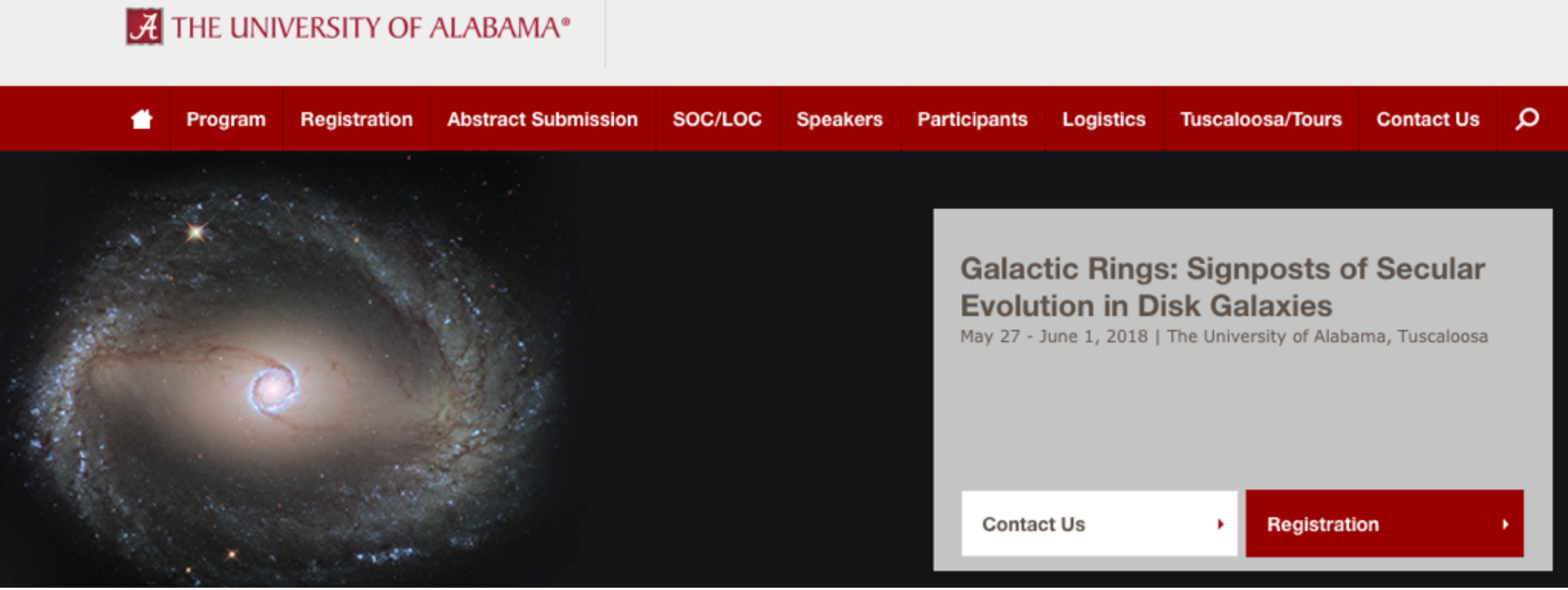
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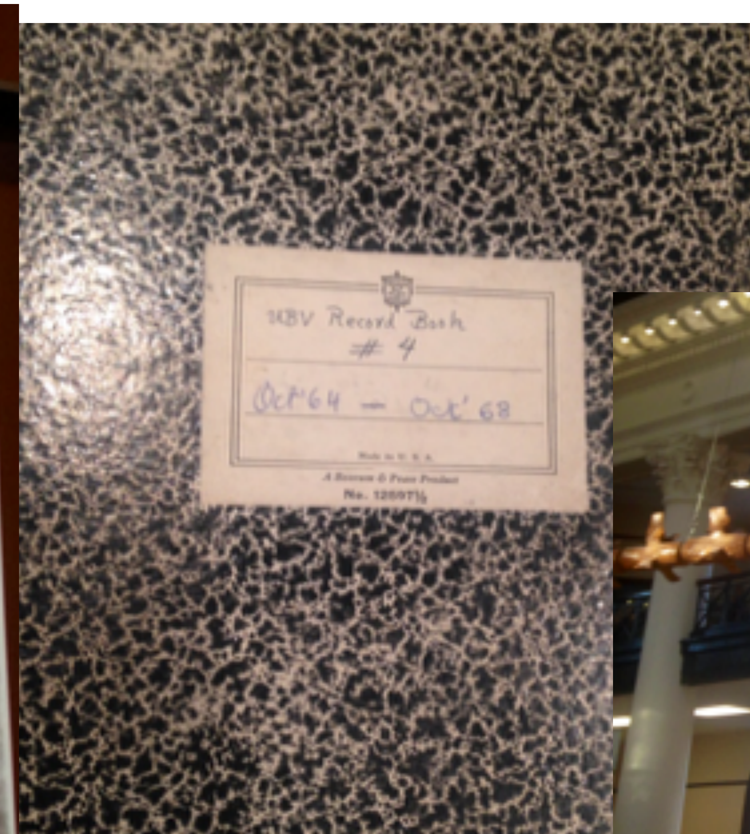
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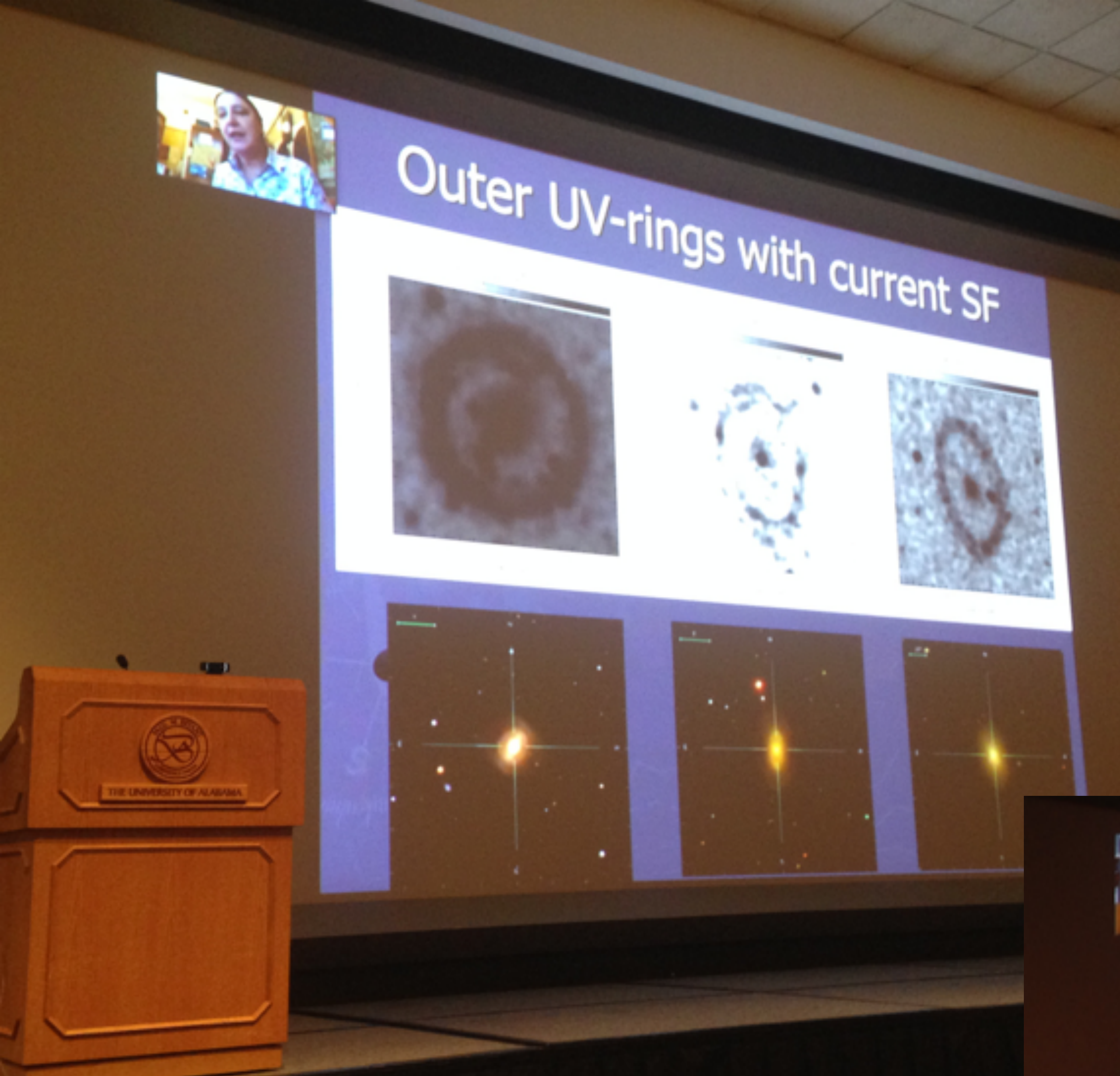
4
Oct'64 — Oct'68


Outer UV-rings with current SF
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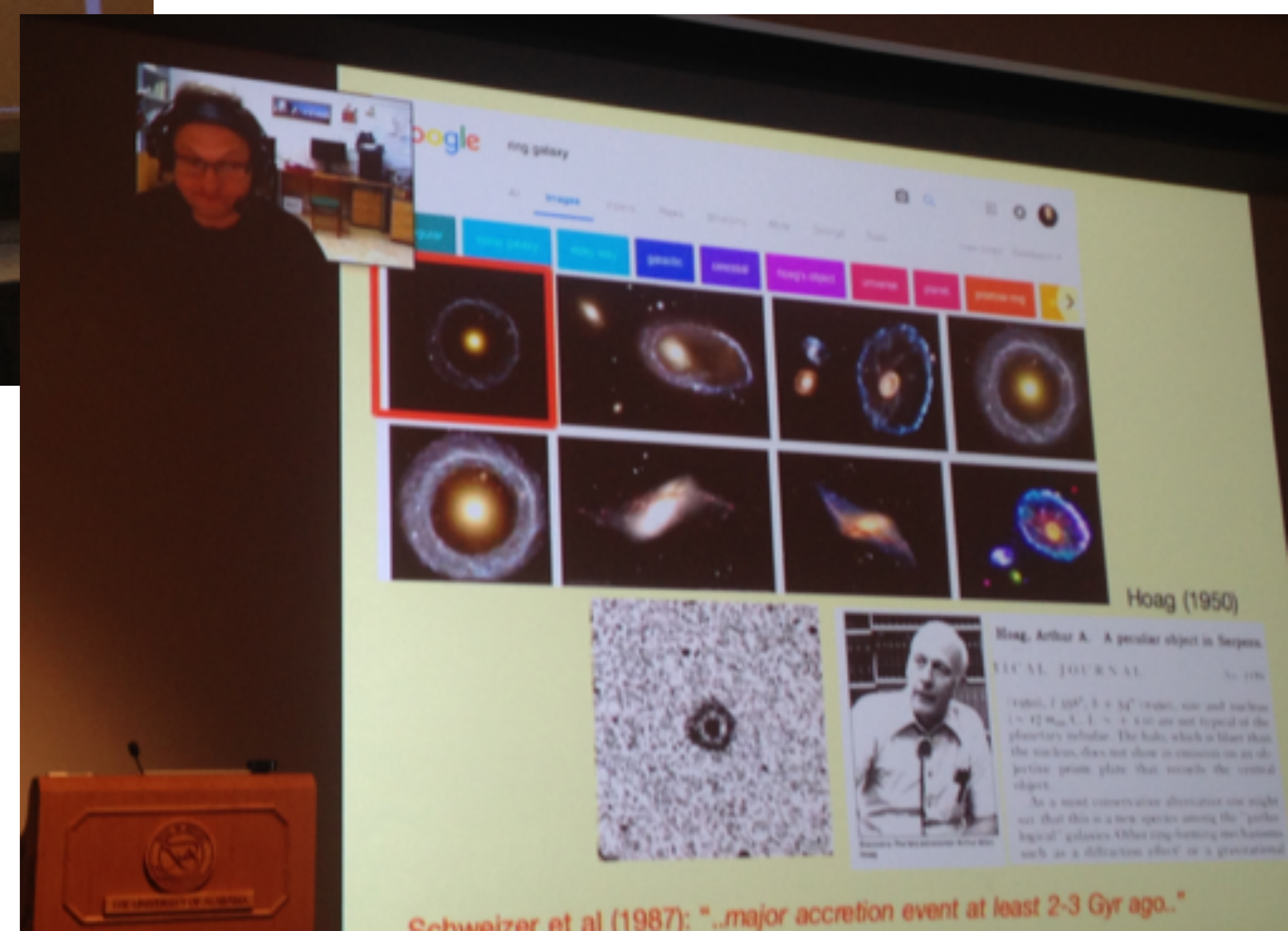
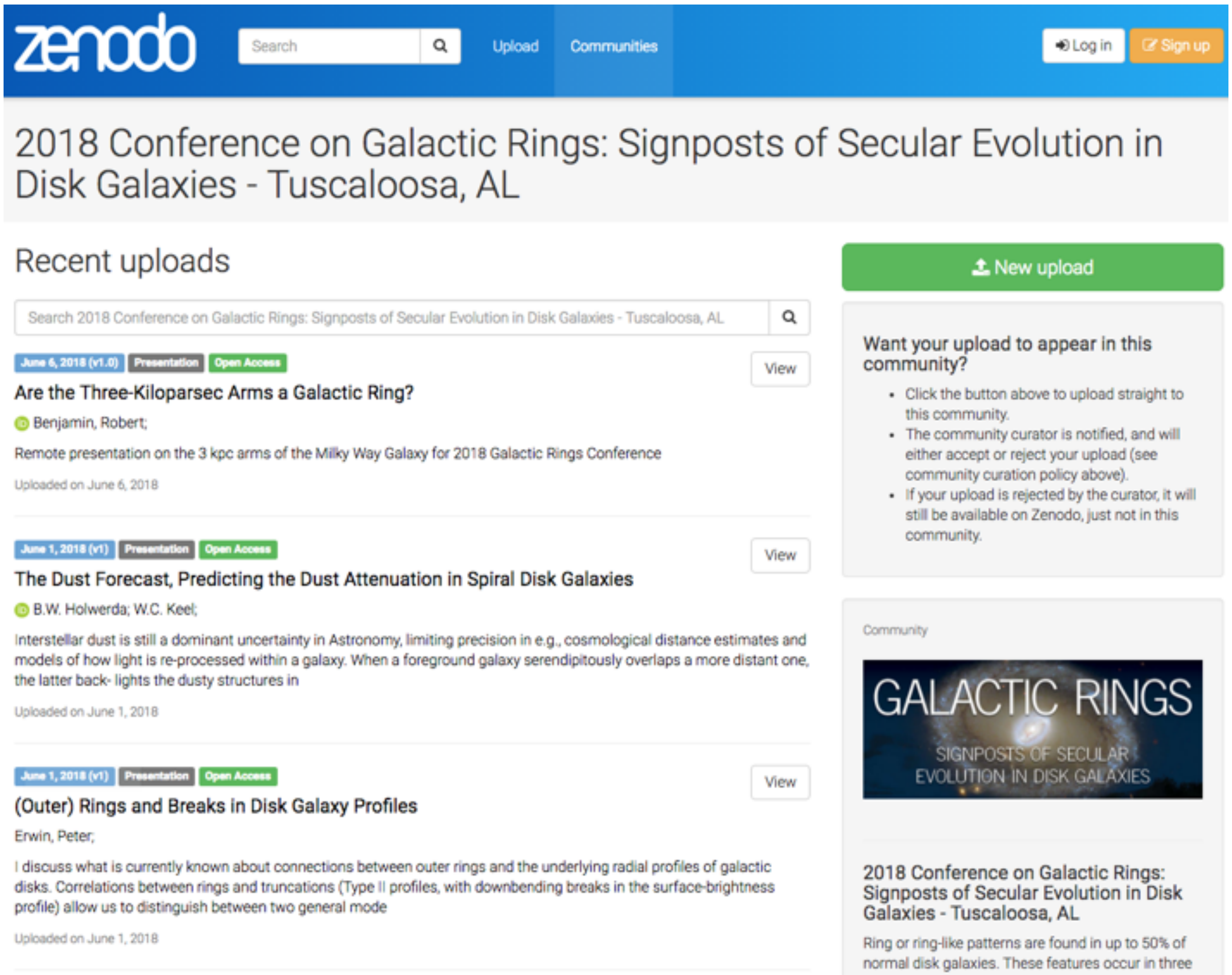

ring galaxy
Hoag (1950)
Hoag, Arthur A. A peculiar object in Serpens.
Schweizer et al (1987): "..major accretion event at least 2-3 Gyr ago."

