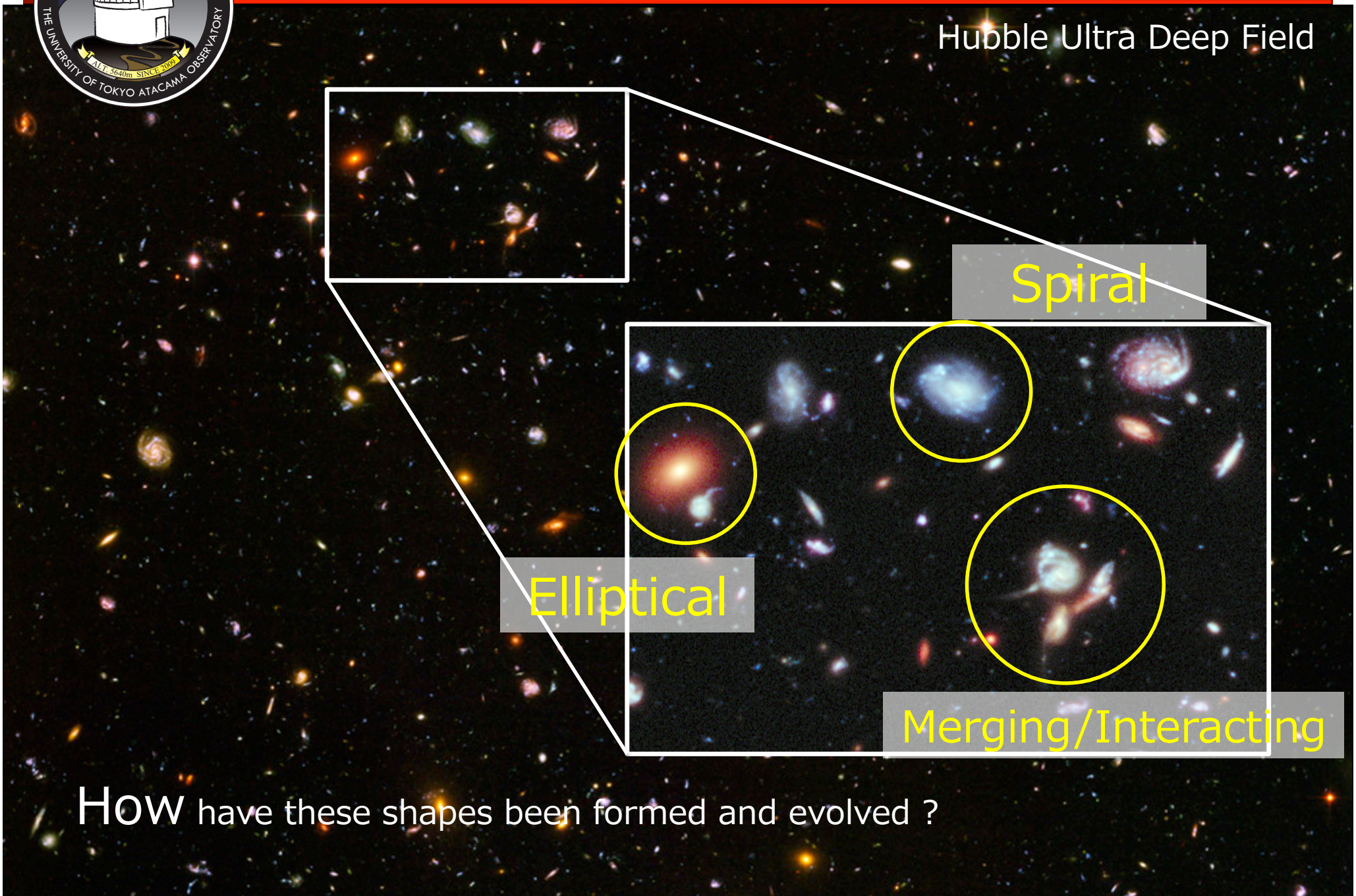
13, Jun., 2013 Subaru GLAO Science WS.

