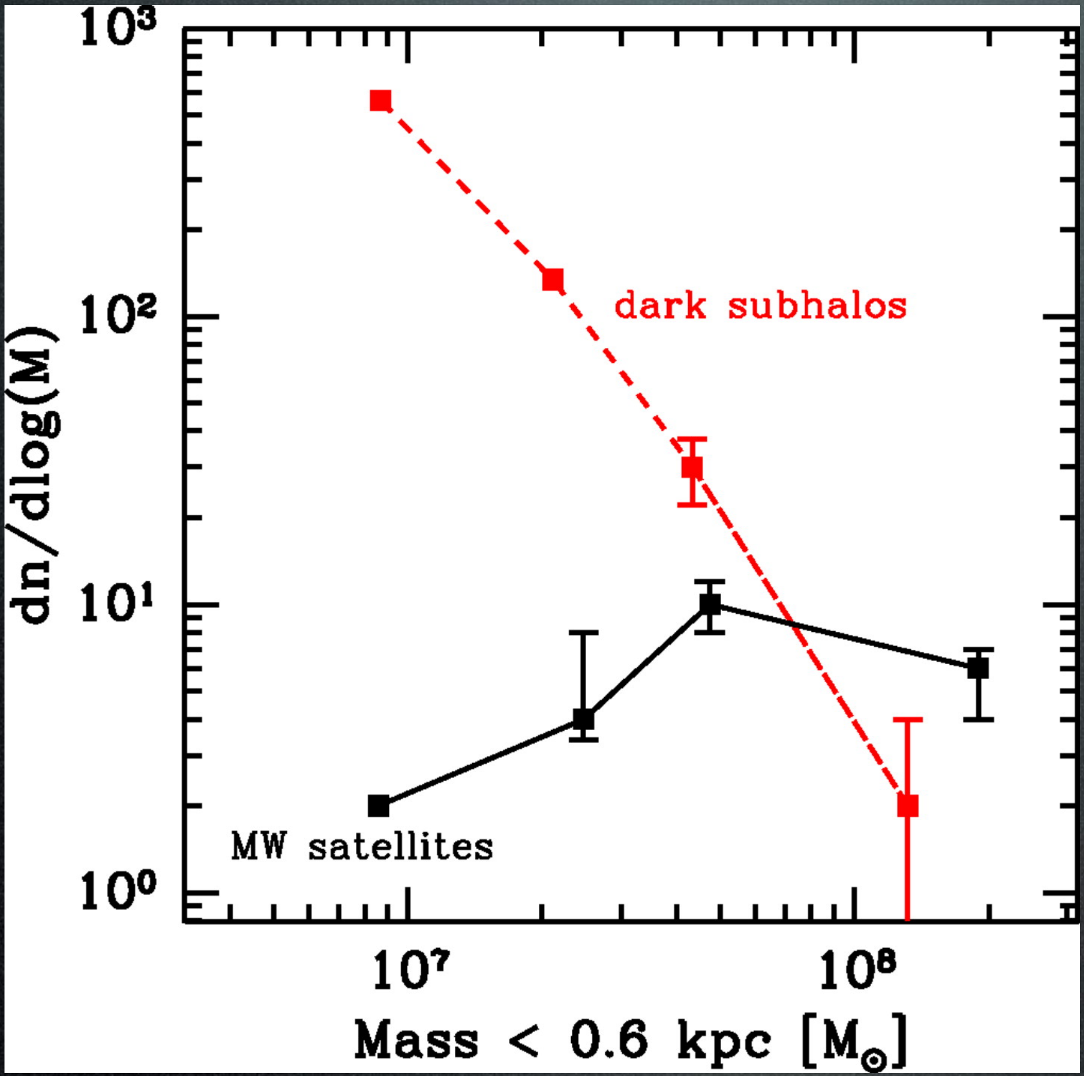
Treu et al. 2006, ApJ, 640, 662

Substructures in Cold Dark Matter Haloes



Dark matter and NOT stars!