Лишь некоторые презентации доступны на Zenodo

https://zenodo.org/communities/galrings18/?page=1&size=20



Ansae in Barred (Ringed) Galaxies

Ivan Katkov[1]
Alexei Kniazev[2]
Olga Sil'chenko[1]

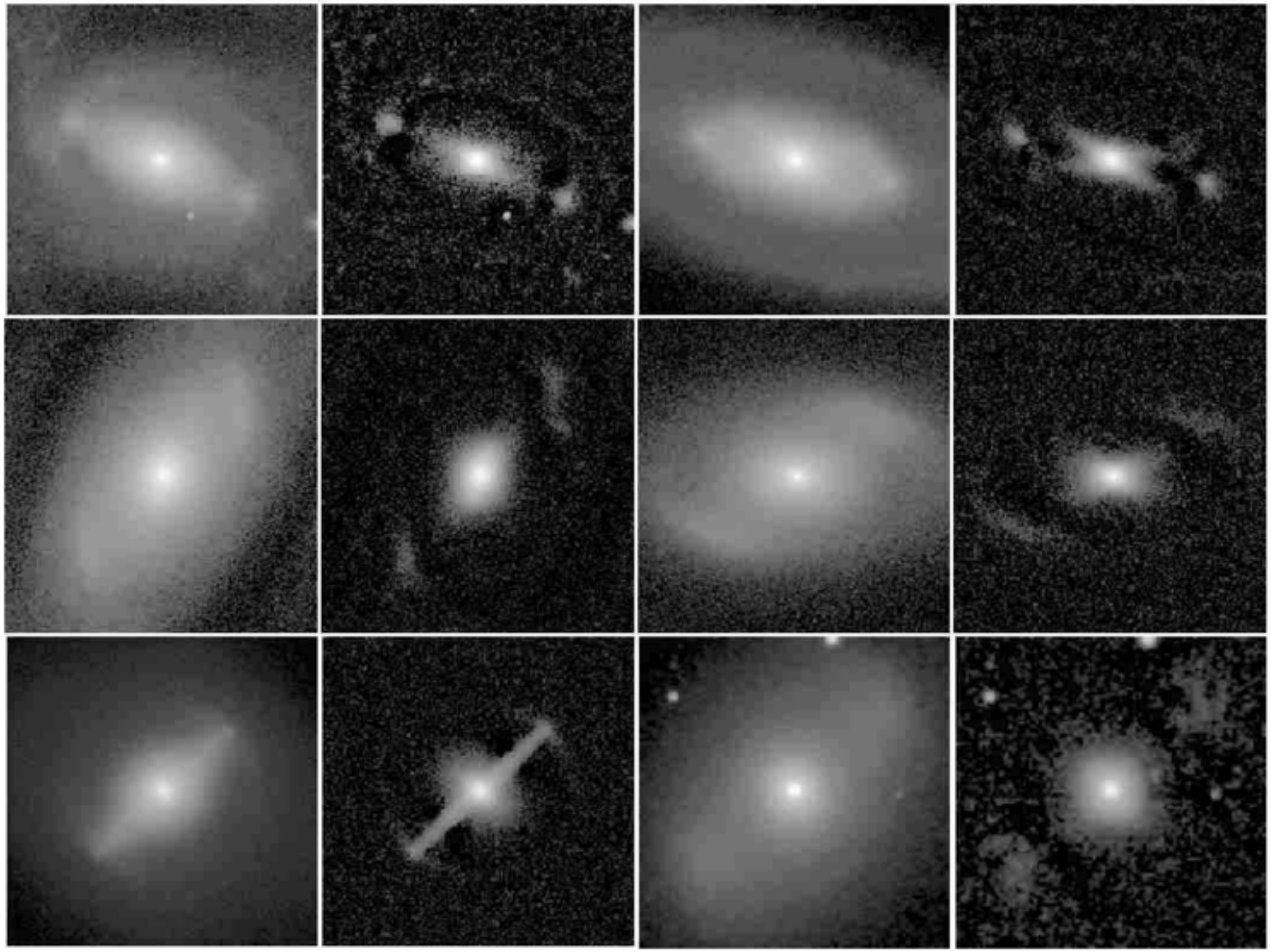
1 - Sternberg Astronomical Institute
Lomonosov Moscow State University

2 - South African Astronomical Observatory
Southern African Large Telescope Foundation

The University of Alabama, Tuscaloosa
May 29, 2018

National Research Foundation
SAAO South African Astronomical Observatory
RSF Russian Science Foundation

Ansae phenomena

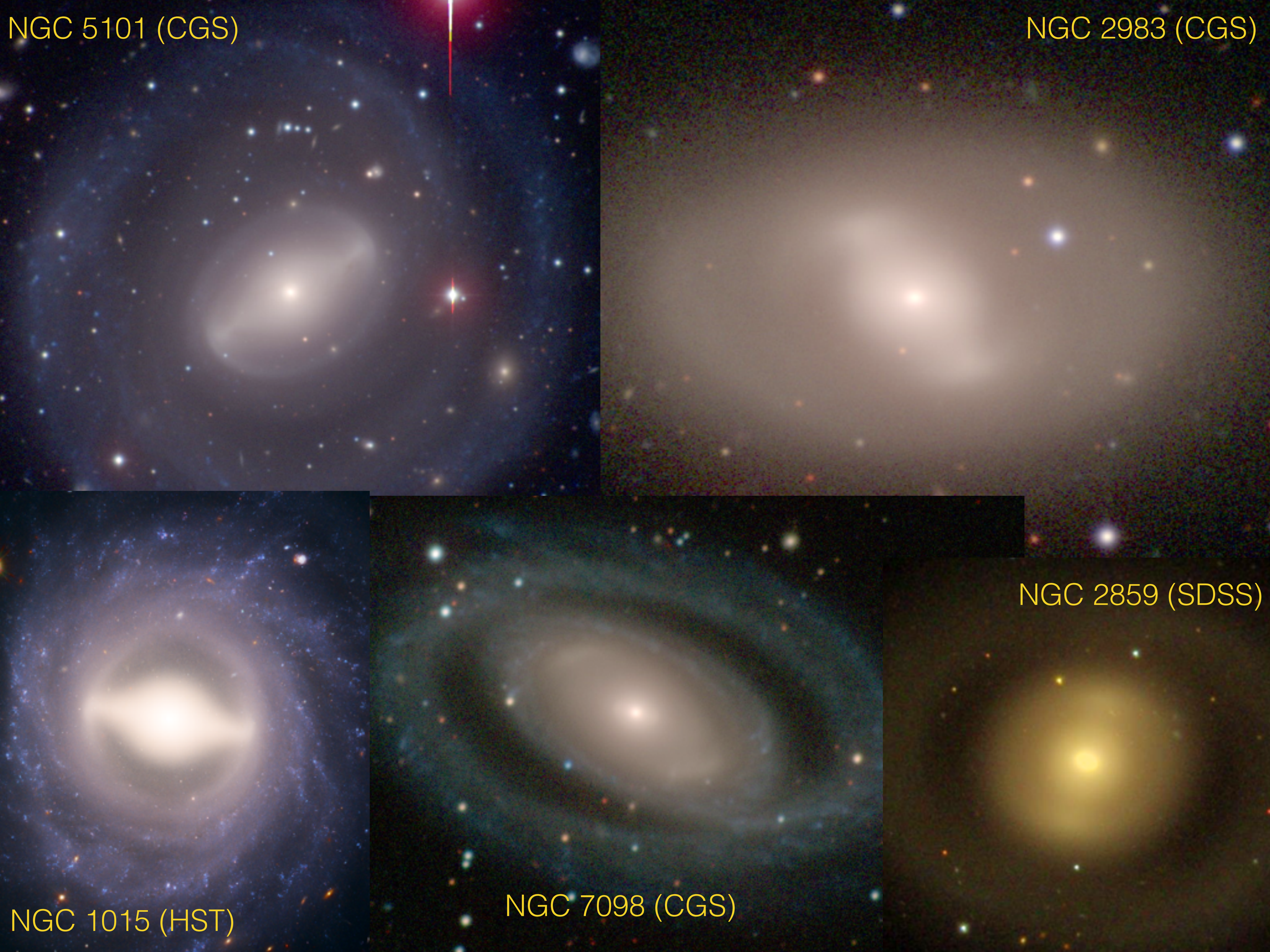


Round

Curved, linear

Ring arc, irregular

Ronald Buta "Galaxy Morphology" 2013


NGC 5101 (CGS)
NGC 2983 (CGS)
NGC 2859 (SDSS)
NGC 1015 (HST)
NGC 7098 (CGS)

Ansae statistics

Martinez-Valpuesta, Knapen, Buta (2007)

“We find that 40% of SB0’s show ansae in their bars, thus confirming that ansae are common features in barred lenticulars.The ansae frequency decreases dramatically with later types, and hardly any ansae are found in galaxies of type Sb or later”

Statistics for the Sample of Barred Galaxies from the Atlas

Type	Total	Ansae	No Ansae	Ansa Fraction (%)
SB0	26	11	15	42 ± 10
SAB0	13	3	10	23 ± 12
SBa	19	5	14	26 ± 10
SABa	27	8	19	30 ± 9
SBab	21	3	18	14 ± 8
SABab	14	2	12	14 ± 9
SBb	21	2	19	10 ± 6
SABb	18	1	17	6 ± 6
SBbc	12	0	12	0
SABbc	19	1	18	5 ± 5
SBc	6	0	6	0
SABc	15	0	15	0
SBcd	11	0	11	0
SABcd	9	0	9	0
SBd	8	0	8	0
SABd	6	0	6	0
SBdm, IBm	15	0	15	0
SABdm, Im	7	0	7	0
S0	39	14	25	36 ± 8
Sa	46	13	33	28 ± 7
Sab	35	5	30	14 ± 6
Sb	39	3	36	8 ± 4
Sbc	31	1	30	3 ± 3
Sc	21	0	21	0
Scd	20	0	20	0
Sd	14	0	14	0
Sdm, Im	22	0	22	0
Total	267	36	231	14 ± 2

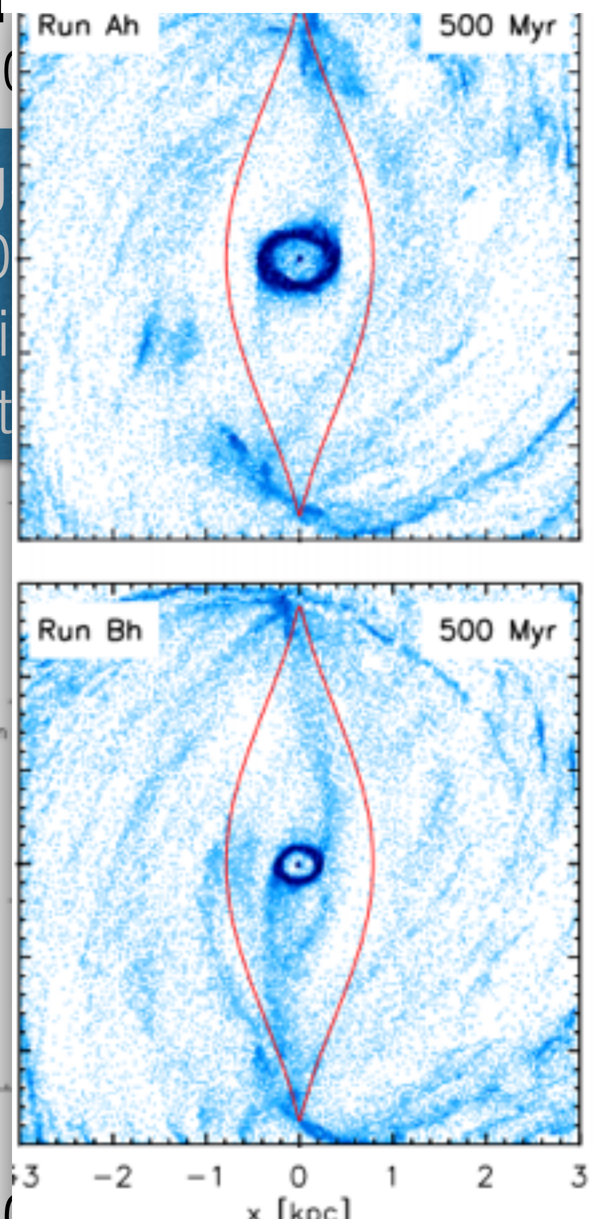
Ansae dynamics

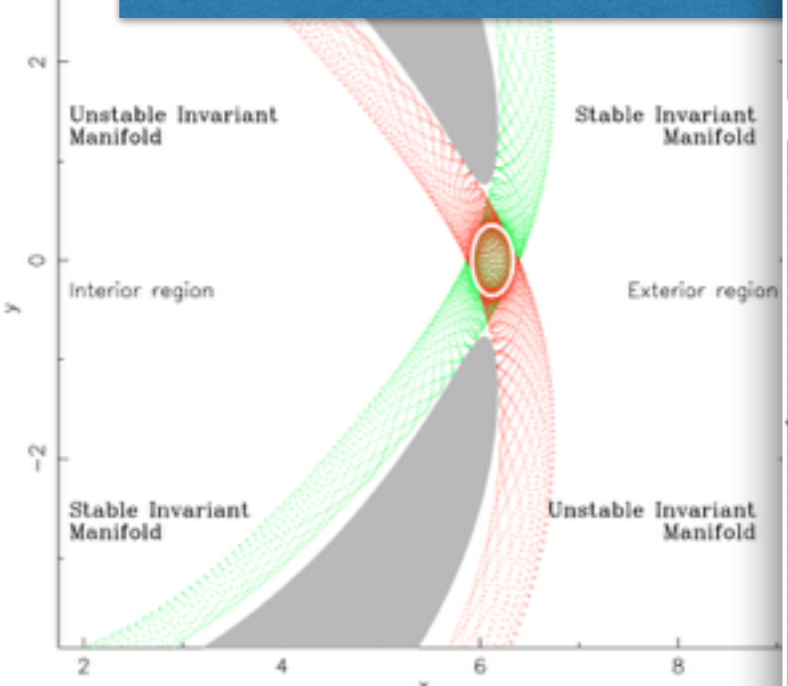
- Martinez-Valpuesta, Shlosman, Heller (2006): the ansae are associated with trapped disk orbits librating around the bar and appeared after second buckling at late stage of bar ev...

- Manifolds dynamical f... ...mez et al. 2006, 2007, 2009, Athanassoula et al. 20...

"the majority of our g... ...nt signs of star formation in these regions (Buta et al. 20... ...aps ansae typically show no color enhancement, indicati... ...ely stellar dynamical phenomena"
Mart... ...en, Buta (2007)

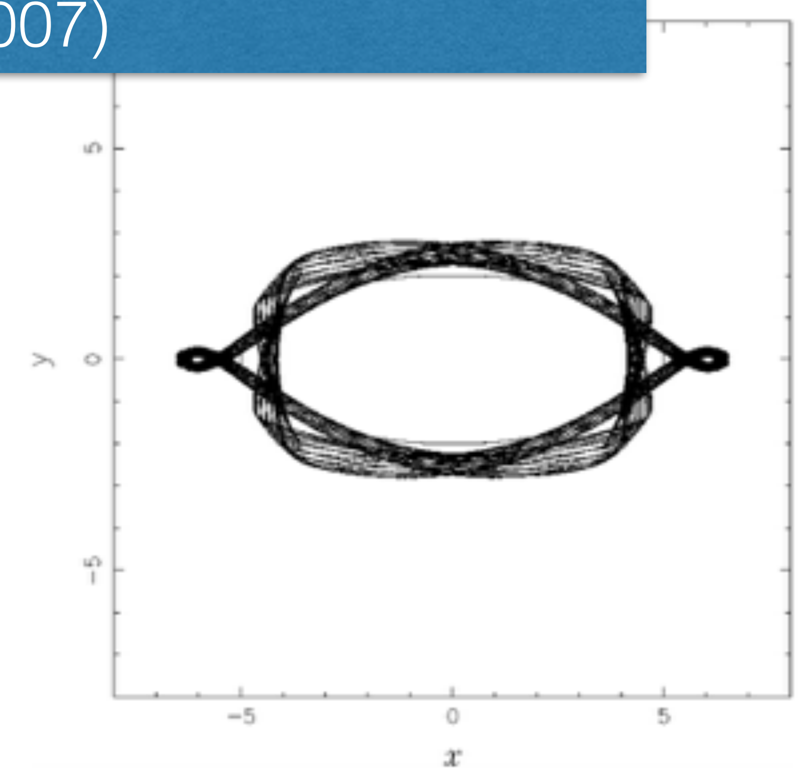
Hydrodynamical simulations Shen et al. 2017



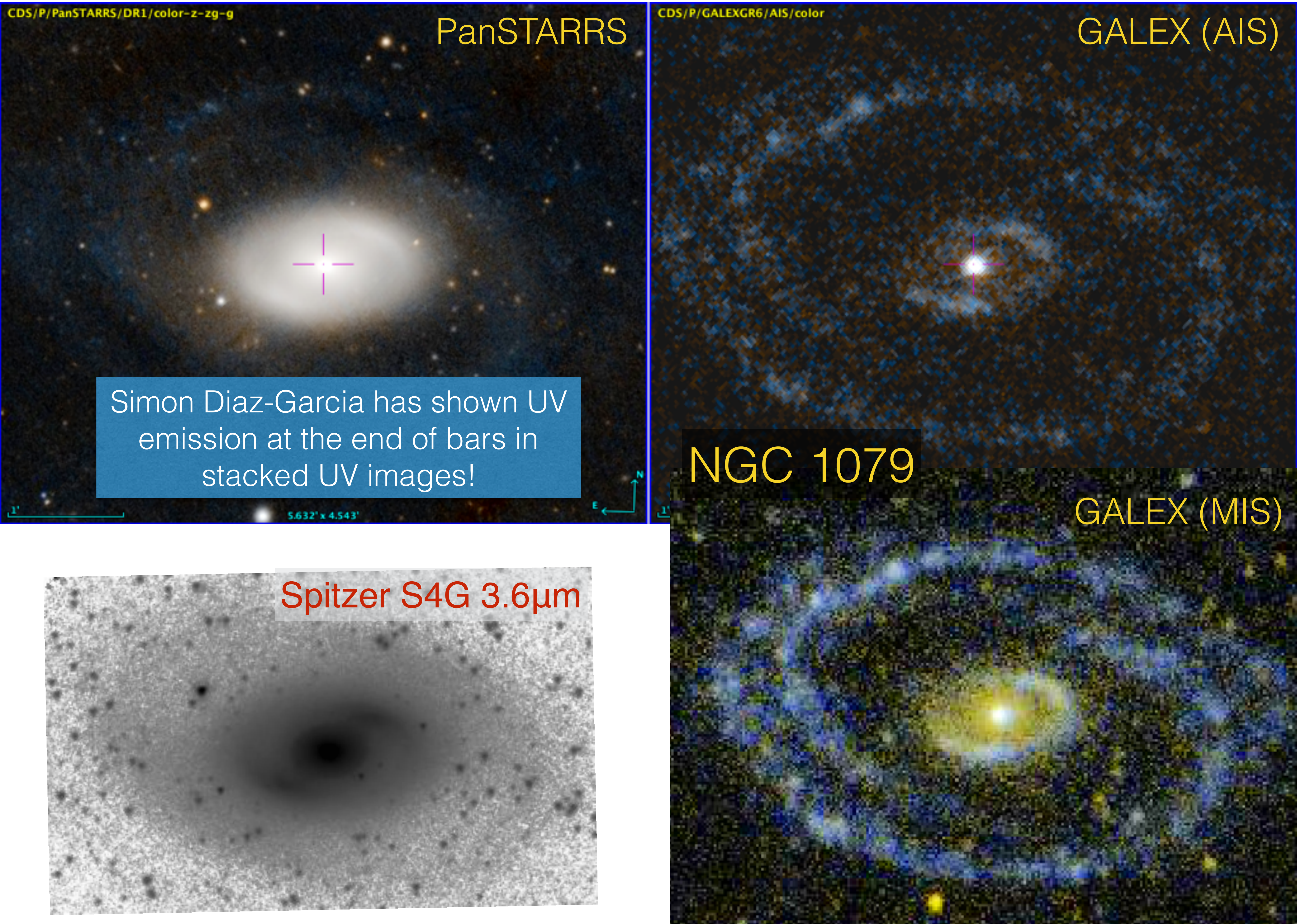


Romero-Gomez et al (20...