Physical Morphology

Bulge Structure and Star Formation Activity in Local LIRG

● Ken Tateuchi (the Univ. of Tokyo) , Kentaro Motohara, Masahiro Konishi, Hidenori Takahashi, Natsuko Kato, Yutaro Kitagawa, Soya Nishijima and TAO project team

Diversity in the form of galaxies



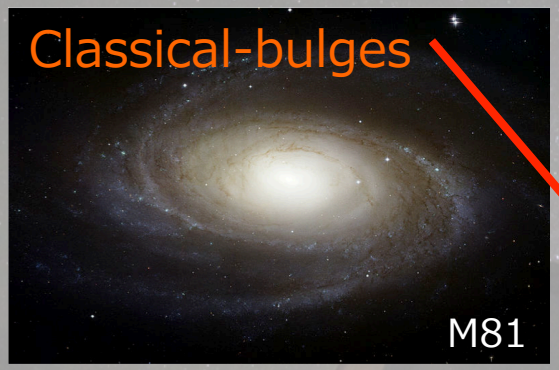
How have these shapes been formed and evolved ?

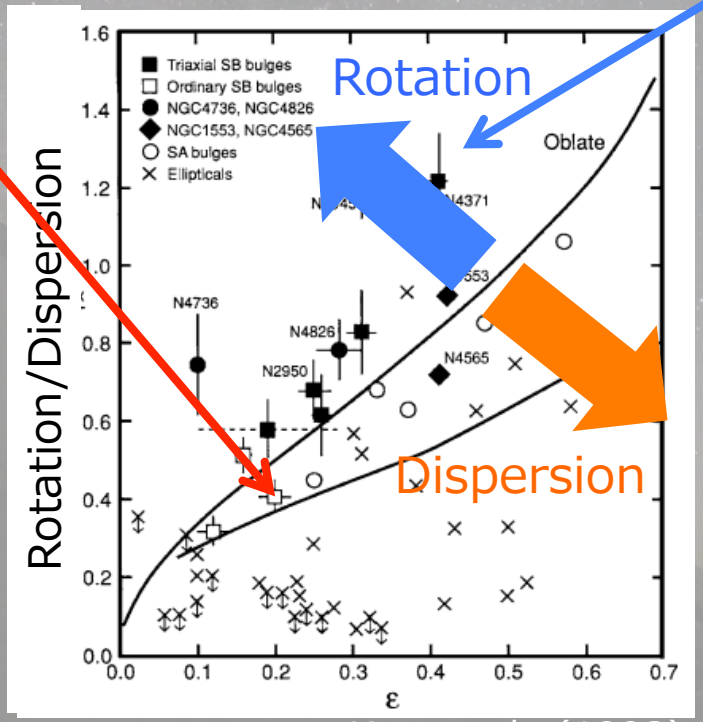
Classical and Pseudo Bulge

Classical Morphology: based on the "Hubble Sequence"
→ Spirals : Barred Spiral ⟷ Non-Barred

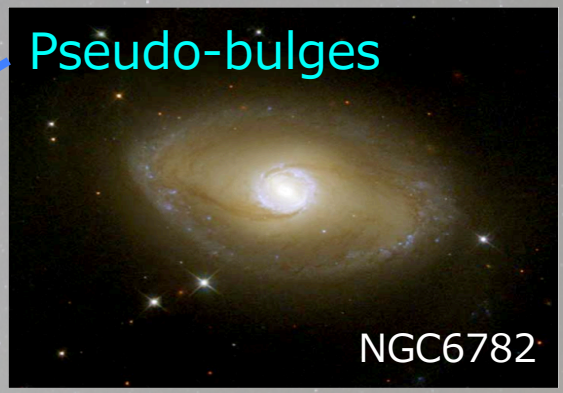
Focus on the bulge structure !!

Physical Morphology





Kormendy (1993)



① Dispersion supported
① Not as flat as disk
② Old stellar population
…

Elliptical like?

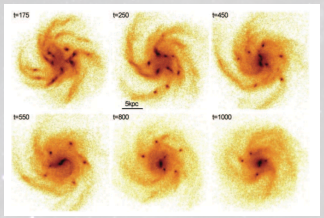
① Rotation supported
① As flat as disk
② Young stellar population
…

Disk like?

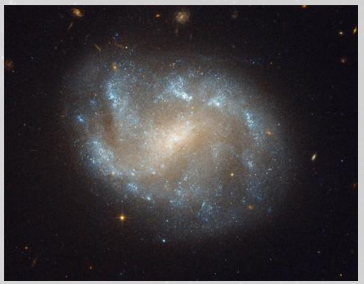
Theoretical Prospect of Morphogenesis

Merging/Interacting

Primordial Disk?
(Elmegreen et al. 2008)



Secular/internal Evolution



?

Dry Merger?
(Kormendy+2004)

?