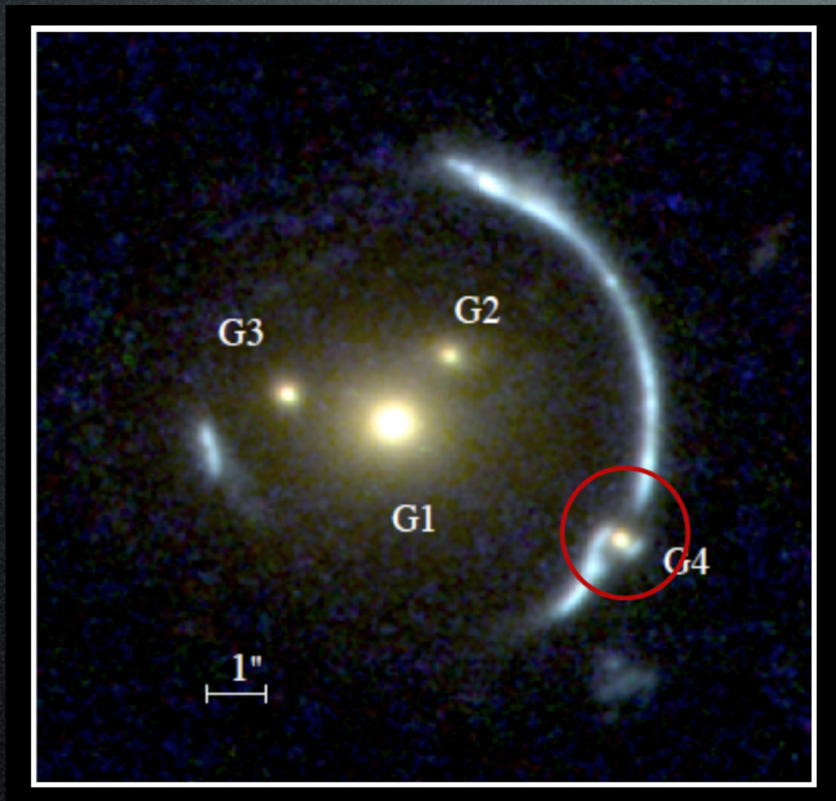
Substructures in Cold Dark Matter Haloes



Based on Via Lactea simulation

Strigari et al. 2007, ApJ, 669, 676

Substructures in Cold Dark Matter Haloes



The “Clone Arc” (Lin et al. 2009)

CDM sub-haloes should produce significant astrometric anomalies in gravitational lenses

This is inherently statistical work requiring surveys with wide-field camera for detection and high-resolution cameras for detailed characterization

Vegetti et al. 2014 (MNRAS, 442, 2017):

No significant detection of mass clumps in 11 SLAC lenses – Infer a substructure mass fraction of f = 0.0076 and slope α < 2.3. This is consistent at the 1-sigma level with CDM values of 0.0064 and 1.90 respectively.

Databases

<u>Basics</u>

- A database is made up of tables
- Tables are defined through their SCHEMA
- Tables can be indexed for (much) faster searches
- Tables can be queried using the “Structured Query Language” (SQL)
- Multiple tables can be joined together in a single query
- Multiple tables can be joined together to create a VIEW
- Useful SQL commands for astronomers are SELECT, INSERT, UPDATE, DELETE
- Databases can be accessed through command-line interface or scripts