...ntrations centered ...gian points, then ...e stable, provided ...ntly massive and

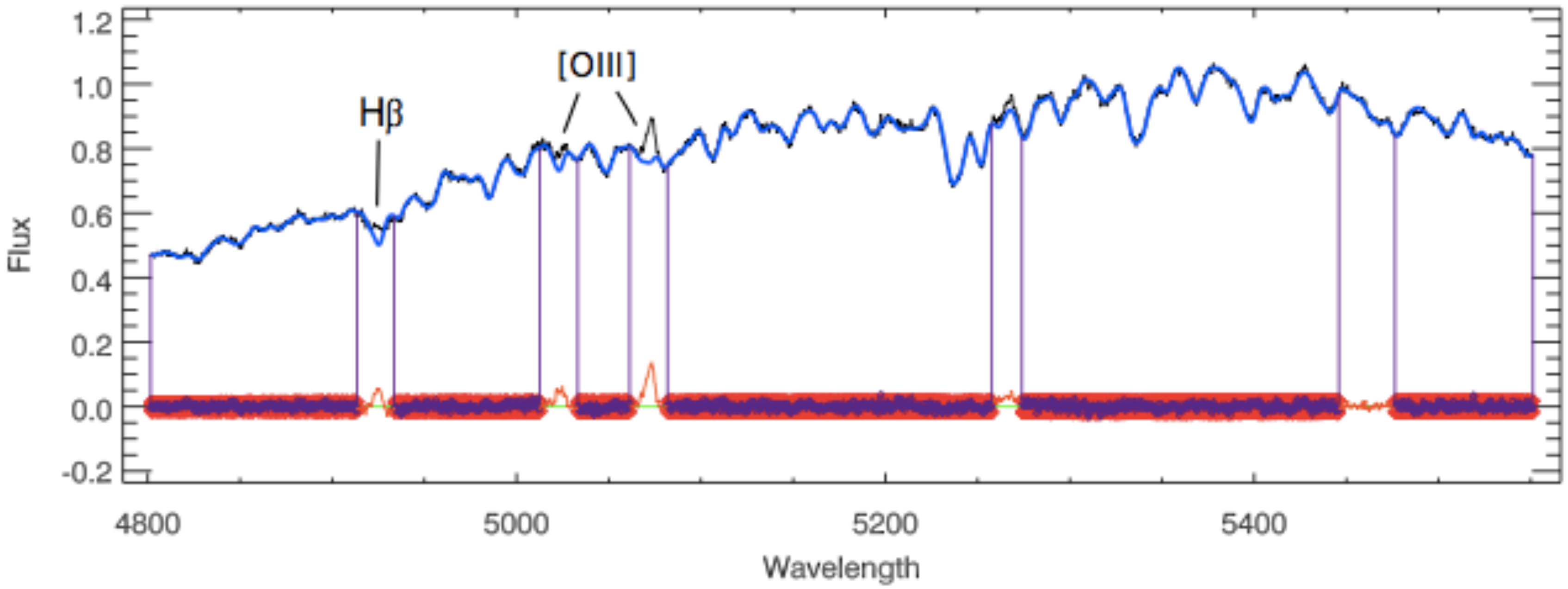


Athanassoula et al (2010)

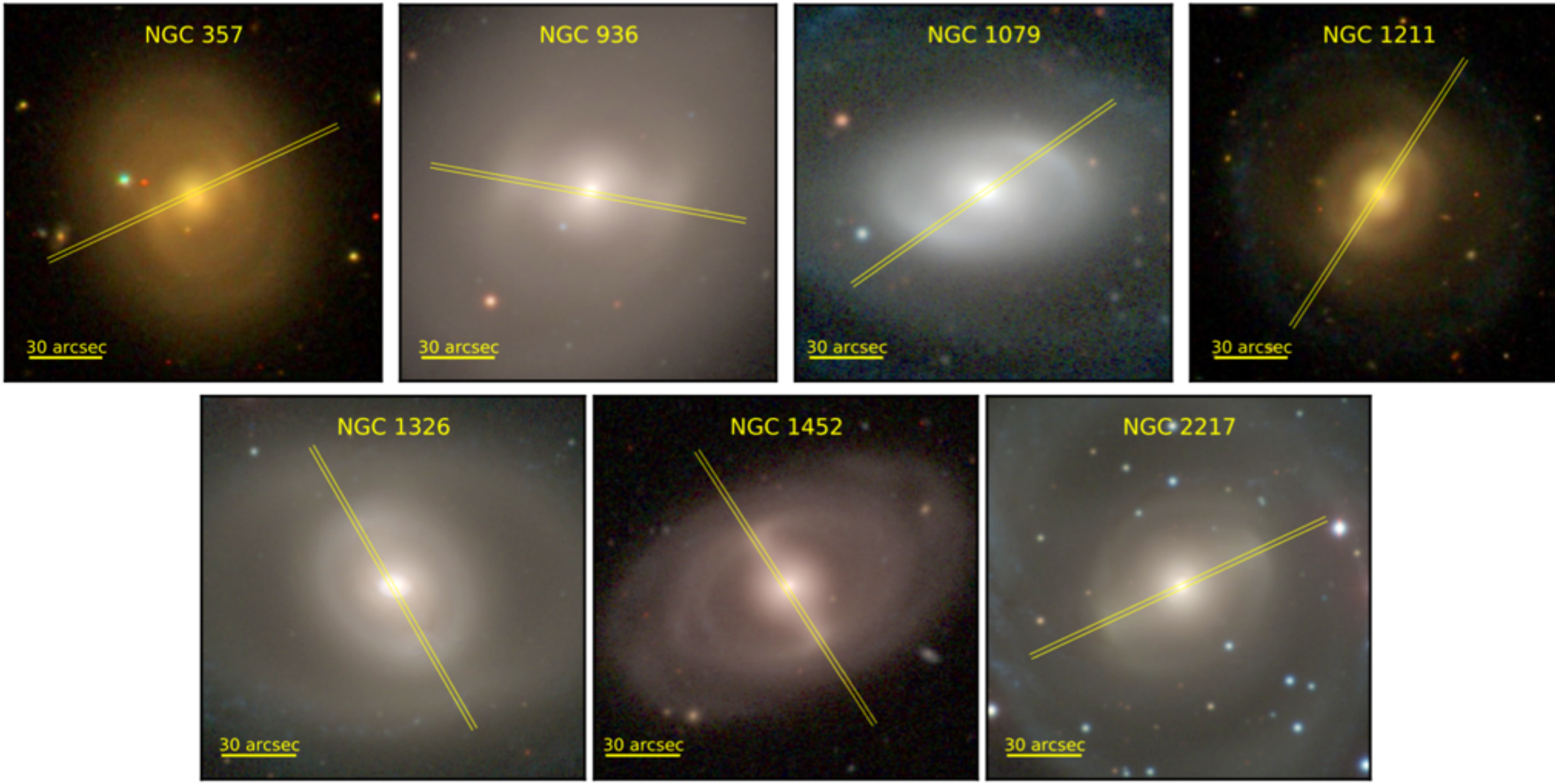

CDS/P/PanSTARRS/DR1/color-z-zg-g
PanSTARRS
Simon Diaz-Garcia has shown UV emission at the end of bars in stacked UV images!
1'
5.632' x 4.543'
N
E
CDS/P/GALEXGR6/AIS/color
GALEX (AIS)
NGC 1079
GALEX (MIS)
Spitzer S4G 3.6μm

Observations and analysis

- Long-slit spectroscopy at SALT telescope of 7 barred galaxies possessing ansae
- Full spectral fitting by means of NBursts package (Chilingarian et al. 2007) with Pegase.HR stellar population models
- SSP-equivalent values of age, metallicity and kinematics
- Analysis of emission line ratios

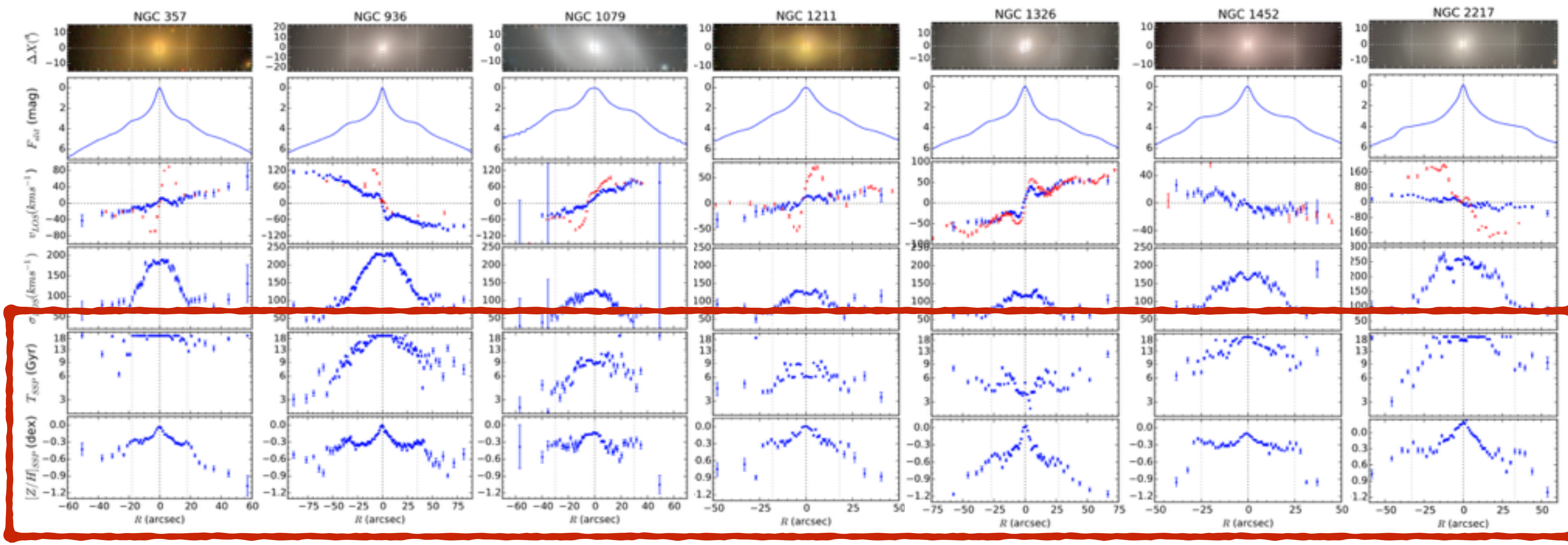


Studied galaxies

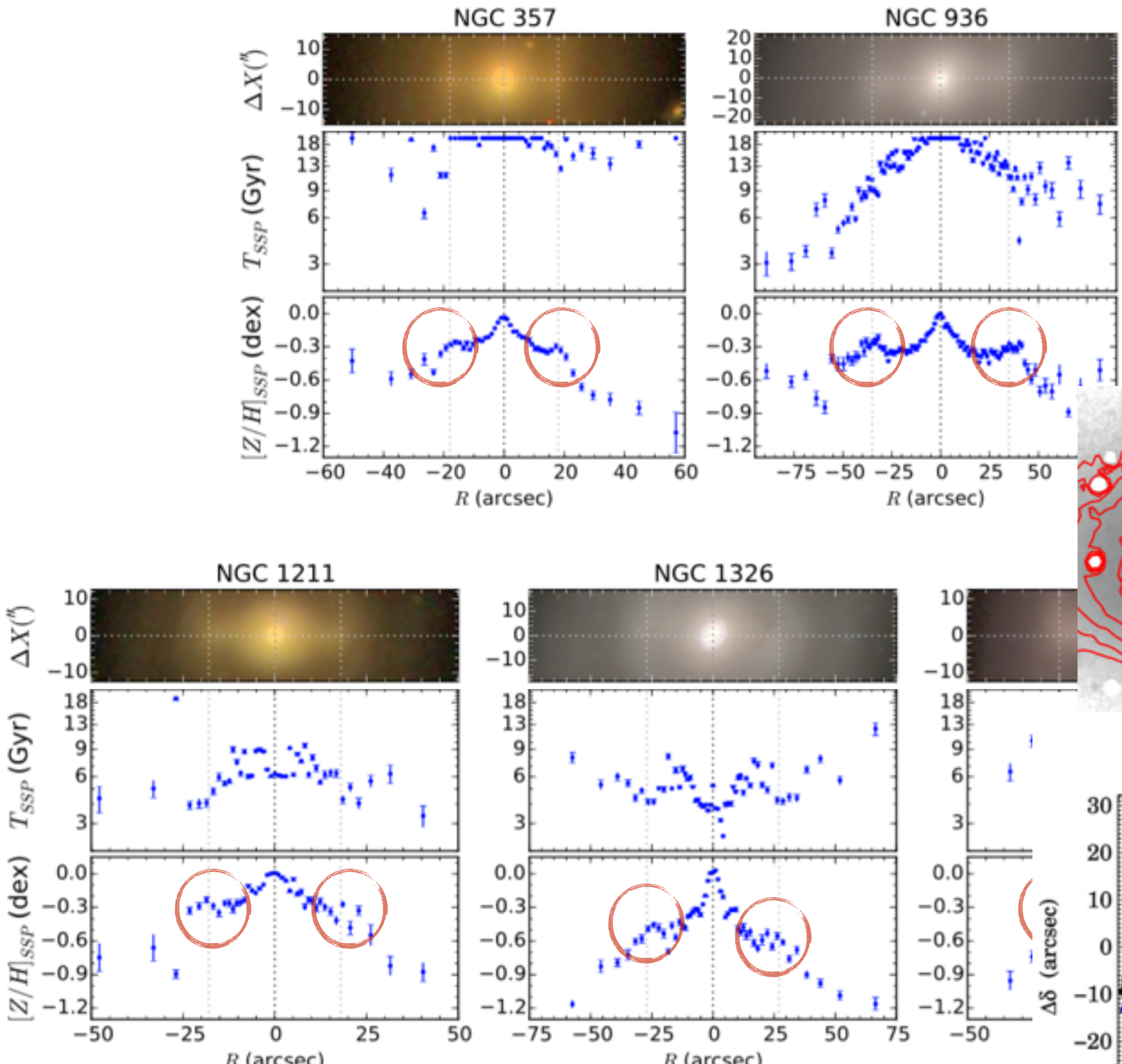


N357, N1211 - SDSS images; other - The Carnegie-Irvine Galaxy Survey (CGS, Ho et al. 2011)