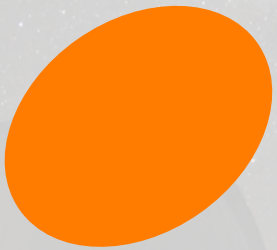
Gas-rich Merger?
(Springel+ 2005,
Kormendy+ 2004)

?

?

Kormendy+ 2004

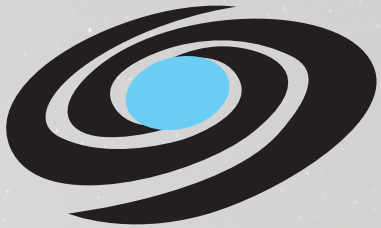
High-redshift starburst ?
(Okamoto+ 2013)



From ULIRG?
(Toomre+ 1977)

Elliptical

Classical Bulge
Dispersion



Pseudo Bulge
Rotation

Spiral

However, there are few observational evidences...

Observational Verification is Necessary !

LIRGs – Ideal Laboratory of Morphogenesis -

Previous works → Normal Galaxies

The form has been formed already....

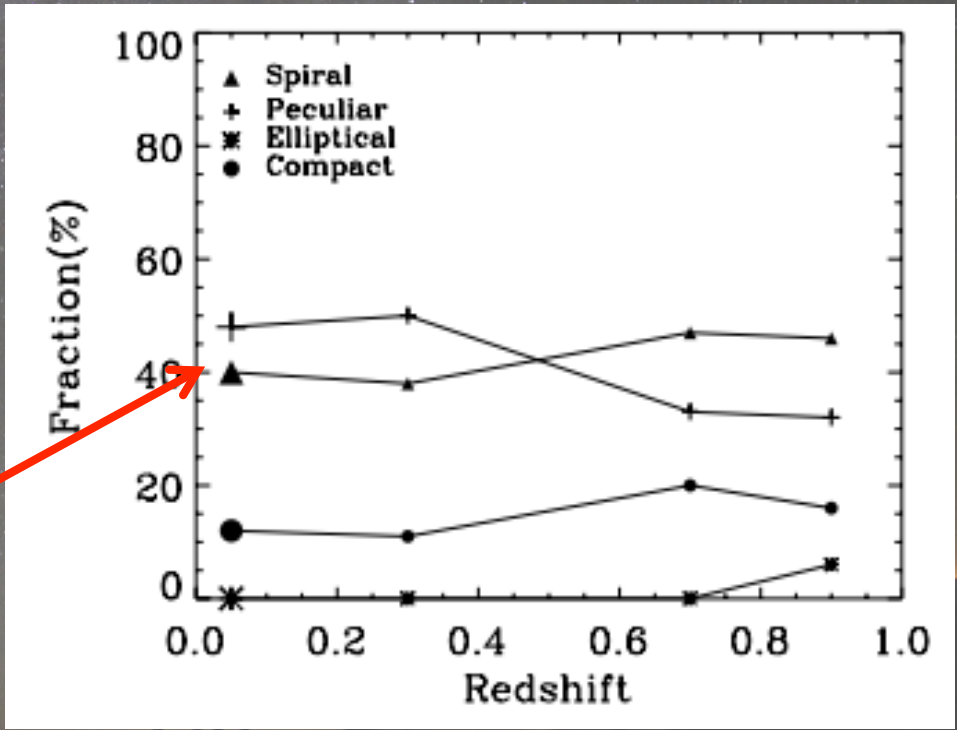
Luminous Infra-Red Galaxies

Starburst galaxies

$10^{11} L_\odot \leqq L_{IR(8\text{-}1000\mu m)} < 10^{12} L_\odot$

$10 < SFR\ (M_\odot\ yr^{-1}) < 100$

- On-going starburst galaxies
  → Ideal Laboratory of Morphogenesis
- Half of them are Spirals
  → Classical-, Pseudo- bugle factory ?