Example of a Simple Schema

xterm

```
| sdss_dr7_morph_u_old                               |
| sdss_s82_morph_mybkg_mydeblend_gr                  |
| sf_pairs_crowding                                  |
| sims_n4_pos                                        |
| sims_ps_pos                                        |
| test_sdss_dr7_morph_mybkg_mydeblend_gr             |
| test_sdss_dr7_morph_mybkg_mydeblend_gr_sims_n4_n4  |
| test_sdss_dr7_morph_mybkg_mydeblend_gr_sims_n4_ps  |
| test_sdss_dr7_morph_mybkg_mydeblend_gr_sims_ps_ps  |
| test_sdss_dr7_morph_mybkg_mydeblend_sersic_ir      |
| test_sdss_s82_morph_mybkg_mydeblend_gr             |
| wigglez                                            |
| wp_pairs_mendel                                    |
+----------------------------------------------------+
205 rows in set (0.00 sec)

mysql> describe dr7_pairs;
+--------------------+-------------+------+-----+---------+-------+
| Field              | Type        | Null | Key | Default | Extra |
+--------------------+-------------+------+-----+---------+-------+
| objID              | varchar(25) | NO   | PRI |         |       |
| ra                 | float       | YES  |     | NULL    |       |
| decl               | float       | YES  |     | NULL    |       |
| rp                 | float       | YES  |     | NULL    |       |
| delv               | float       | YES  |     | NULL    |       |
| mratio             | float       | YES  |     | NULL    |       |
| z                  | float       | YES  |     | NULL    |       |
| plateID            | int(11)     | YES  |     | NULL    |       |
| fiberID            | int(11)     | YES  |     | NULL    |       |
| JD                 | int(11)     | YES  |     | NULL    |       |
| inspected          | int(11)     | YES  |     | NULL    |       |
| mass               | float       | YES  |     | NULL    |       |
| scienceprimary     | int(11)     | YES  | MUL | NULL    |       |
| companion_objID    | varchar(25) | YES  |     | NULL    |       |
| offset_mzr         | float       | YES  |     | NULL    |       |
| offset_sfr_fib     | float       | YES  |     | NULL    |       |
| offset_sfr_tot     | float       | YES  |     | NULL    |       |
| offset_poly_mzr_fib | float      | YES  |     | NULL    |       |
| offset_poly_mzr_tot | float      | YES  |     | NULL    |       |
| offset_poly_sfr_fib | float      | YES  |     | NULL    |       |
| offset_poly_sfr_tot | float      | YES  |     | NULL    |       |
+--------------------+-------------+------+-----+---------+-------+
21 rows in set (0.03 sec)

mysql>
```

SDSS Schema Browser

SkyServer Schema Browser

cas.sdss.org/dr7/en/help/browser/browser.asp

Sloan Digital Sky Survey / SkyServer

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Schema Browser

Glossary
Algorithms

Search for [ ] Go

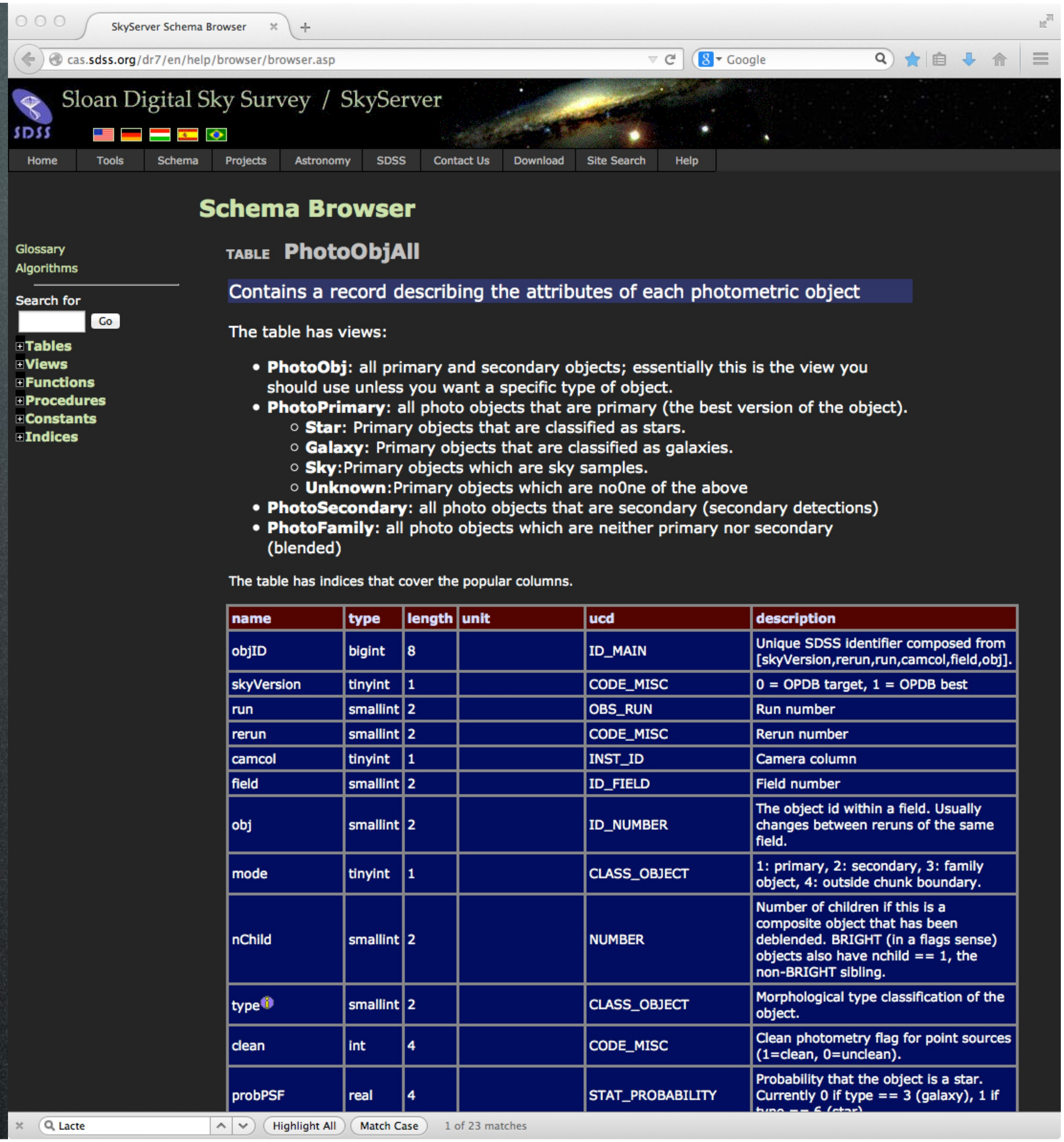
- Tables
- Views
- Functions
- Procedures
- Constants
- Indices