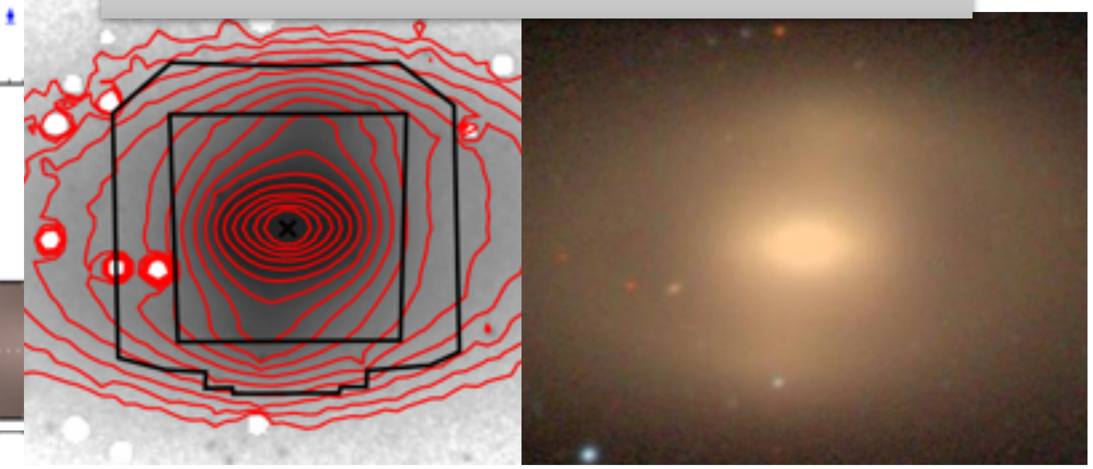
Stellar population profiles

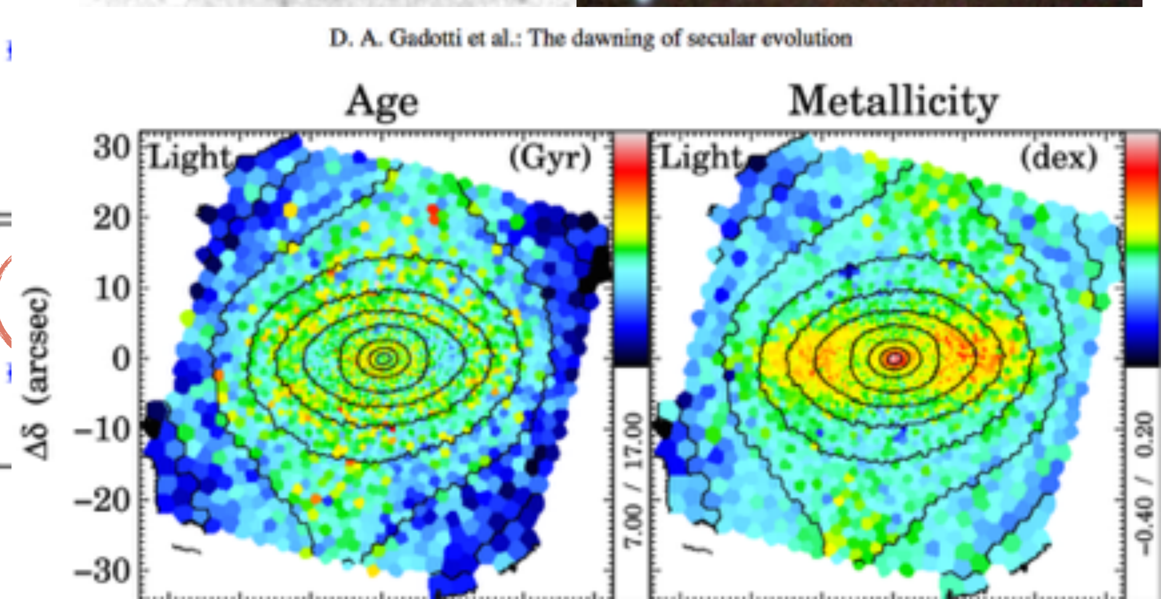


Stellar population profiles

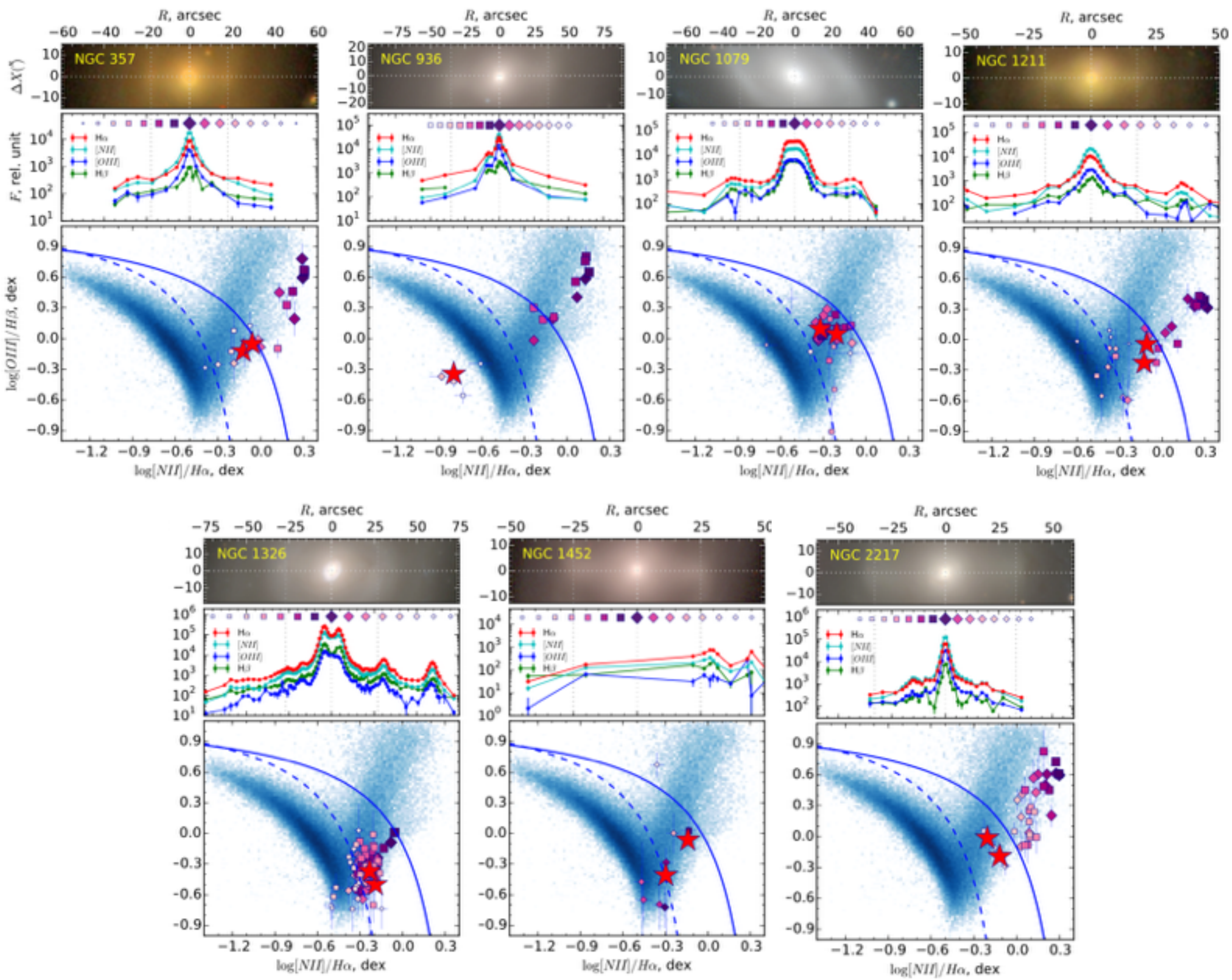


NGC 4371 Gadotti et al. 2015



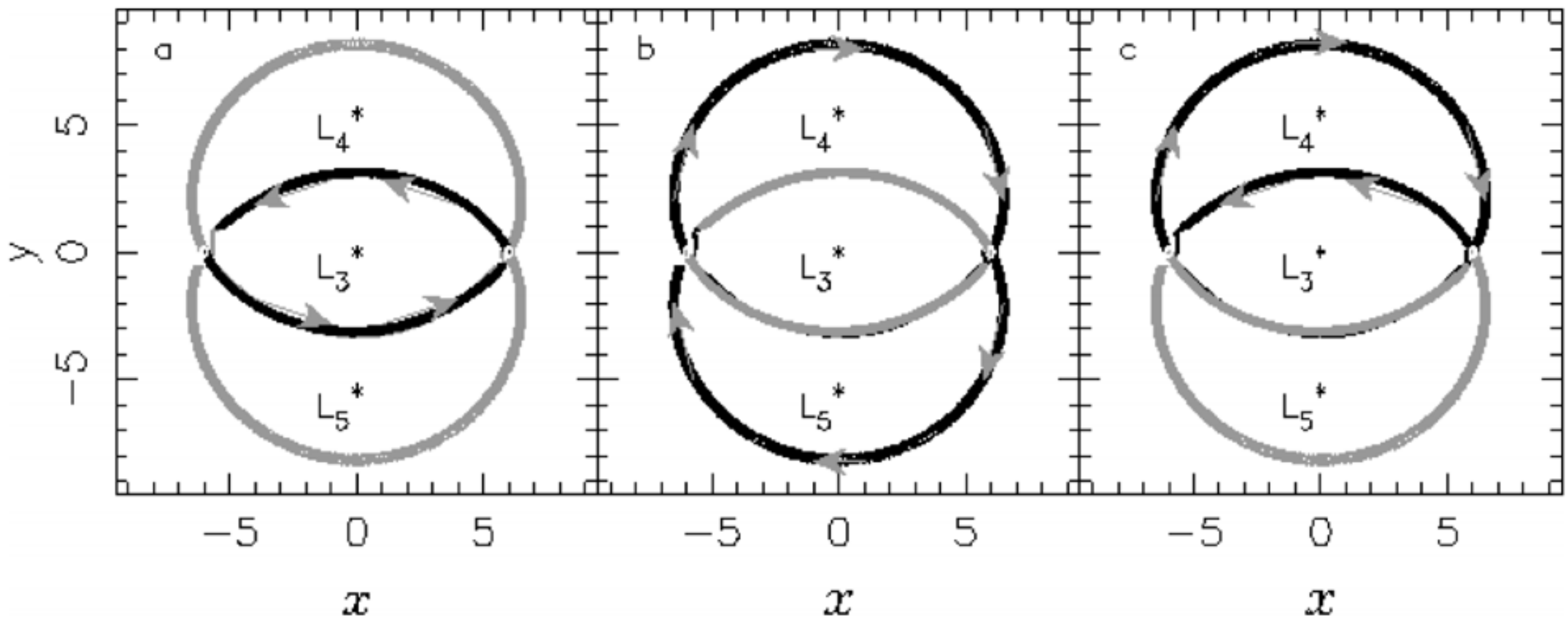


Emission line analysis



Manifolds and decoupled star formation history

Athanassoula et al. (2010)



“Three possible circulation patterns for particles on orbits guided by the manifolds in an example with an rR1 morphology”

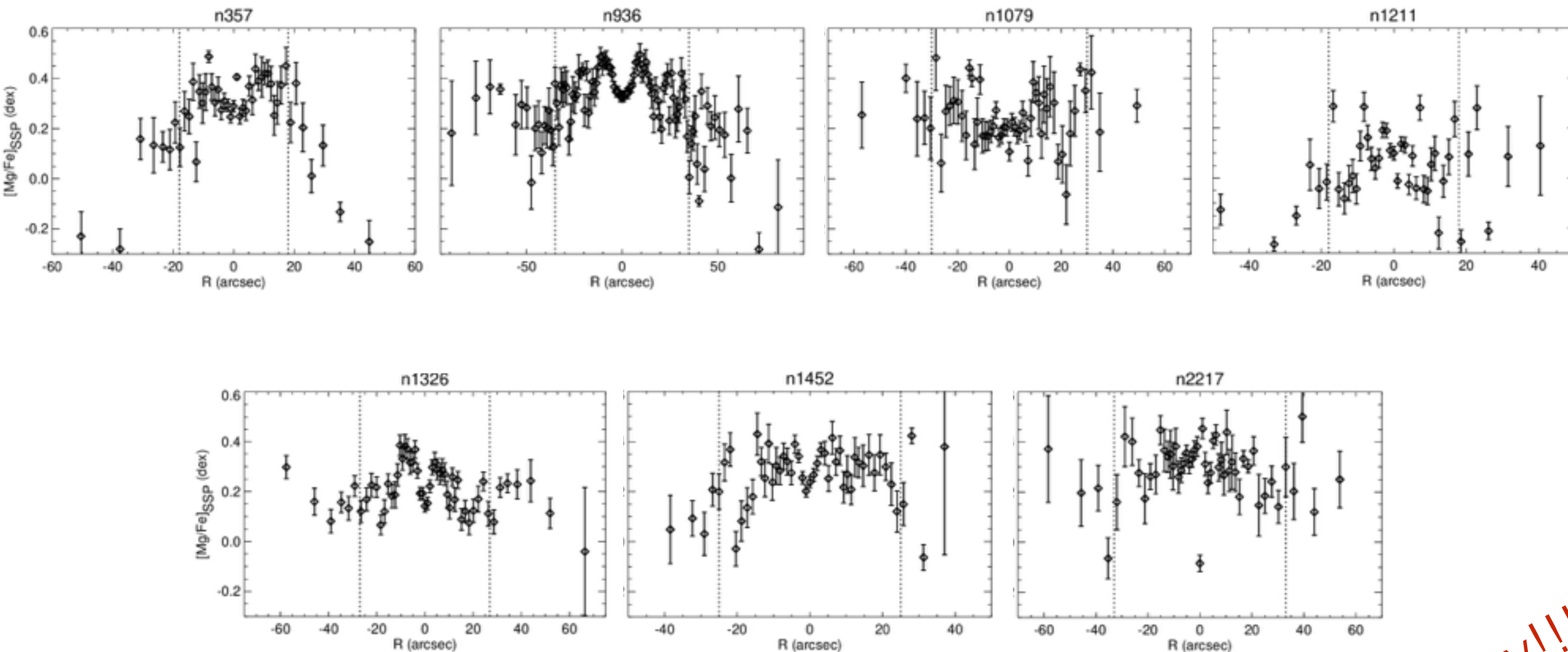
Summary

- Ansae regions are significantly distinguished in the stellar metallicities in all studied galaxies
- Peculiarities in the stellar age are less prominent
- BPT diagrams indicate some contribution of current star formation into ionized gas excitation
- In the framework of manifolds theory the decoupled star formation and chemical enrichment histories are might be considered

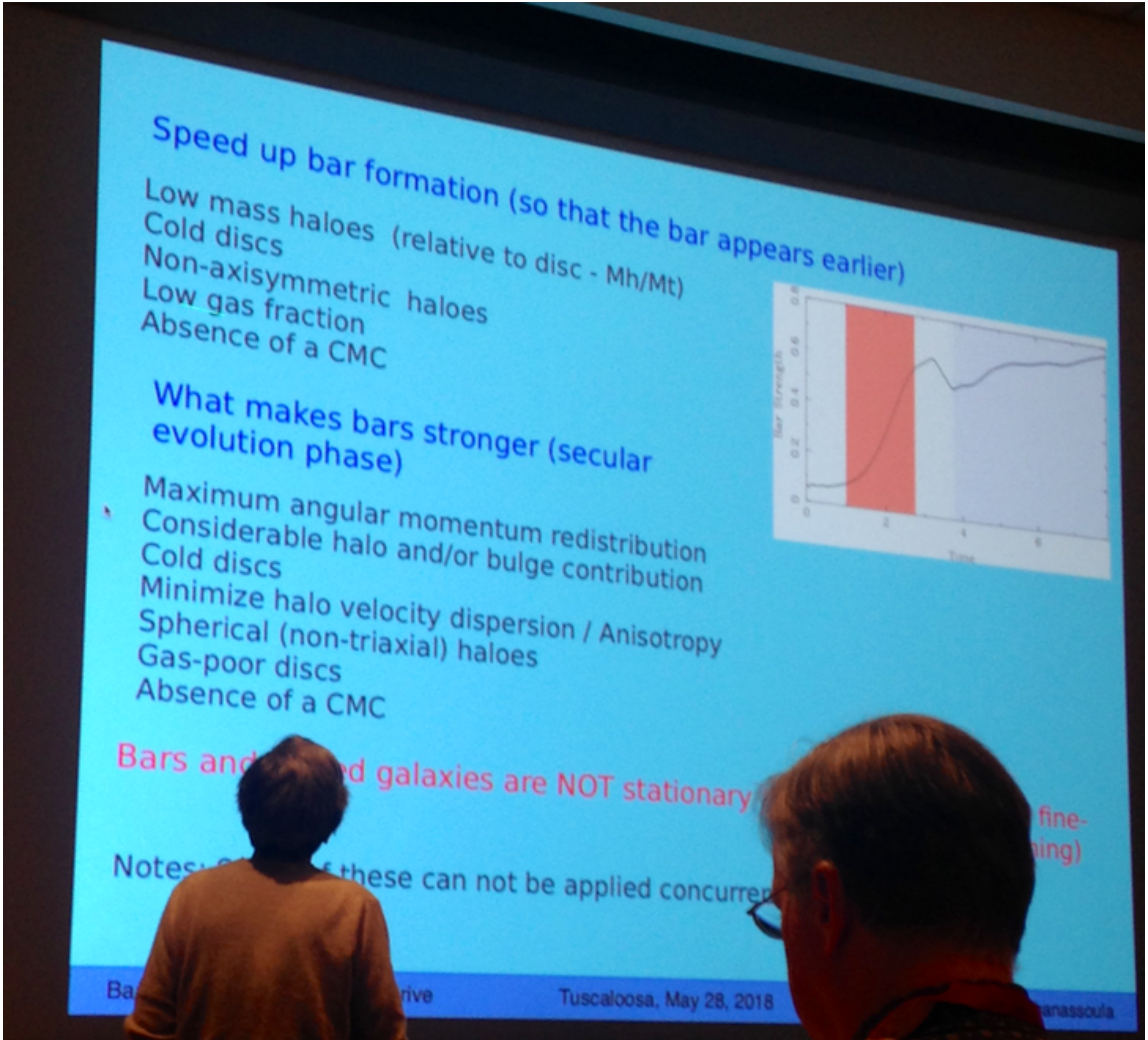
Thank you for attention!

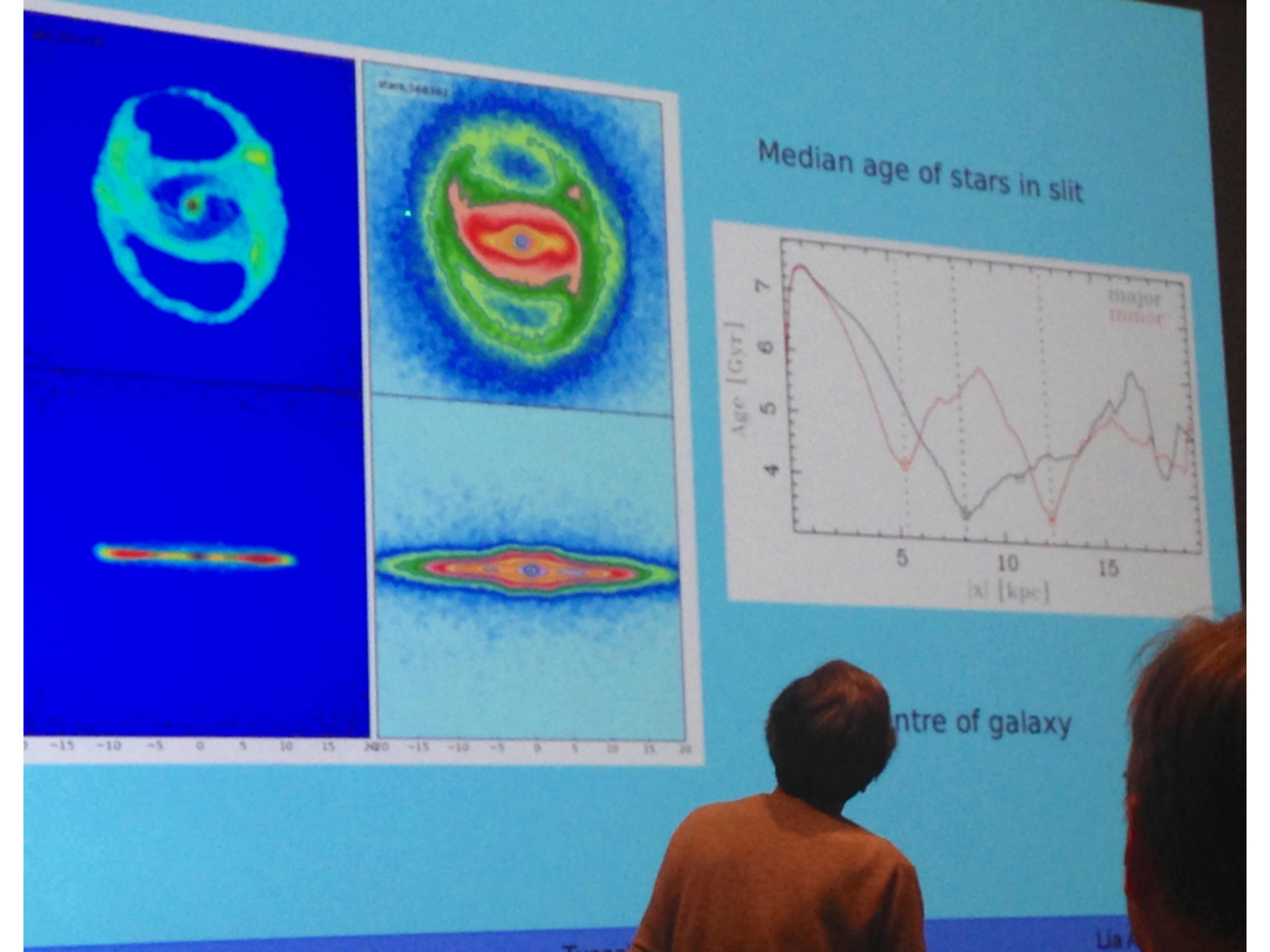
Project partly supported by
Russian Science Foundation