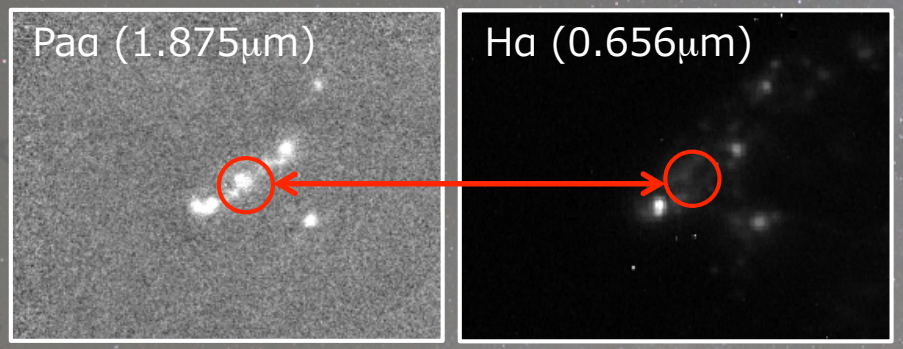
Wang et al. 2006

However, LIRGs are so Dusty...

Paα observation of Local LIRGs

Paα is hydrogen recombination line at 1.8751 um

The advantages of Paα



VV254 (Komugi, Tateuchi+ 2013)

① Unbiased tracer of the current SFR

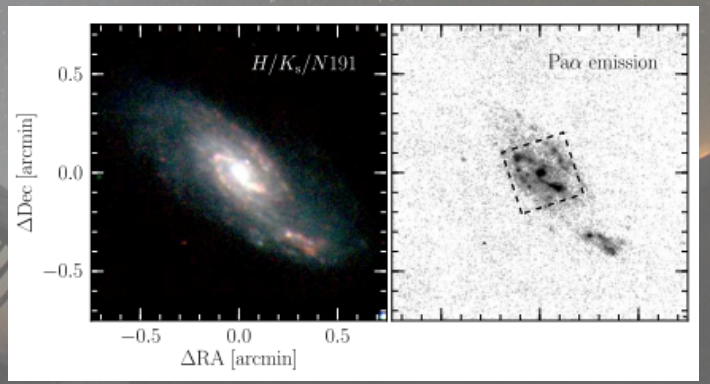
② One of the STRONGEST hydrogen recombination lines @ near-IR

③ Far less affected by dust extinction

④ High spatial resolution
※ Compared to far-IR and mid-IR

Observation with miniTAO/ANIR

38 LIRGs (Sanders et al. 2003 IRAS catalog)
miniTAO 1m Telescope/Atacama NIR camera
→ Paα : Narrow-band Imaging
→ Ks : Broad-band Imaging

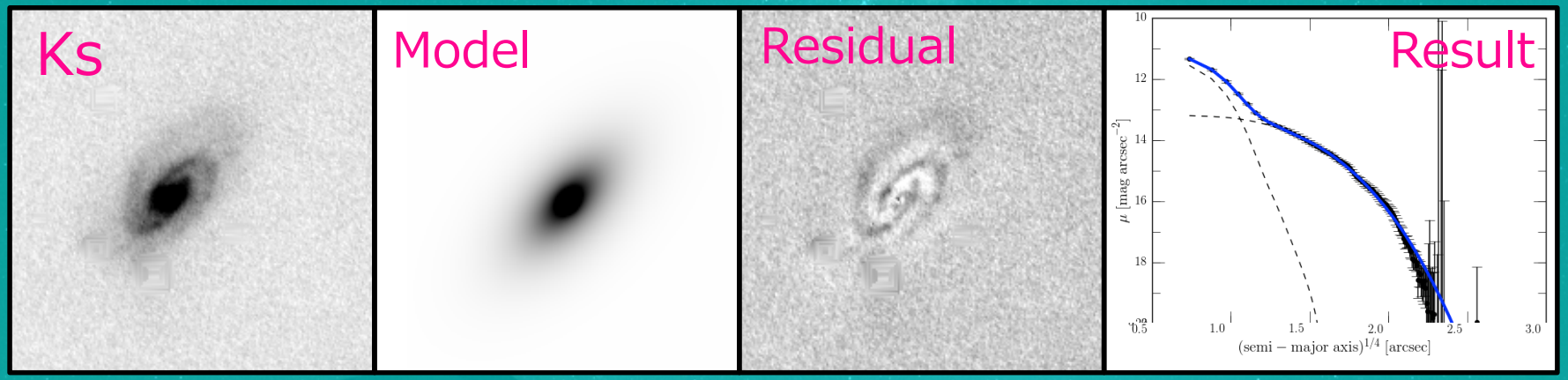


See through the internal bulge with Paα !