Tables

name	description
Algorithm	Contains a paragraph of text for each algorithm
Ap7Mag	Contains the aperture 7 magnitudes for all objects in PhotoObjAll.
BestTarget2Sector	Map PhotoObj which are potential targets to sectors
Chunk	Contains basic data for a Chunk
DataConstants	The table is storing various enumerated constants for flags, etc
DBColumns	Every column of every table has a description in this table
DBObjects	Every SkyServer database object has a one line description in this table
DBViewCols	The columns of each view are stored for the auto-documentation
Dependency	Contains the detailed inventory of database objects
DR3QuasarCatalog	The catalog of all confirmed quasars in SDSS Data Release 3. *NOTE: The DRxQuasarCatalog a derived science table that may not be loaded for every release or available at the time the release is published.*
DR5QuasarCatalog	The catalog of all confirmed quasars in SDSS Data Release 5. *NOTE: The DRxQuasarCatalog tables are derived science tables that may not be loaded for every release or available at the time the release is published.*
ELRedShift	Contains data for the Emission Line Redshifts
Field	Contains all the measured parameters of a photometric field
FieldProfile	The mean PSF profile for the field as determined from bright stars.
FieldQA	
First	SDSS objects that match to FIRST objects have their match parameters stored here
Frame	Contains JPEG images of fields at various zoom factors, and their astrometry.
Glossary	Contains a paragraph of text for each keyword in the Glossary
HalfSpace	The contraints for boundaries of the the different regions
History	Contains the detailed history of schema changes
HoleObj	Information for holes on a Plate
Inventory	Contains the detailed inventory of database objects
LoadHistory	Tracks the loading history of the database
Mask	Contains a record describing the each mask object
MaskedObject	Contains the objects inside a specific mask
Match	records what objects in one run are re-observed in other runs.
MatchHead	describes each bundle of matching objects from different runs
Neighbors	All PhotoObj pairs within 0.5 arcmins
ObjMask	Contains a record describing each ObjMask/Atlas object

Lacte | Highlight All | Match Case | 1 of 23 matches

SDSS PhotoObjAll Table Schema



SkyServer Schema Browser

cas.sdss.org/dr7/en/help/browser/browser.asp

Sloan Digital Sky Survey / SkyServer

SDSS

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Schema Browser

Glossary
Algorithms

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- Indices

TABLE **PhotoObjAll**

Contains a record describing the attributes of each photometric object

The table has views:

- **PhotoObj**: all primary and secondary objects; essentially this is the view you should use unless you want a specific type of object.
- **PhotoPrimary**: all photo objects that are primary (the best version of the object).
  - **Star**: Primary objects that are classified as stars.
  - **Galaxy**: Primary objects that are classified as galaxies.
  - **Sky**:Primary objects which are sky samples.
  - **Unknown**:Primary objects which are no0ne of the above
- **PhotoSecondary**: all photo objects that are secondary (secondary detections)
- **PhotoFamily**: all photo objects which are neither primary nor secondary (blended)

The table has indices that cover the popular columns.

name	type	length	unit	ucd	description
objID	bigint	8		ID_MAIN	Unique SDSS identifier composed from [skyVersion,rerun,run,camcol,field,obj].
skyVersion	tinyint	1		CODE_MISC	0 = OPDB target, 1 = OPDB best
run	smallint	2		OBS_RUN	Run number
rerun	smallint	2		CODE_MISC	Rerun number
camcol	tinyint	1		INST_ID	Camera column
field	smallint	2		ID_FIELD	Field number
obj	smallint	2		ID_NUMBER	The object id within a field. Usually changes between reruns of the same field.
mode	tinyint	1		CLASS_OBJECT	1: primary, 2: secondary, 3: family object, 4: outside chunk boundary.
nChild	smallint	2		NUMBER	Number of children if this is a composite object that has been deblended. BRIGHT (in a flags sense) objects also have nchild == 1, the non-BRIGHT sibling.
type	smallint	2		CLASS_OBJECT	Morphological type classification of the object.
clean	int	4		CODE_MISC	Clean photometry flag for point sources (1=clean, 0=unclean).
probPSF	real	4		STAT_PROBABILITY	Probability that the object is a star. Currently 0 if type == 3 (galaxy), 1 if

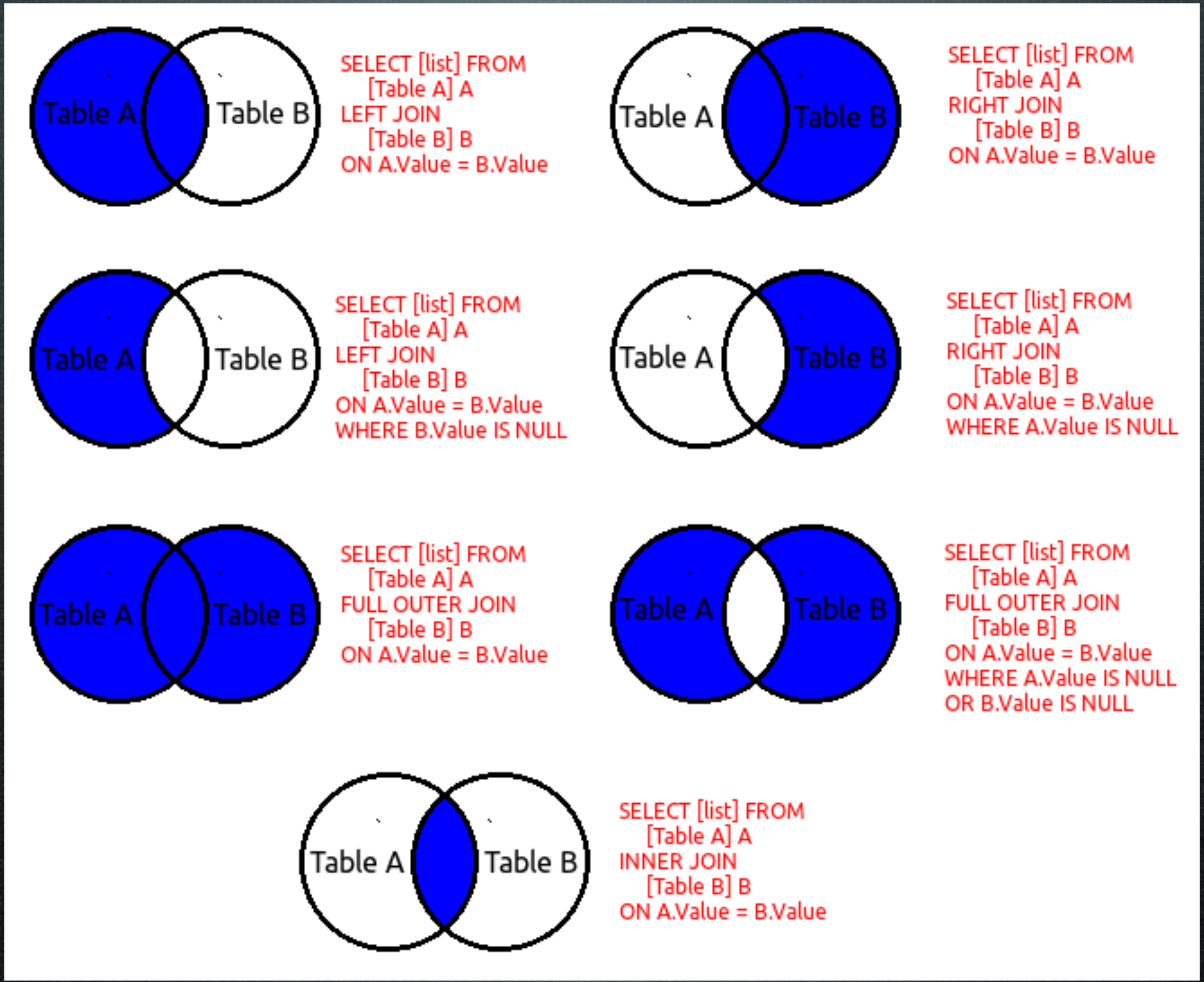
Lacte | Highlight All | Match Case | 1 of 23 matches