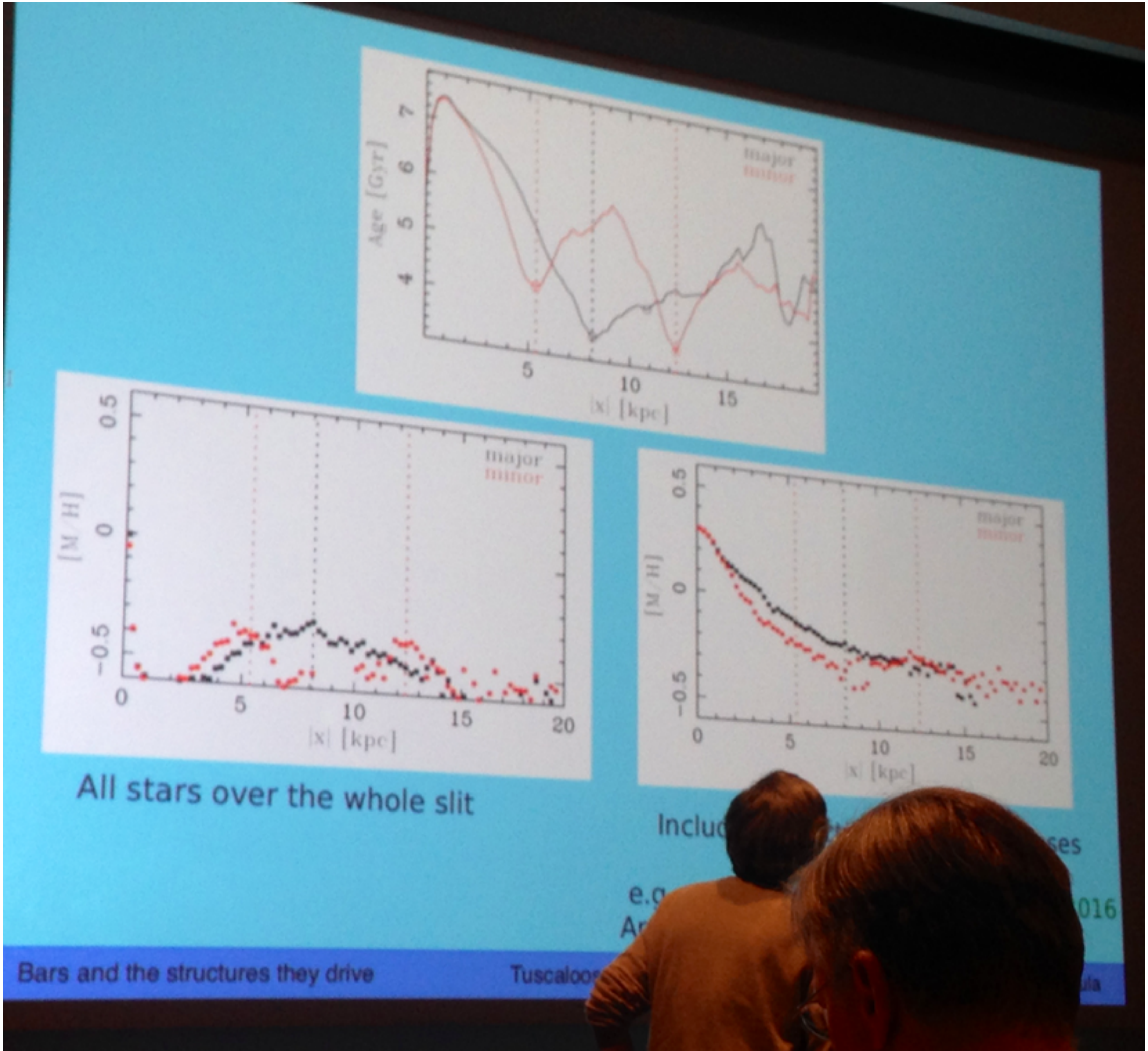
α-element abundance (star formation duration)



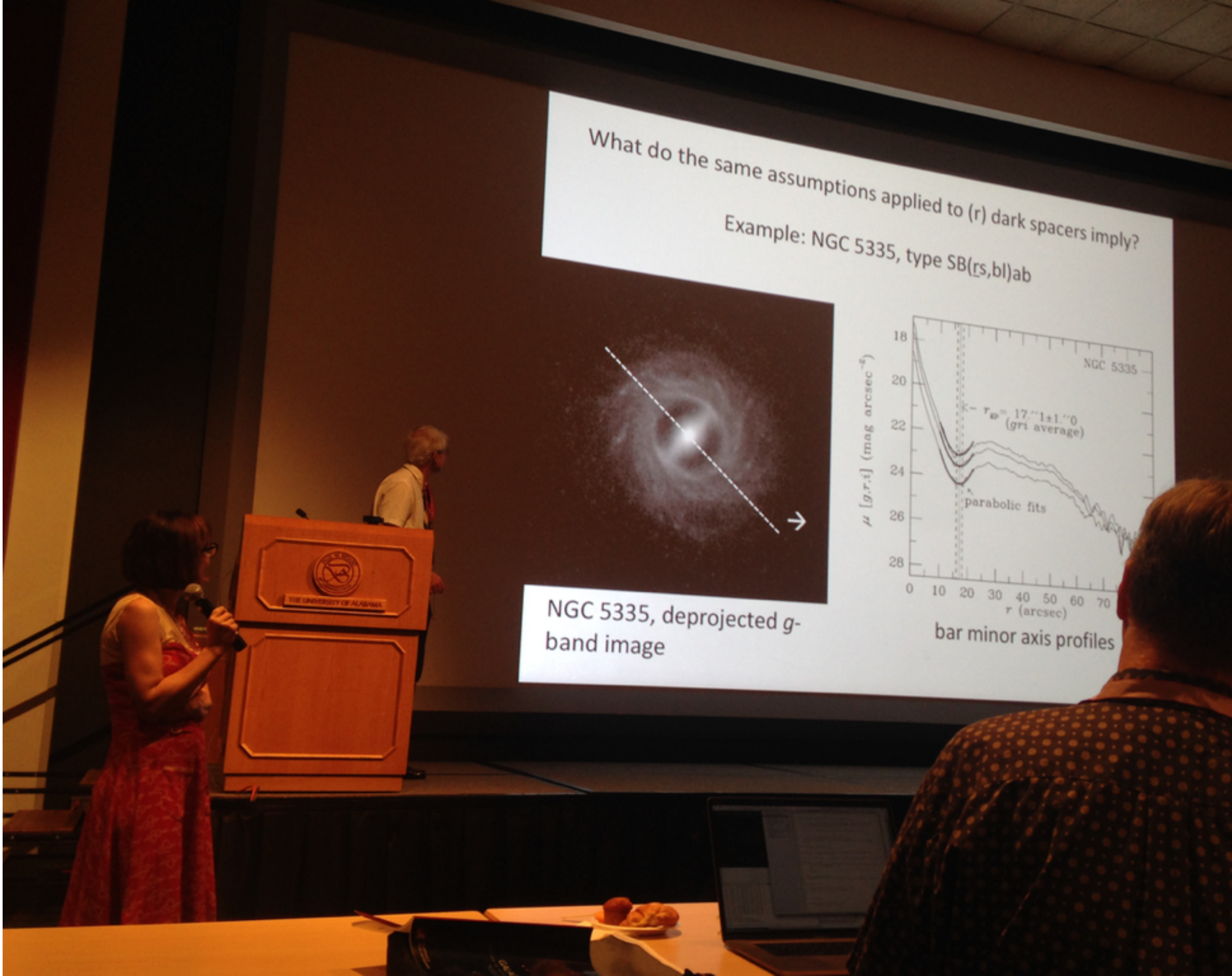
Very preliminary!!!


Speed up bar formation (so that the bar appears earlier)
Low mass haloes (relative to disc - Mh/Mt)
Cold discs
Non-axisymmetric haloes
Low gas fraction
Absence of a CMC
What makes bars stronger (secular evolution phase)
Maximum angular momentum redistribution
Considerable halo and/or bulge contribution
Cold discs
Minimize halo velocity dispersion / Anisotropy
Spherical (non-triaxial) haloes
Gas-poor discs
Absence of a CMC
galaxies are NOT stationary
these can not be applied
Tuscaloosa, May 28, 2018


Median age of stars in slit
major
minor
Age [Gyr]
|x| [kpc]
4
5
6
7
5
10
15
ntre of galaxy
-15
-10
-5
0
5
10
15
20



Age [Gyr]
major
minor
|x| [kpc]
[M/H]
major
minor
|x| [kpc]
[M/H]
major
minor
|x| [kpc]
All stars over the whole slit
Bars and the structures they drive


What do the same assumptions applied to (r) dark spacers imply?
Example: NGC 5335, type SB(r̲s,bl)ab
NGC 5335, deprojected g-band image
NGC 5335
parabolic fits
(gri average)
r (arcsec)
bar minor axis profiles
THE UNIVERSITY OF ALABAMA

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY

MNRAS **470,** 3819–3849 (2017) doi:10.1093/mnras/stx1392
Advance Access publication 2017 June 7

Galactic rings revisited. II. Dark gaps and the locations of resonances in early-to-intermediate-type disc galaxies

Ronald J. Buta★

Department of Physics and Astronomy, University of Alabama, P.O. Box 870324, Tuscaloosa, AL 35487, USA

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ABSTRACT

Dark gaps are commonly seen in early-to-intermediate-type barred galaxies having inner and outer rings or related features. In this paper, the morphologies of 54 barred and oval ringed galaxies have been examined with the goal of determining what the dark gaps are telling us about the structure and evolution of barred galaxies. The analysis is based mainly on galaxies selected from the Galaxy Zoo 2 data base and the Catalogue of Southern Ringed Galaxies. The dark gaps between inner and outer rings are of interest because of their likely association with the L_4 and L_5 Lagrangian points that would be present in the gravitational potential of a bar or oval. Since the points are theoretically expected to lie very close to the corotation resonance (CR) of the bar pattern, the gaps provide the possibility of locating corotation in some galaxies simply by measuring the radius r_{gp} of the gap region and setting r_{CR}=r_{gp}. With the additional assumption of generally flat rotation curves, the locations of other resonances can be predicted and compared with observed morphological features. It is shown that this 'gap method' provides remarkably consistent interpretations of the morphology of early-to-intermediate-type barred galaxies. The paper also brings attention to cases where the dark gaps lie inside an inner ring, rather than between inner and outer rings. These may have a different origin compared to the inner/outer ring gaps.

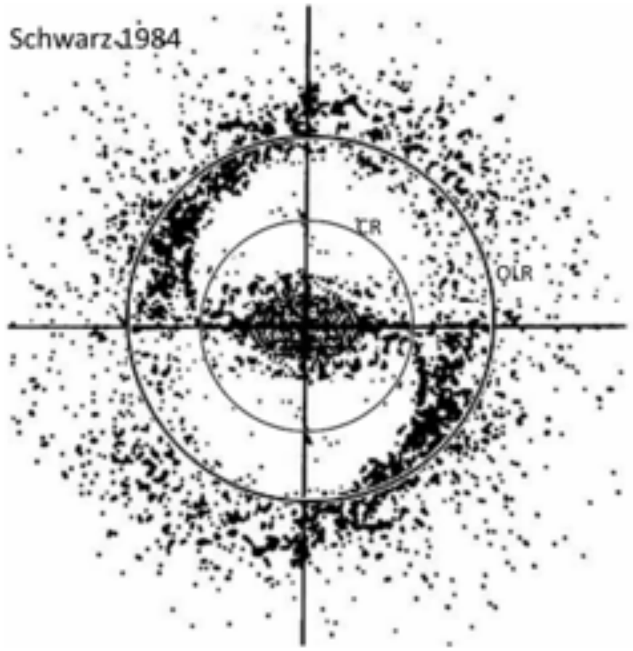


Figure 2. A test-particle frame from a simulation (Schwarz 1984a, fig. 6) of a strongly barred disc galaxy showing the depopulation of the broad zones around the L_4 and L_5 Lagrangian points. The CR and OLR circles for the model are superposed.

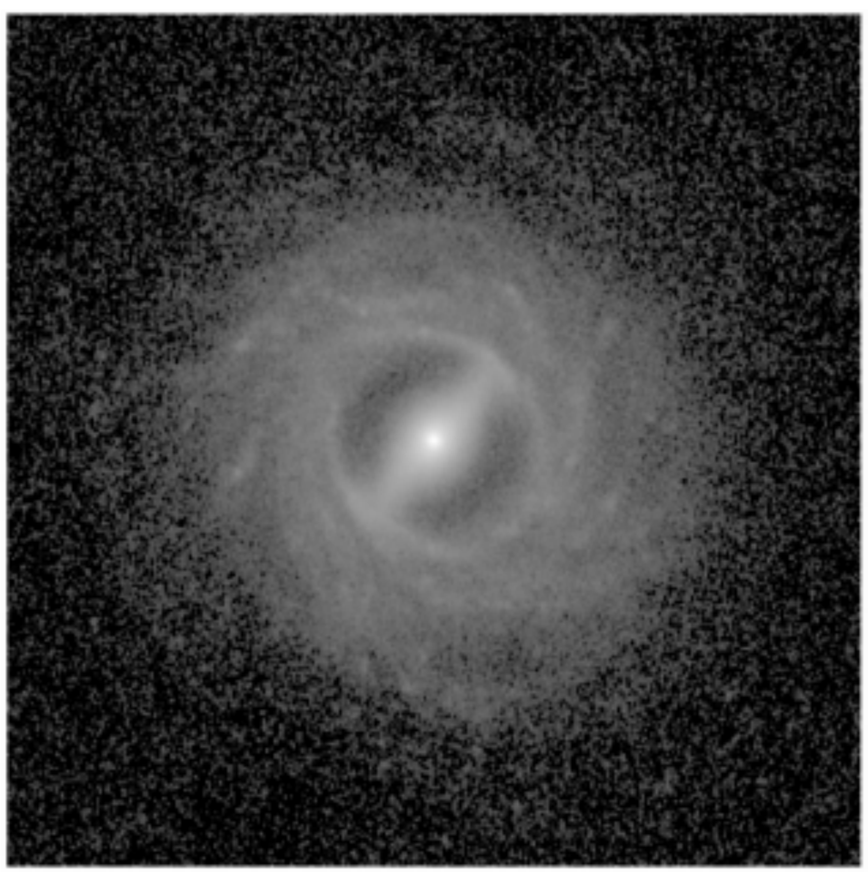


Figure 8. Deprojected g-band image (top) and $g - i$ colour index map of NGC 5335, type SB(rs,bl)ab. The field shown is 3.38 × 3.38 arcmin^2.

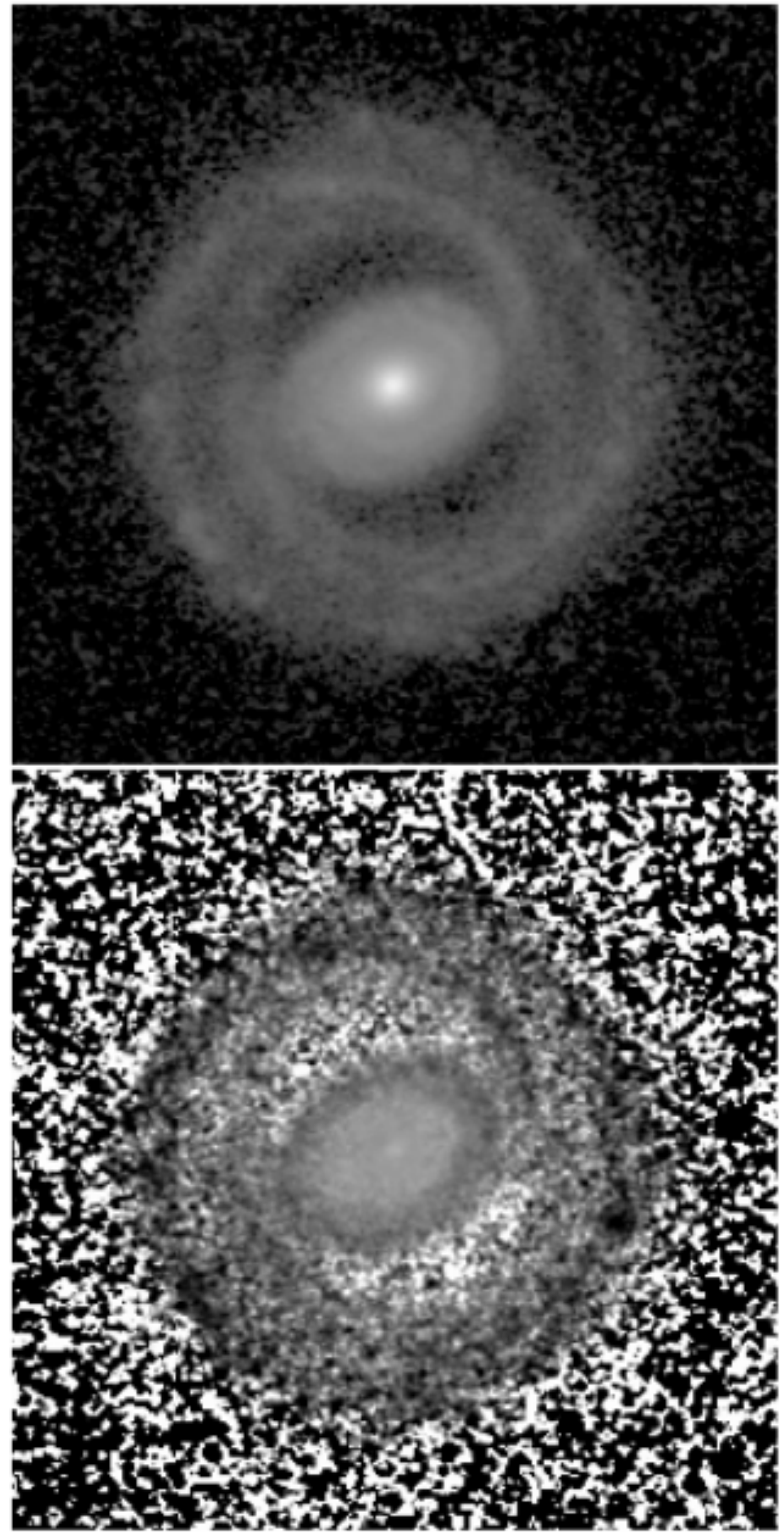


Figure 3. Deprojected g-band image (top) and $g - i$ colour index map of UGC 4596, type (R$_1$R$_2'$)SA(rr)b. Both images are in units of mag arcsec^{-2}. The $g - i$ colour index map is coded such that redder features are light and bluer features are dark. The field shown is 1.69 × 1.69 arcmin^2.