Data Analysis

Class the two type of bulge by observation
→ Sersic Index of bulge

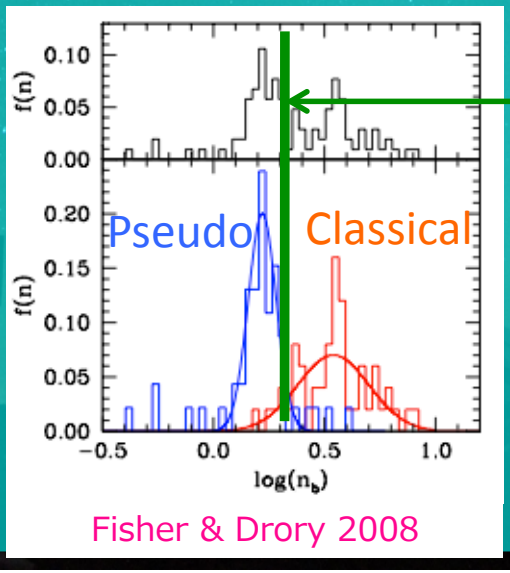
Bulge-disk decomposition with GALFIT



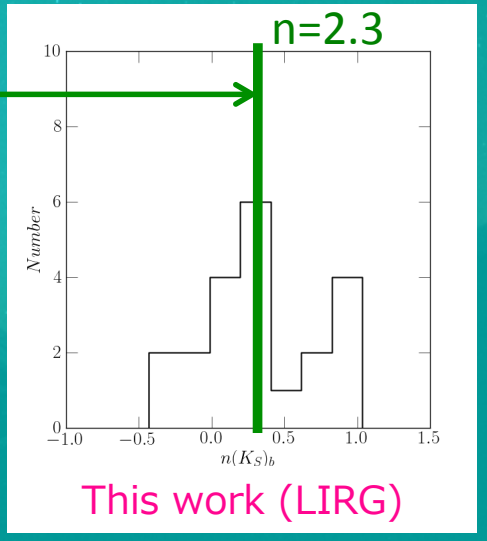
Sersic bulge + exponential disk

Normal galaxies

n>2.3 : Classical bulge
n<=2.3 : Pseudo bulge
(Fisher & Drory 2008)