Example of Simple Queries

xterm

```
mysql> select count(*) from dr7_pairs;
+----------+
| count(*) |
+----------+
|    22777 |
+----------+
1 row in set (0.00 sec)

mysql> select objID,ra,decl,rp,delv from dr7_pairs limit 5;
+--------------------+---------+---------+-------+------+
| objID              | ra      | decl    | rp    | delv |
+--------------------+---------+---------+-------+------+
| 587725818560118838 | 179.105 | 68.1789 | 42.75 | 3593 |
| 587725818560118915 | 179.056 | 68.1735 |  33.1 |   57 |
| 587725818560118919 | 179.079 | 68.1662 |  33.1 |   57 |
| 587738066202919059 | 149.283 | 68.0932 | 29.53 |  785 |
| 587738066202919061 | 149.325 | 68.0872 | 29.53 |  785 |
+--------------------+---------+---------+-------+------+
5 rows in set (0.01 sec)

mysql> select objID,ra,decl,rp,delv from dr7_pairs where rp >= 20.0 and rp <= 30 limit 5;
+--------------------+---------+---------+-------+------+
| objID              | ra      | decl    | rp    | delv |
+--------------------+---------+---------+-------+------+
| 587738066202919059 | 149.283 | 68.0932 | 29.53 |  785 |
| 587738066202919061 | 149.325 | 68.0872 | 29.53 |  785 |
| 587725551747399842 | 173.293 | 67.2819 | 25.97 |  134 |
| 587725551747399839 | 173.287 | 67.2784 | 25.97 |  134 |
| 587725551213477935 | 190.725 | 67.0262 | 27.94 |  355 |
+--------------------+---------+---------+-------+------+
5 rows in set (0.02 sec)

mysql> select objID,ra,decl,rp,delv from dr7_pairs order by rp asc limit 5;
+--------------------+---------+---------+------+------+
| objID              | ra      | decl    | rp   | delv |
+--------------------+---------+---------+------+------+
| 587742615635755157 | 240.915 | 14.8507 | 1.91 |  144 |
| 587742615635755155 | 240.916 | 14.8497 | 1.91 |  144 |
| 587738411946344459 | 174.268 | 15.9154 |    2 |  111 |
| 587738411946344462 | 174.269 | 15.9149 |    2 |  111 |
| 588017604143939618 | 173.721 | 44.0049 |  2.1 |   26 |
+--------------------+---------+---------+------+------+
5 rows in set (0.06 sec)

mysql>
```

Joining Tables



Exercise CAUTION! Think about the tables you want to join and what kind of join you want to use. Joining two large tables may take a very, very long time (think days) and may even hang the database server!