When combined with a multi-armed outer spiral pattern as opposed to an outer ring or pseudo-ring, then NGC 5335 becomes even more

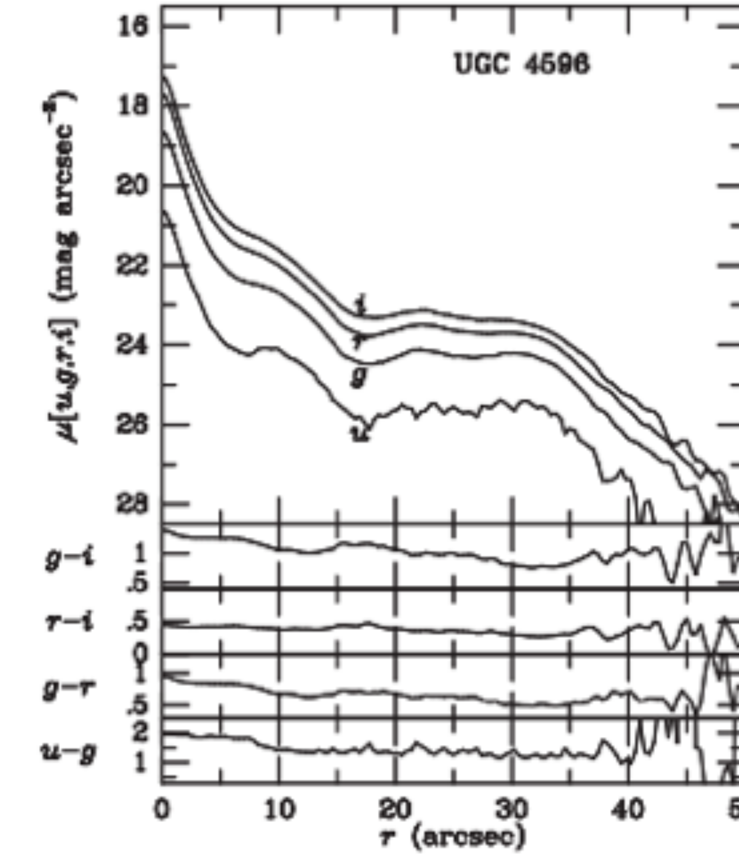


Figure 4. Azimuthally averaged *ugri* surface brightness and colour inc profiles of UGC 4596.

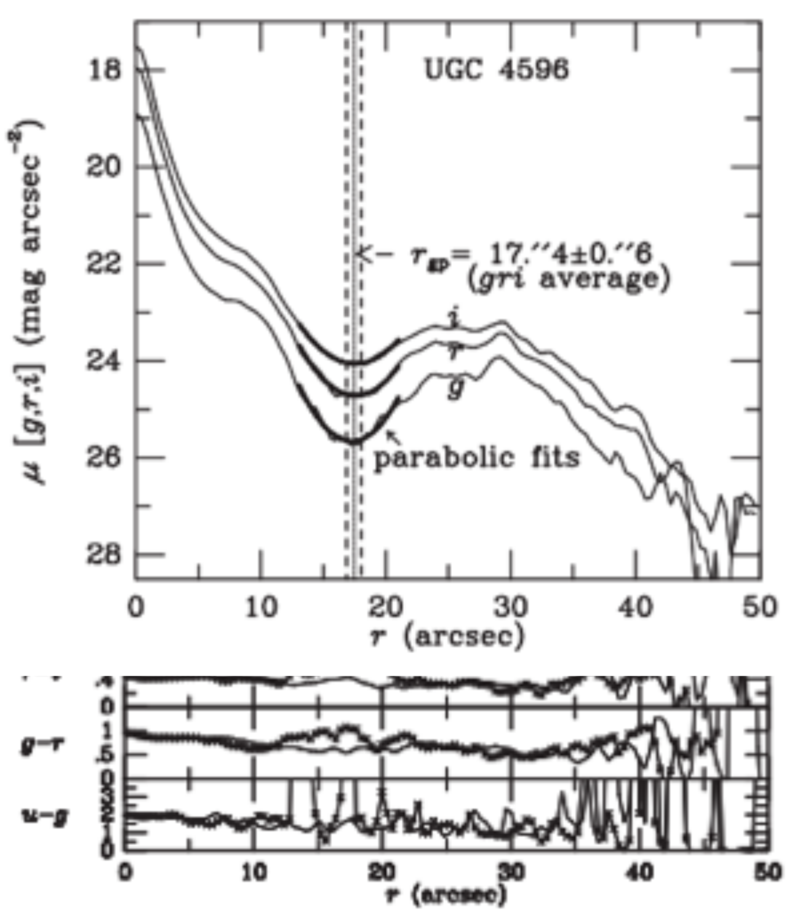


Figure 5. Profiles of UGC 4596 parallel (solid curve) and perpendicu (solid curve marked with crosses) to the deprojected massive oval.

MNRAS 000, 1–16 (2018) Preprint 25 May 2018 Compiled using MNRAS LATEX style file v3.0

1805.09481

The intrinsic three-dimensional shape of galactic bars

J. Méndez-Abreu[1,2]★, L. Costantin[3], J. A. L. Aguerri[1,2], A. de Lorenzo-Cáceres[1,2], E. M. Corsini[3,4]

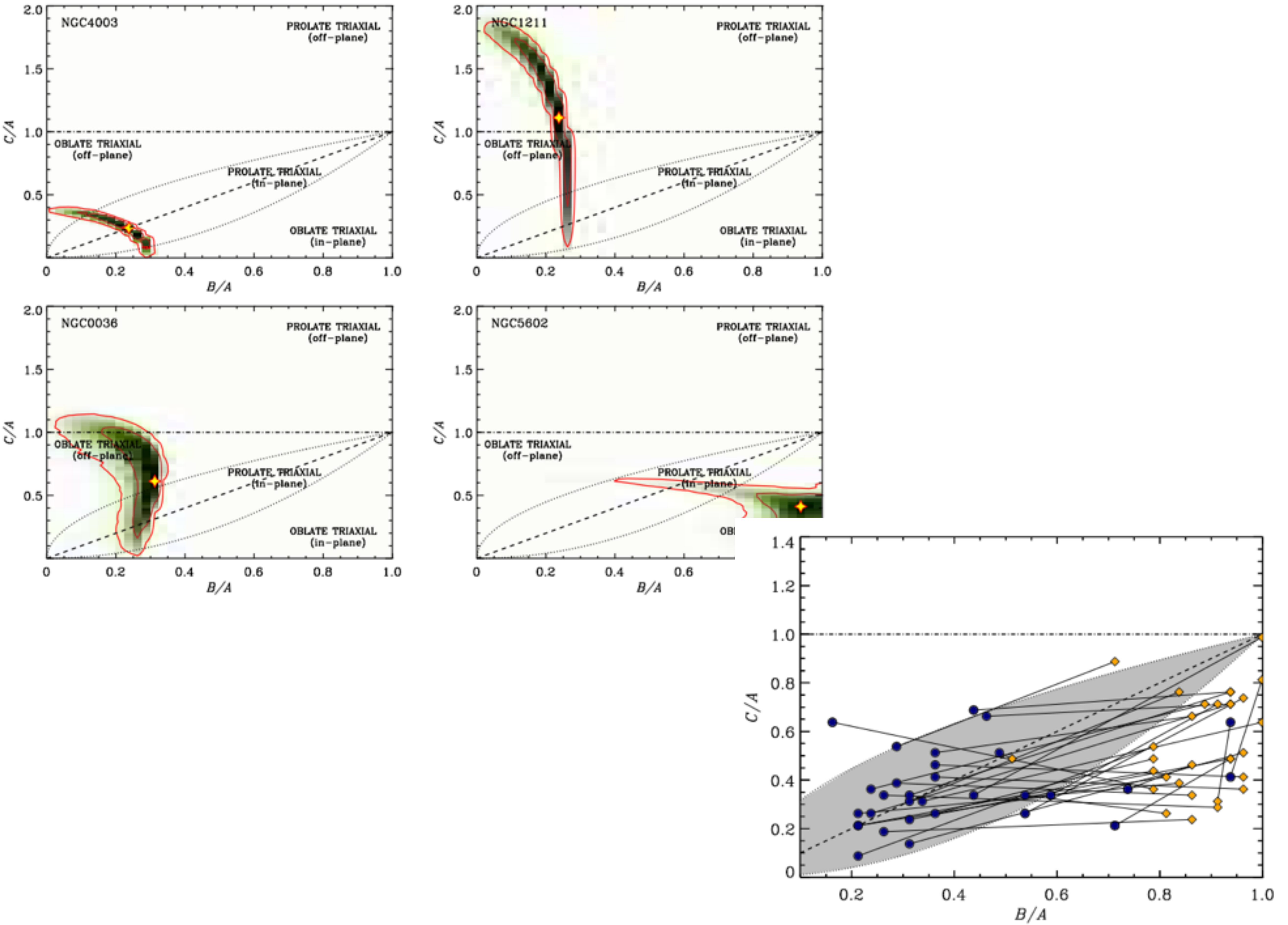
[1] *Instituto de Astrofísica de Canarias, Calle Vía Láctea s/n, E-38205 La Laguna, Tenerife, Spain*
[2] *Departamento de Astrofísica, Universidad de La Laguna, E-38200 La Laguna, Tenerife, Spain*
[3] *Dipartimento di Fisica e Astronomia 'G. Galilei', Universitá di Padova, vicolo dell'Osservatorio 3, I-35122 Padova, Italy*
[4] *INAF-Osservatorio Astronomico di Padova, vicolo dell'Osservatorio 5, I-35122 Padova, Italy*

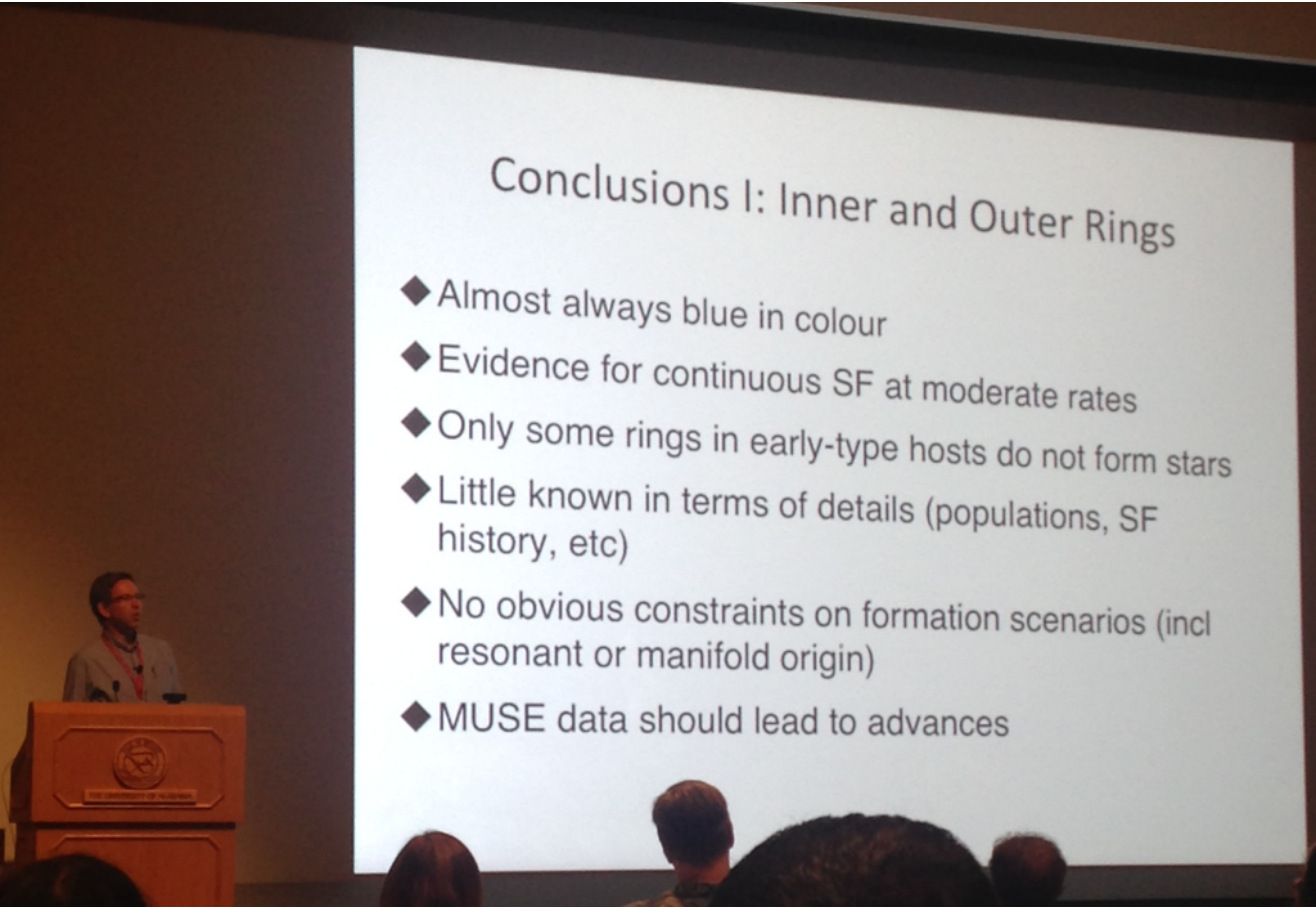
Accepted XXX. Received YYY; in original form ZZZ

ABSTRACT

We present the first statistical study on the intrinsic three-dimensional (3D) shape of a sample of 83 galactic bars extracted from the CALIFA survey. We use the galaXYZ code to derive the bar intrinsic shape with a statistical approach. The method uses only the geometric information (ellipticities and position angles) of bars and discs obtained from a multi-component photometric decomposition of the galaxy surface-brightness distributions. We find that bars are predominantly prolate-triaxial ellipsoids (68%), with a small fraction of oblate-triaxial ellipsoids (32%). The typical flattening (intrinsic C/A semiaxis ratio) of the bars in our sample is 0.34, which matches well the typical intrinsic flattening of stellar discs at these galaxy masses. We demonstrate that, for prolate-triaxial bars, the intrinsic shape of bars depends on the galaxy Hubble type and stellar mass (bars in massive S0 galaxies are thicker and more circular than those in less massive spirals). The bar intrinsic shape correlates with bulge, disc, and bar parameters. In particular with the bulge-to-total (B/T) luminosity ratio, disc $g-r$ color, and central surface brightness of the bar, confirming the tight link between bars and their host galaxies. Combining the probability distributions of the intrinsic shape of bulges and bars in our sample we show that 52% (16%) of bulges are thicker (flatter) than the surrounding bar at 1σ level. We suggest that these percentages might be representative of the fraction of classical and disc-like bulges in our sample, respectively.