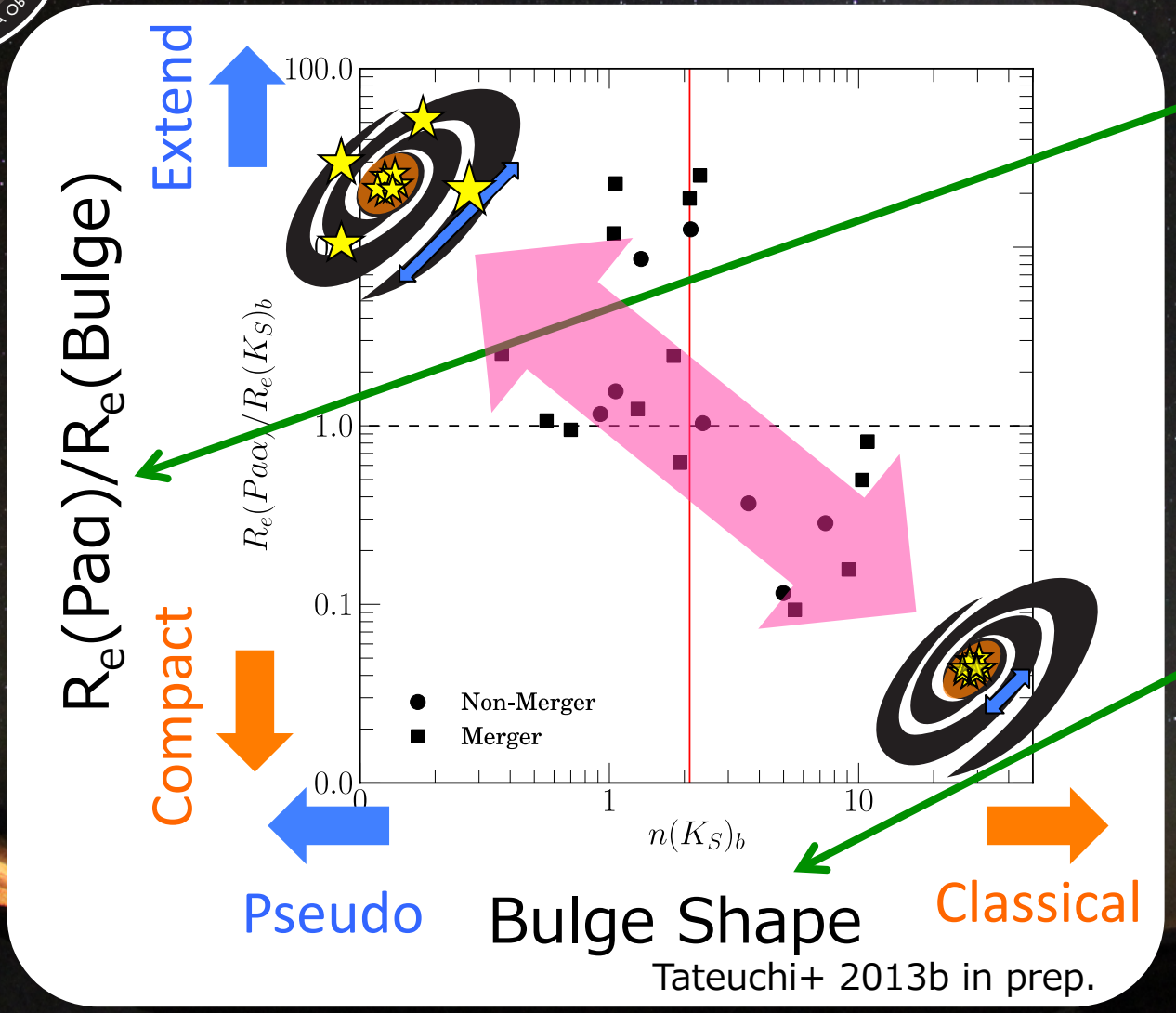
Fisher & Drory 2008



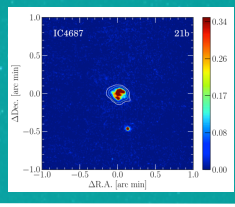
This work (LIRG)

Bulge Structure and SF Region I

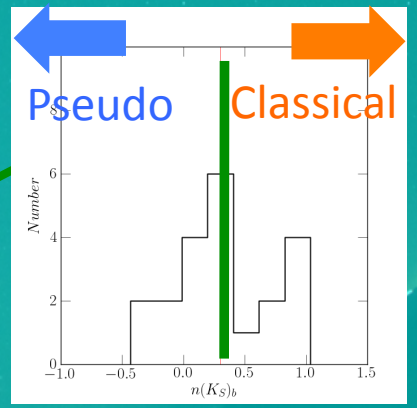
Nearby (z~0.03) LIRGs: Field Galaxies



Paα Distribution
(50% of Luminosity)



Bulge Radius (GALFIT)



Decomposition of
Disk-Bulge by GALFIT

Classical: compact-, Pseudo: Extend- starburst

Bulge Structure and SF Region II

From Theoretical prospects ...

Extend

Compact

$R_e(Paα)/R_e(Bulge)$

$R_e(Paα)/R_e(K_S)_b$

$n(K_S)_b$

Non-Merger

Merger

Internal ?

Major Merger ?

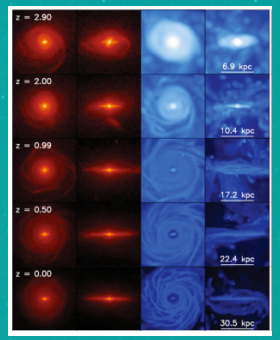
Pseudo

Classical

Bulge Shape

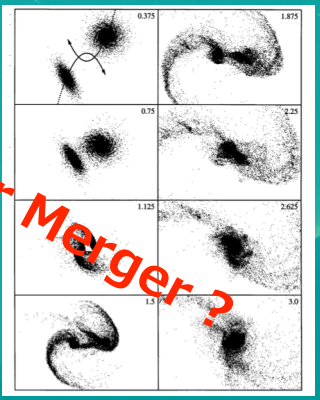
Tateuchi+ 2013b in prep.

Starburst at
bar-end, along spiral arms



Okamoto+ (2013)