Creating a table with a script

```
llaima2.uvic.ca% cat create_mytable.sql
use sdss;
drop table if exists test_luc;
create table test_luc (
        objID           varchar(25)     not null,
        spid            varchar(25)     null,
        specObjID       varchar(25)     null,
        mjd             int             null,
        plate           int             null,
        fiberID         int             null,
        TType           int             null,
        barflag         int             null);
create unique index i1 on test_luc(objID);
llaima2.uvic.ca% mysql --verbose -h llaima1p.mysql.uvic.ca -u simardl -p < create_mytable.sql
```

Script does the following:

- Checks if table already exists – deletes table if yes
- Creates table following specified schema
- Creates index or indices – note the UNIQUE type here

Script is executed from command-line

Loading Data into a Table

xterm

```
#!/home1y/simardl/python/python2.4.2/bin/python

import os,sys, MySQLdb

infile = '/home1y/simardl/astro-apps/sdss/preethi_morph/SaraTerms.tbl'
db = MySQLdb.connect(host='llaima1p.mysql.uvic.ca',db='sdss',user='your_username',passwd='your_password')
c = db.cursor()
f = open(infile,'r')
for line in f.readlines():
    data = line.split('\t')
    try:
            dbcmd = 'insert into test_luc (spid,objID,specObjID,mjd,plateID,fiberID,TType,barflag) values ("'+data[0]+'","'+data[1]+'","'+data[2]
+'",'+data[3]+','+data[4]+','+data[5]+','+data[6]+','+data[7].replace('\r\r\n','')+')'
            c = db.cursor()
            c.execute(dbcmd)
            db.commit()
            c.close()
    except:
            print dbcmd
            continue
db.close()
f.close()

sys.exit()

~
load_data.py lines 1-24/24 (END)
```

This is a Python script, but your choice of scripting language does not matter – All we are really doing here is using an INSERT statement on every row of our input data file

Retrieving Data from a Table with Python

```
#!/home1y/simardl/python/python2.4.2/bin/python

import os, sys, string, MySQLdb

if os.access(sys.argv[2],0): os.remove(sys.argv[2])
f_out = open(sys.argv[2],"w")

db = MySQLdb.connect(host='llaima1p.mysql.uvic.ca',db='sdss',user='your_username',passwd='your_password')
dbcmd = sys.argv[1]
c = db.cursor()
c.execute(dbcmd)
gal_list = c.fetchall()
for gal in gal_list:
    outline = ""
    for i in range(len(gal)):
        outline = outline+"%s "%(str(gal[i]))
    outline = outline+"\n"
    f_out.write(outline)
c.close()
f_out.close()
db.close()
sys.exit()
~
query_mysdss.py lines 1-22/22 (END)
```

Script can run any query from the unix shell command-line as follows:

./query_mysdss.py “select objID, rp from dr7_pairs limit 50” rp_data.dat

Retrieving Data from a Table with PERL

xterm

```
#!/usr/bin/perl -w

use DBI;

# File to write output to
open(OUT,">output.dat");

@row=();

$dsn =  "dbi:mysql:database=sdss;host=llaima1p.mysql.uvic.ca;port=3306";

#  Put your own netlink username and MYSQL (not netlink) passwd
$dbh = DBI->connect($dsn, 'username', 'password')
        or die "Couldn't connect to db: " . DBI->errstr;

# Write your query in here

$test_qry = $dbh->prepare( "select objID,ra,decl from dr7_uberuber limit 10;"  );

# Send query to database

$test_qry->execute()
        or die "Couldn't execute statement: " . $test_qry->errstr;

# Extract information row by row

while (@row = $test_qry->fetchrow) {

    # Print to output
    print(OUT "@row \n");
}

$dbh->disconnect();
(END)
```

OK. Let’s play with the llaima database now. ☺