Starburst at
galactic central region



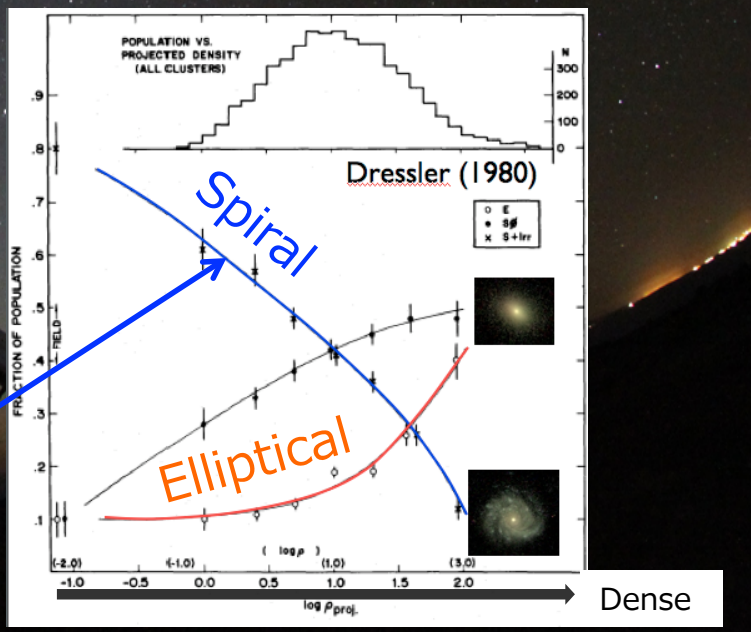
Barnes & Henquist (1996)

Our Results are Consistent with Theoretical Predictions !?

Physical Morphology

Towards Subaru/GLAO

We want to know the environmental effects on the bulges ...



Add the classification of
"Classical" and "Pseudo" bulge
in the right figure !!

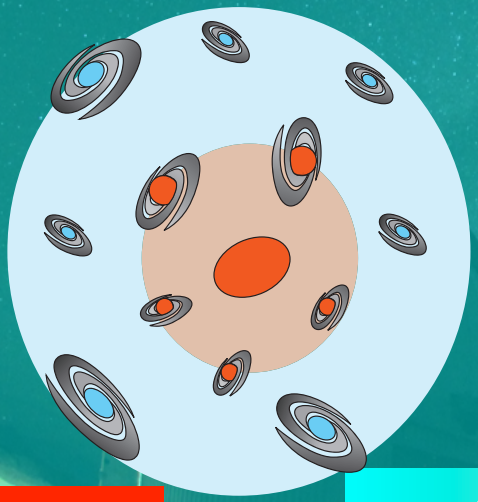
K-band Science w/ Subaru/GLAO

To understand the Environmental effects on bulge structures...

→ we propose to observe nearby cluster of galaxies and field galaxies by K-broad band with GLAO

K-band observations of Nearby Cluster of Galaxies

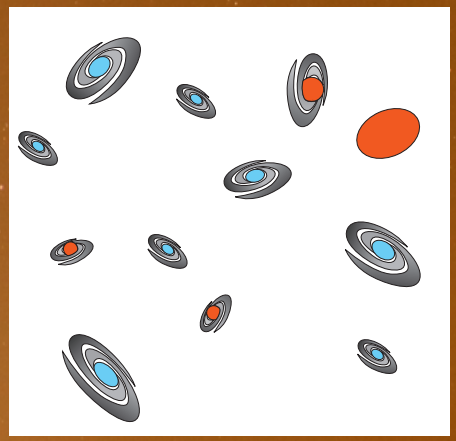
About 2700 systems (Abell; z<0.2)
→ bulge-disk decomposition w/ 0".2



Cluster

K-band observations of Nearby Field Galaxies

COSMOS Field ?
New fields by HSC ?



Field

Classical ?

Pseudo ?

Compartmentalization ?
Ratio of Classical and Pseudo ?

Wide-Field Near-IR Imager w/ GLAO is Essential !?

Resolution and Coverage of Clusters

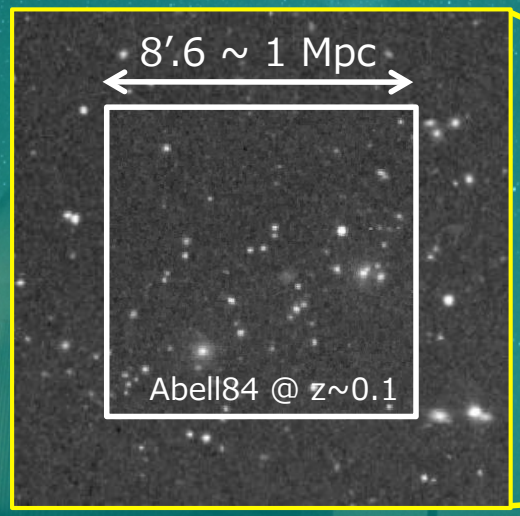
To decompose the bulge-disk and evaluate the shapes ...

→ a few hundreds (2~300) pc scale resolution is necessary !

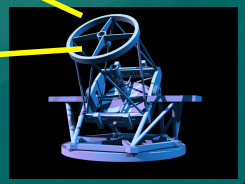
	Our nearby Science	z = 0.05	z = 0.1	z = 0.2	z = 0.3
D_A	80 Mpc	200 Mpc	400 Mpc	700 Mpc	1000 Mpc
Physical Scale w/ GLAO (0".2)	300 pc	200 pc	300-400 pc	500-700 pc	700- pc

To cover the whole cluster of galaxies ...

→ Wide-FoV is necessary !



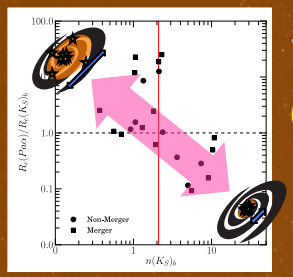
Subaru/GLAO can cover the whole cluster with 1 Snapshot !!



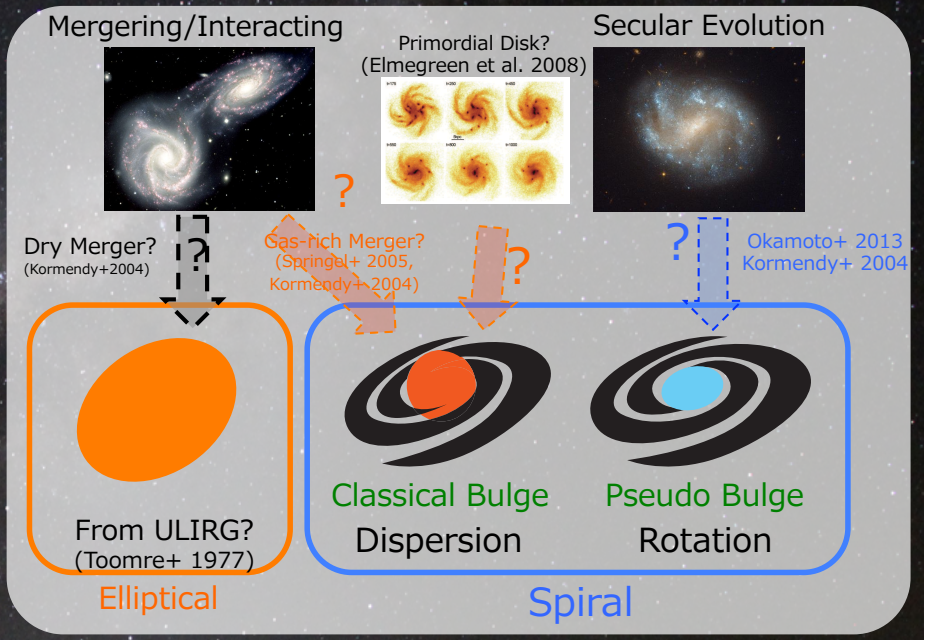
GLAO is suitable for the Science of Nearby Cluster of Galaxy!

Summary

To reveal these theoretical prospects...



We found that
Classical: compact starburst
Pseudo : extended starburst
in the near-by field galaxies



We want to know the effects of environment on these galaxies...

K-band snapshot survey with Subaru/GLAO

0.05 < z < 0.2 Clusters of Galaxies and Field Galaxies

Cluster

・K-band snap-shot survey : 10 min/cluster (2700 clusters are available)

Field

・K-band snap-shot survey : 10 min/FoV (?? area)

The specifications of Subaru/GLAO is sufficient and suitable for our science !

※The observation time is estimated as follows,
miniTAO=1m → Subaru=8m (64times), miniTAO sources=80Mpc → Subaru=600-700Mpc (about 64 times)
So, it is comparable observation time of miniTAO near-by sources with Subaru high red-shift sources

If we can observe some galaxies with Subaru/GLAO...

Kintaro

Acchan

We will be able to tell
which the galaxy (person) “Pseudo” is !!

※ sorry for Japanese Joke

13, Jun., 2013 Subaru GLAO Science WS.

Q.1

Wide-Field Wide-Field Near-IR Imager

Q.2

The specifications of Subaru/GLAO is sufficient and suitable for our science !

Q.3

Supply many sources of Classical and Pseudo bulges !

Q.5

Observe nearby (0.05<z<0.2) clusters by K-band snapshot survey !!
If GLAO has narrow-band filters...

Thank you !