Key words: galaxies: bars - galaxies: evolution - galaxies: formation - galaxies: structure - galaxies: photometry


NGC4003
NGC1211
NGC0036
NGC5602
PROLATE TRIAXIAL (off-plane)
OBLATE TRIAXIAL (off-plane)
PROLATE TRIAXIAL (in-plane)
OBLATE TRIAXIAL (in-plane)
C/A
B/A


Conclusions I: Inner and Outer Rings
Almost always blue in colour
Evidence for continuous SF at moderate rates
Only some rings in early-type hosts do not form stars
Little known in terms of details (populations, SF history, etc)
No obvious constraints on formation scenarios (incl resonant or manifold origin)
MUSE data should lead to advances

The TIMER Project: Time Inference with MUSE in Extragalactic Rings

Dimitri Gadotti
(ESO)

on behalf of the TIMER team

P. Coelho, C. Donohoe-Keyes, J. Falcón-Barroso, F. Fragkoudi, B. Husemann, T. Kim, R. Leaman, G. Leung, A. de Lorenzo-Cáceres, M. Martig, I. Martinez-Valpuesta, J. Méndez-Abreu, J. Neumann, I. Pérez, M. Querejeta, P. Sánchez-Blázquez, M. Seidel, G. van de Ven, P. James, M. Lyubenova

Bar-Driven Secular Evolution

- Bars in disc galaxies drive some of the major physical processes that shape galaxy properties

- Nuclear stellar rings and inner discs are built from gas brought to inner regions by bars

Bar-Driven Secular Evolution

- The star formation history of the nuclear ring tells us when the bar formed and pushed gas to the inner regions

- Therefore, it also tells us when the main disc became dynamically mature enough to develop a bar

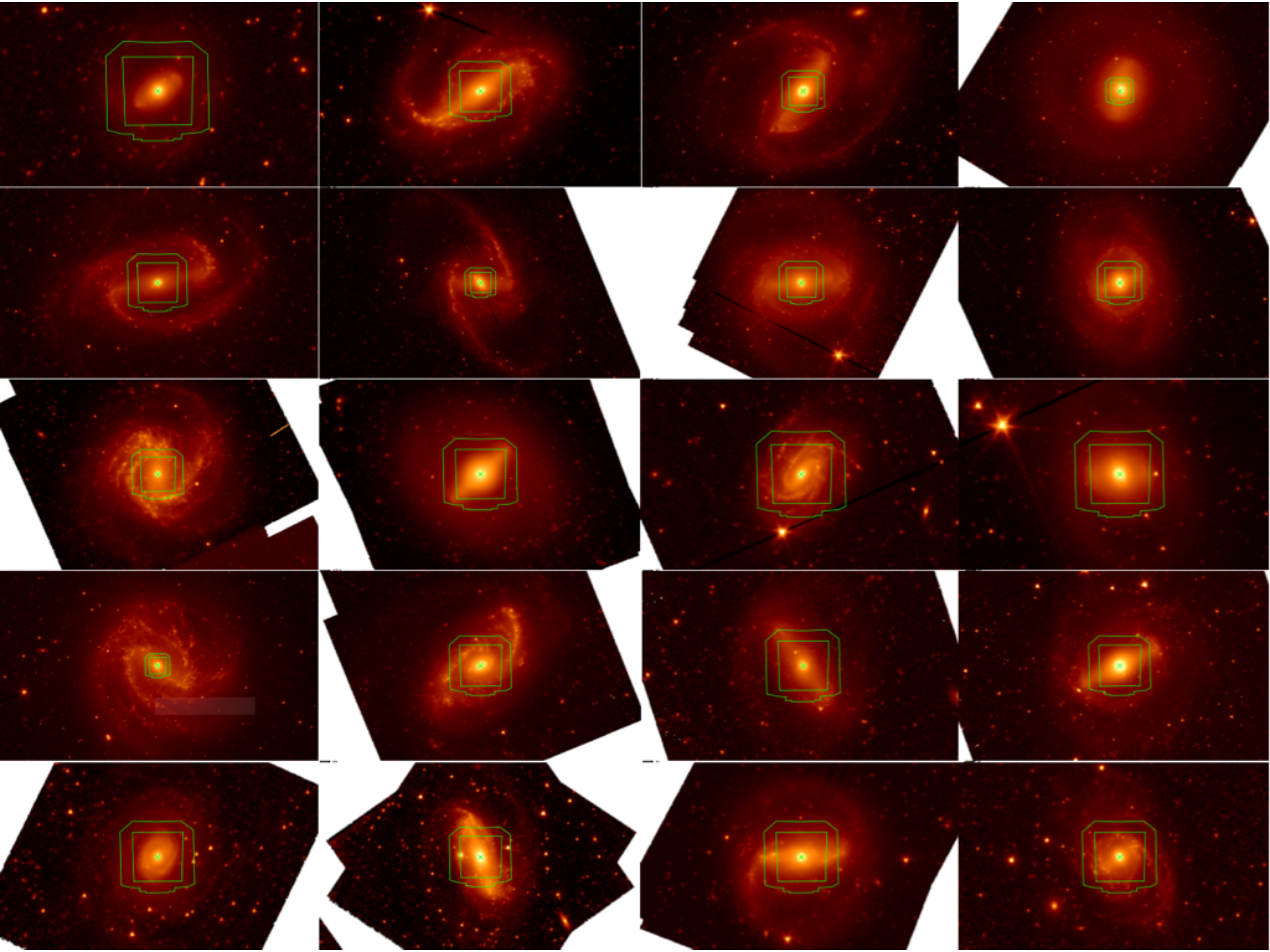
The TIMER Project

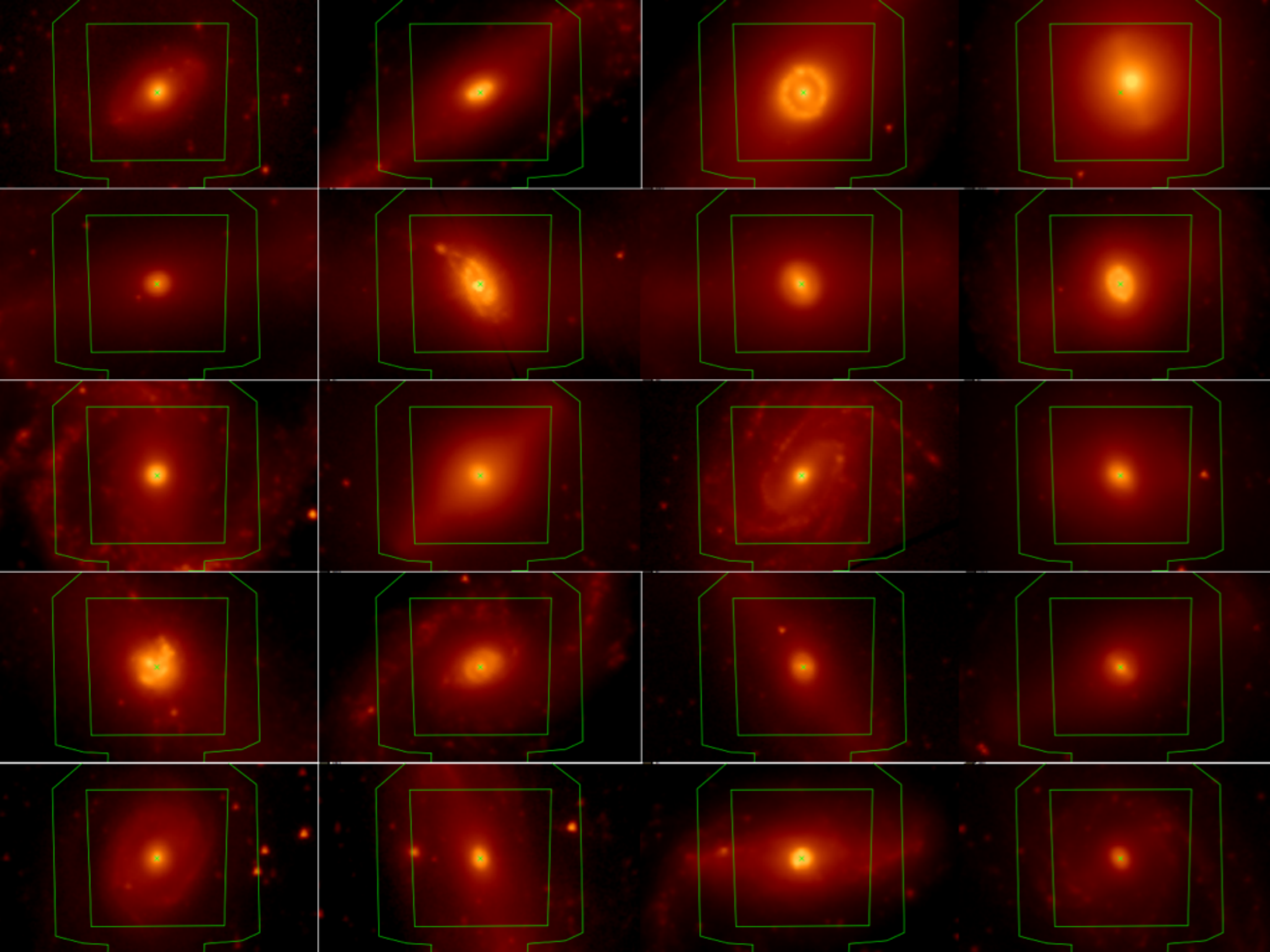
- **T**ime **I**nference with **M**USE in **E**xtragalactic **R**ings (Gadotti+2018)

  - A survey of the central region of 24 nearby barred galaxies (d ~ 20Mpc) with MUSE

  - All galaxies with bar-built nuclear structures, e.g., nuclear rings and inner discs

  - Important legacy value





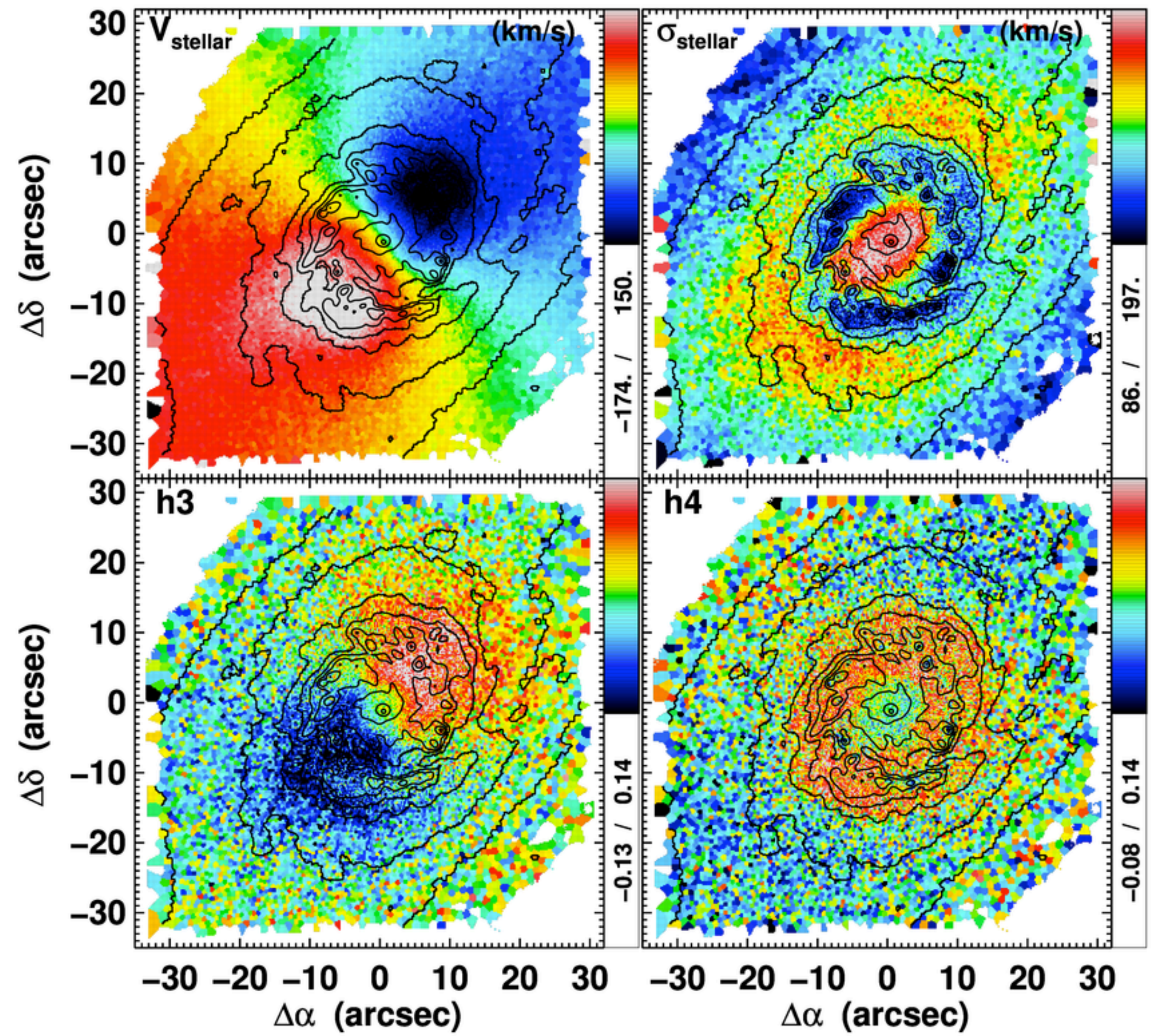
The TIMER Project

- Kinematic maps reveal inner component with:

1. high radial velocity and low velocity dispersion
2. near-circular orbits (from v-h_3 anti-correlation)
3. and separate from the main disc (from high values of h_4)

- Consistent with the picture in which inner discs are built from bar-driven gas inflow

NGC 1097



Gadotti+2018

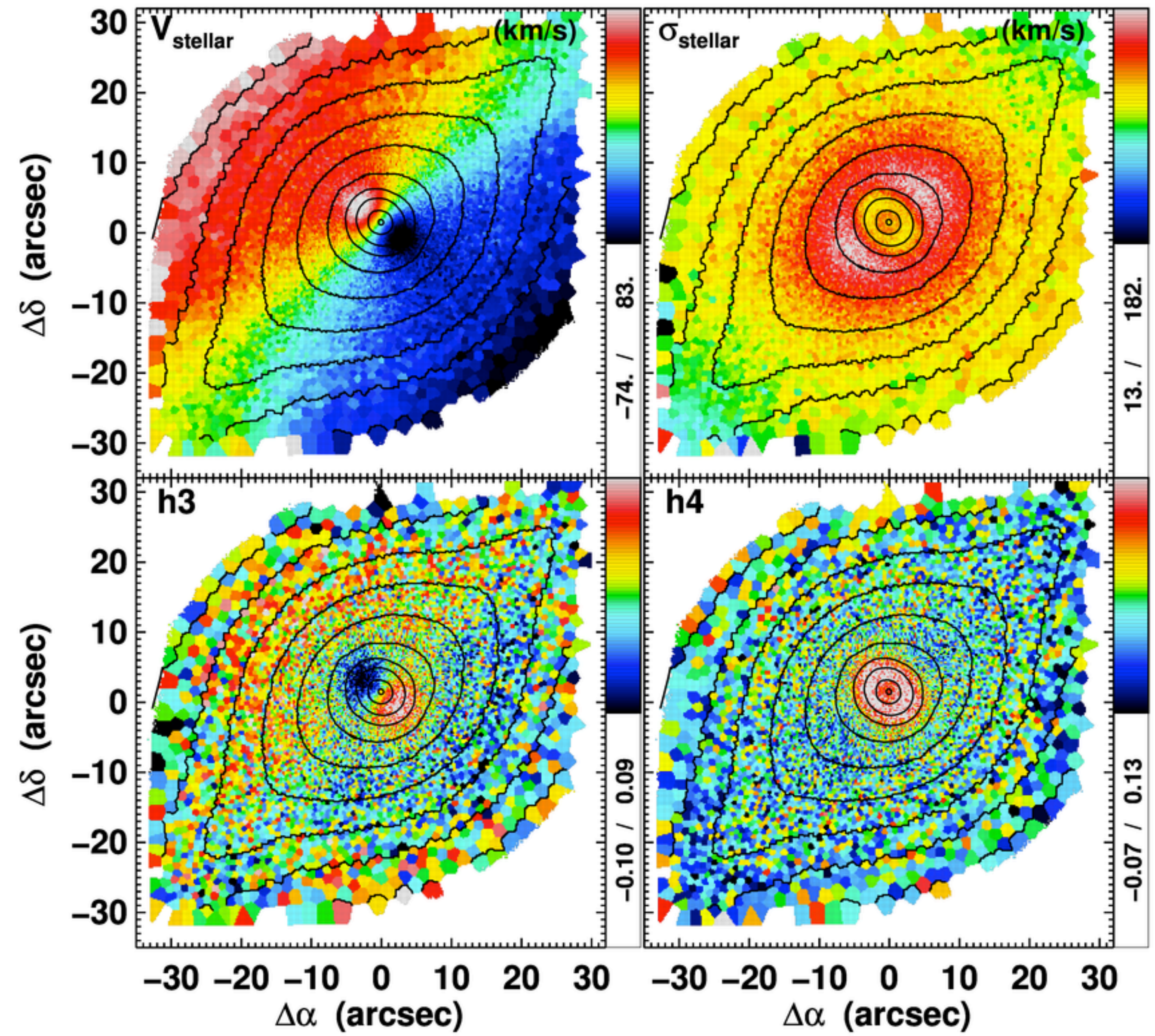
The TIMER Project

➢ Kinematic maps reveal inner component with:

1. high radial velocity and low velocity dispersion
2. near-circular orbits (from v-h_3 anti-correlation)
3. and separate from the main disc (from high values of h_4)

➢ Consistent with the picture in which inner discs are built from bar-driven gas inflow

NGC 4643



Gadotti+2018

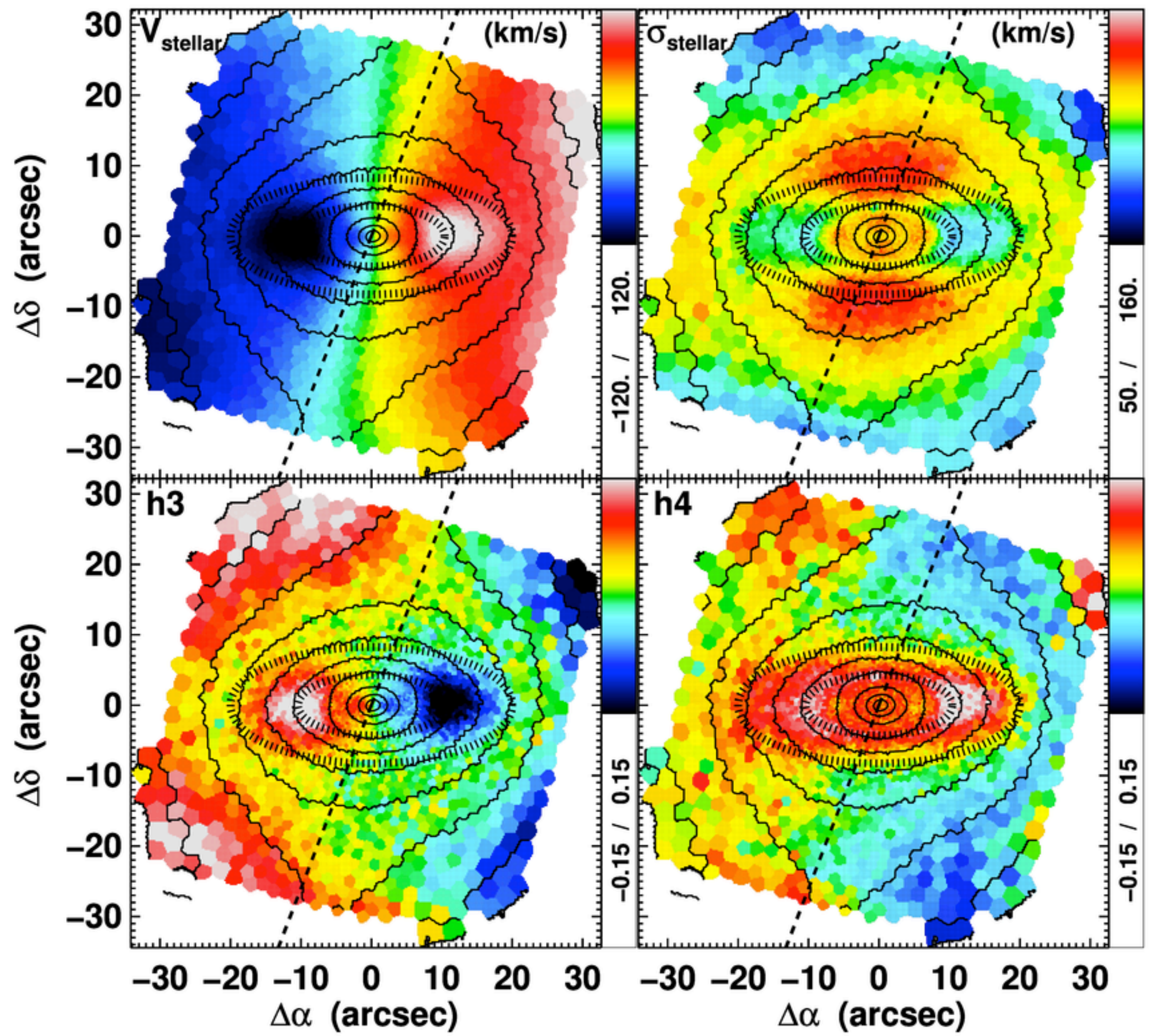
The TIMER Project

- ➢ Kinematic maps reveal inner component with:

1. high radial velocity and low velocity dispersion
2. near-circular orbits (from v-h_3 anti-correlation)
3. and separate from the main disc (from high values of h_4)

- ➢ Consistent with the picture in which inner discs are built from bar-driven gas inflow

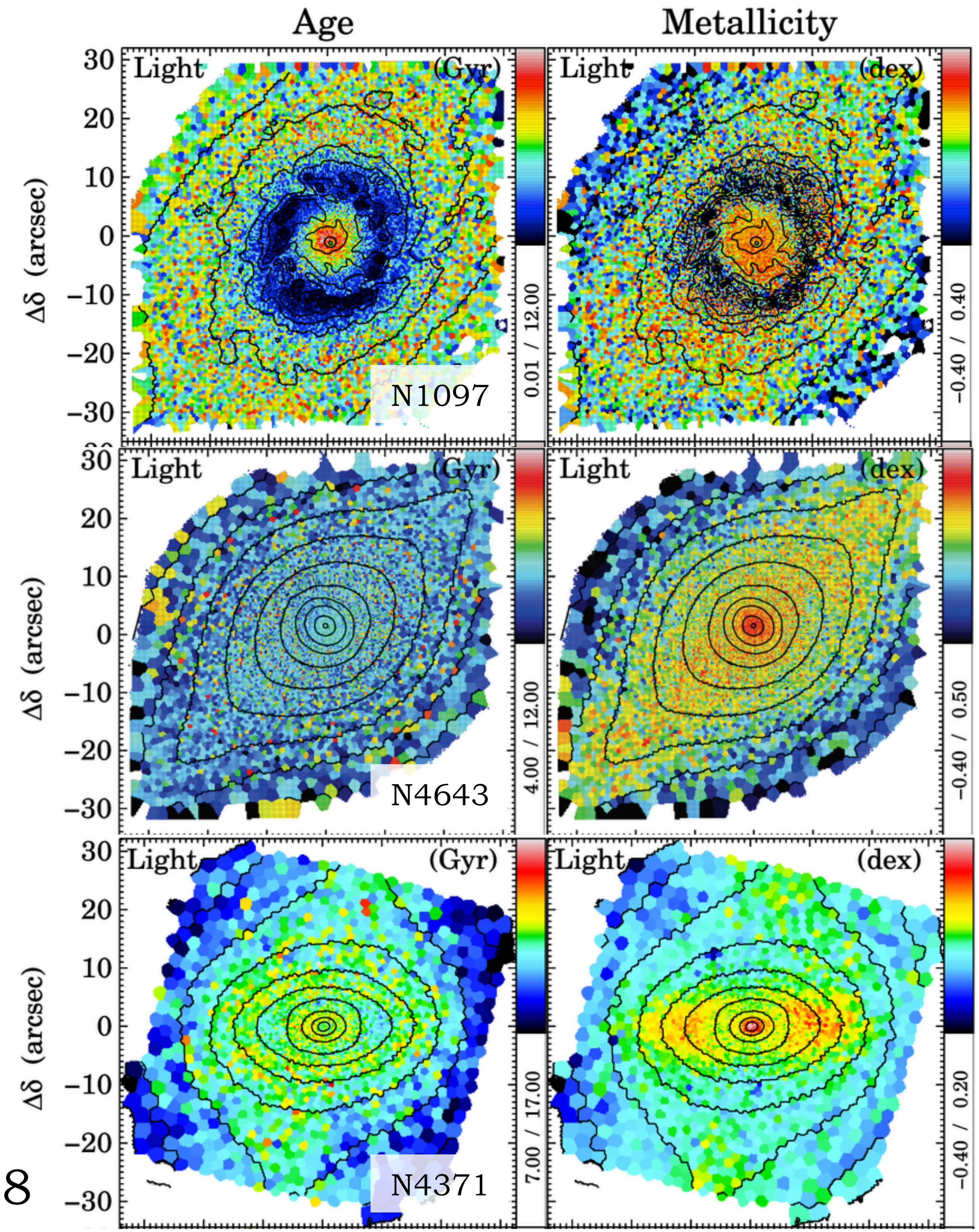
NGC 4371



Gadotti+2015

The TIMER Project

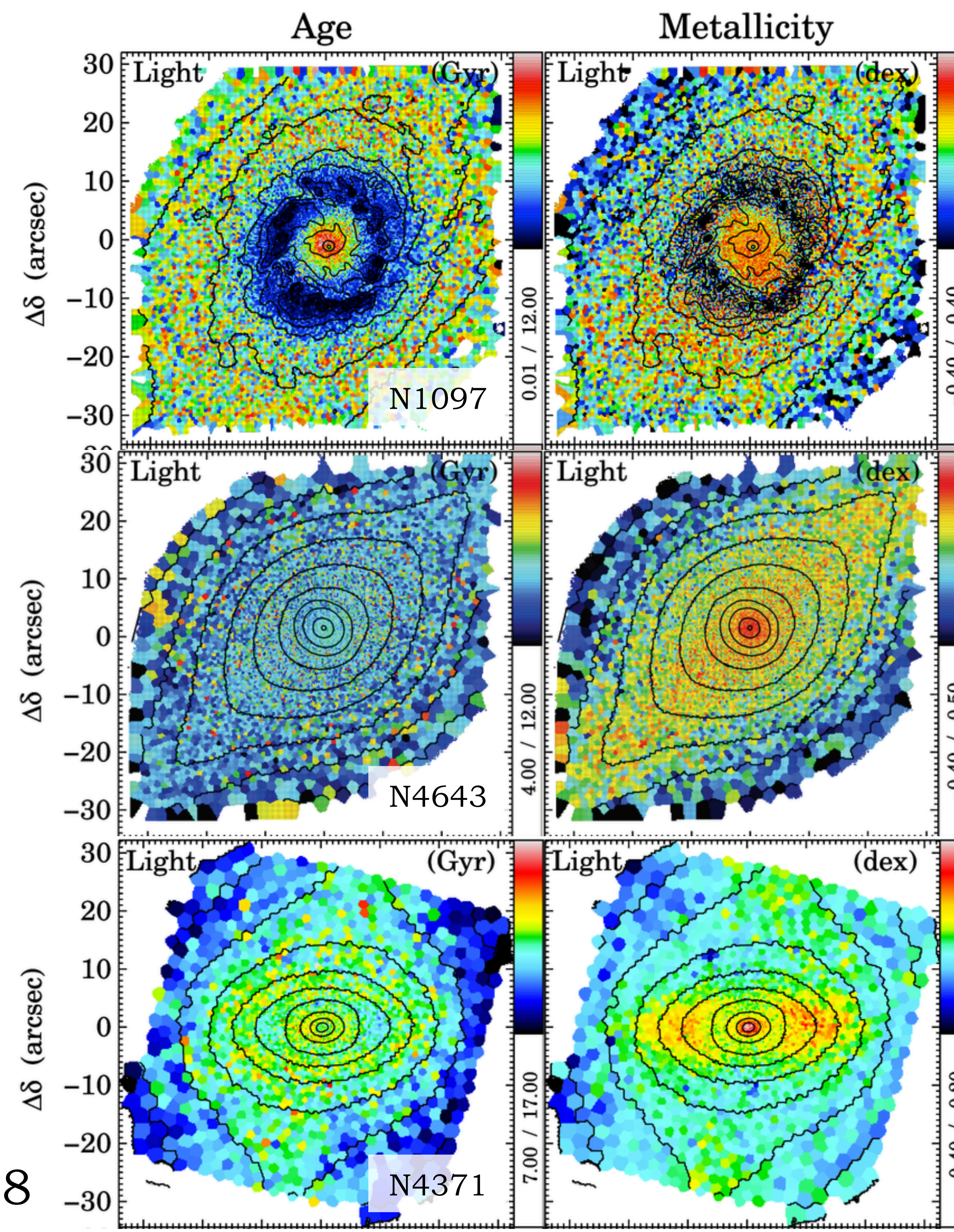
- Maps of mean stellar age and metallicity reveal central metal-rich component
- In NGC 1097, this component is also the oldest, and the nuclear ring is the youngest and most metal-poor component
- Gas feeding the nuclear ring is not pre-processed in the galaxy and likely comes from the low-mass companion (see also Seidel+2015 for the case of NGC 7552)
- Nuclear ring acts as an efficient barrier to the gas inflow



Gadotti+2015,2018

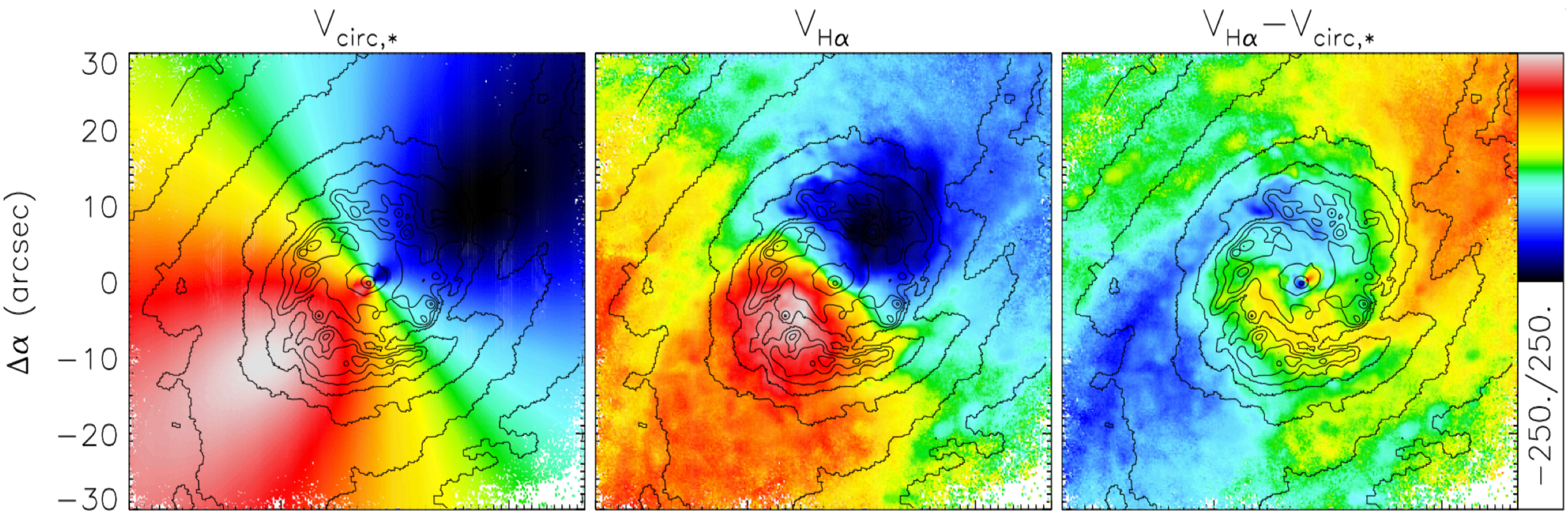
The TIMER Project

- Bar-built nuclear structures can have a range of ages and chemical content



Gadotti+2015,2018

The TIMER Project

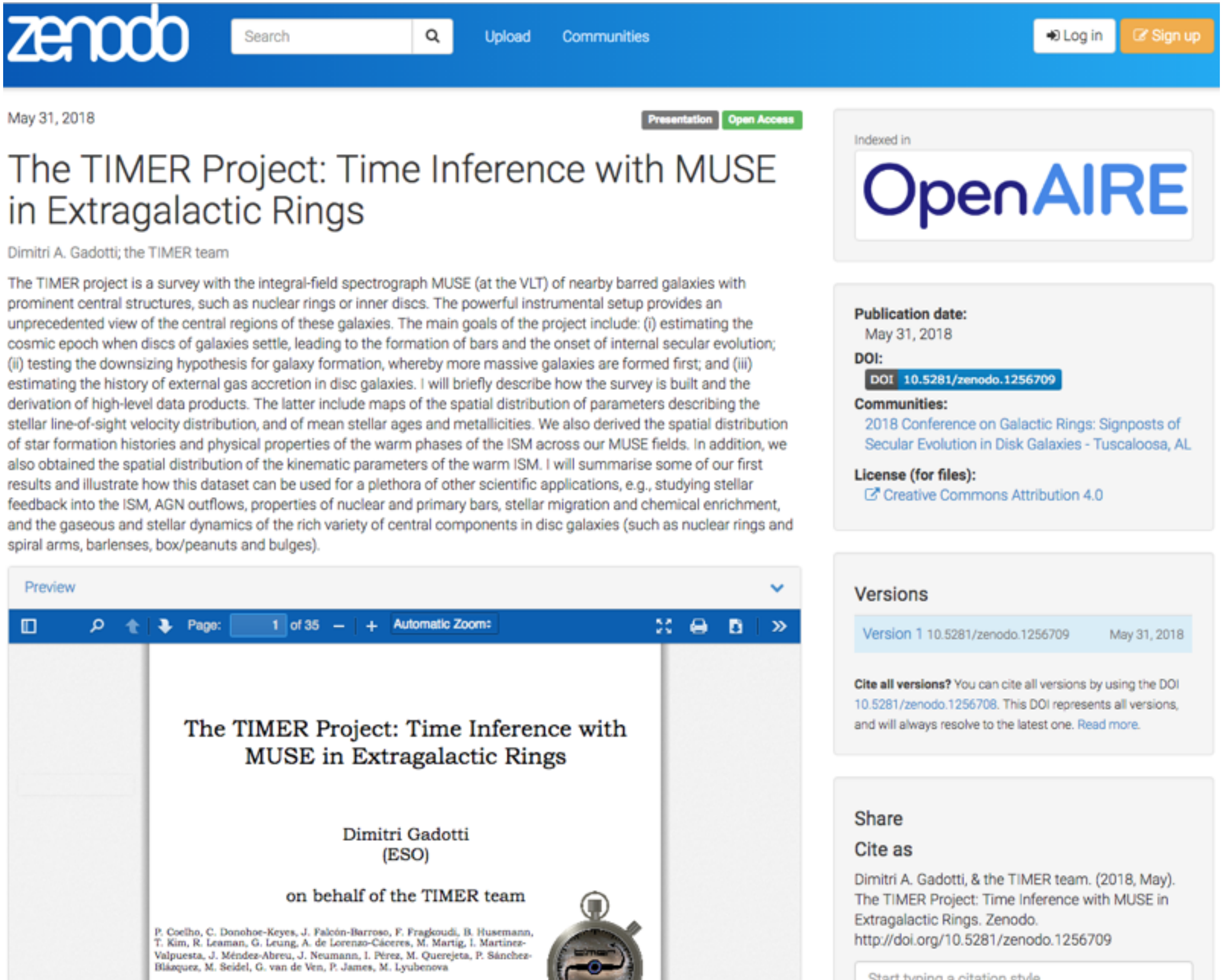


NGC 1097

Gadotti+2018

- Stellar dynamical modelling provides circular velocity
- Combined with gas velocity field from Hα emission allows one to see streaming motion along the bar

https://zenodo.org/record/1256709



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May 31, 2018 — Presentation — Open Access

The TIMER Project: Time Inference with MUSE in Extragalactic Rings

Dimitri A. Gadotti; the TIMER team

The TIMER project is a survey with the integral-field spectrograph MUSE (at the VLT) of nearby barred galaxies with prominent central structures, such as nuclear rings or inner discs. The powerful instrumental setup provides an unprecedented view of the central regions of these galaxies. The main goals of the project include: (i) estimating the cosmic epoch when discs of galaxies settle, leading to the formation of bars and the onset of internal secular evolution; (ii) testing the downsizing hypothesis for galaxy formation, whereby more massive galaxies are formed first; and (iii) estimating the history of external gas accretion in disc galaxies. I will briefly describe how the survey is built and the derivation of high-level data products. The latter include maps of the spatial distribution of parameters describing the stellar line-of-sight velocity distribution, and of mean stellar ages and metallicities. We also derived the spatial distribution of star formation histories and physical properties of the warm phases of the ISM across our MUSE fields. In addition, we also obtained the spatial distribution of the kinematic parameters of the warm ISM. I will summarise some of our first results and illustrate how this dataset can be used for a plethora of other scientific applications, e.g., studying stellar feedback into the ISM, AGN outflows, properties of nuclear and primary bars, stellar migration and chemical enrichment, and the gaseous and stellar dynamics of the rich variety of central components in disc galaxies (such as nuclear rings and spiral arms, barlenses, box/peanuts and bulges).

Preview

Page: 1 of 35 — Automatic Zoom:

The TIMER Project: Time Inference with MUSE in Extragalactic Rings

Dimitri Gadotti
(ESO)

on behalf of the TIMER team

P. Coelho, C. Donohoe-Keyes, J. Falcón-Barroso, F. Fragkoudi, B. Husemann, T. Kim, R. Leaman, G. Leung, A. de Lorenzo-Cáceres, M. Martig, I. Martinez-Valpuesta, J. Méndez-Abreu, J. Neumann, I. Pérez, M. Querejeta, P. Sánchez-Blázquez, M. Seidel, G. van de Ven, P. James, M. Lyubenova

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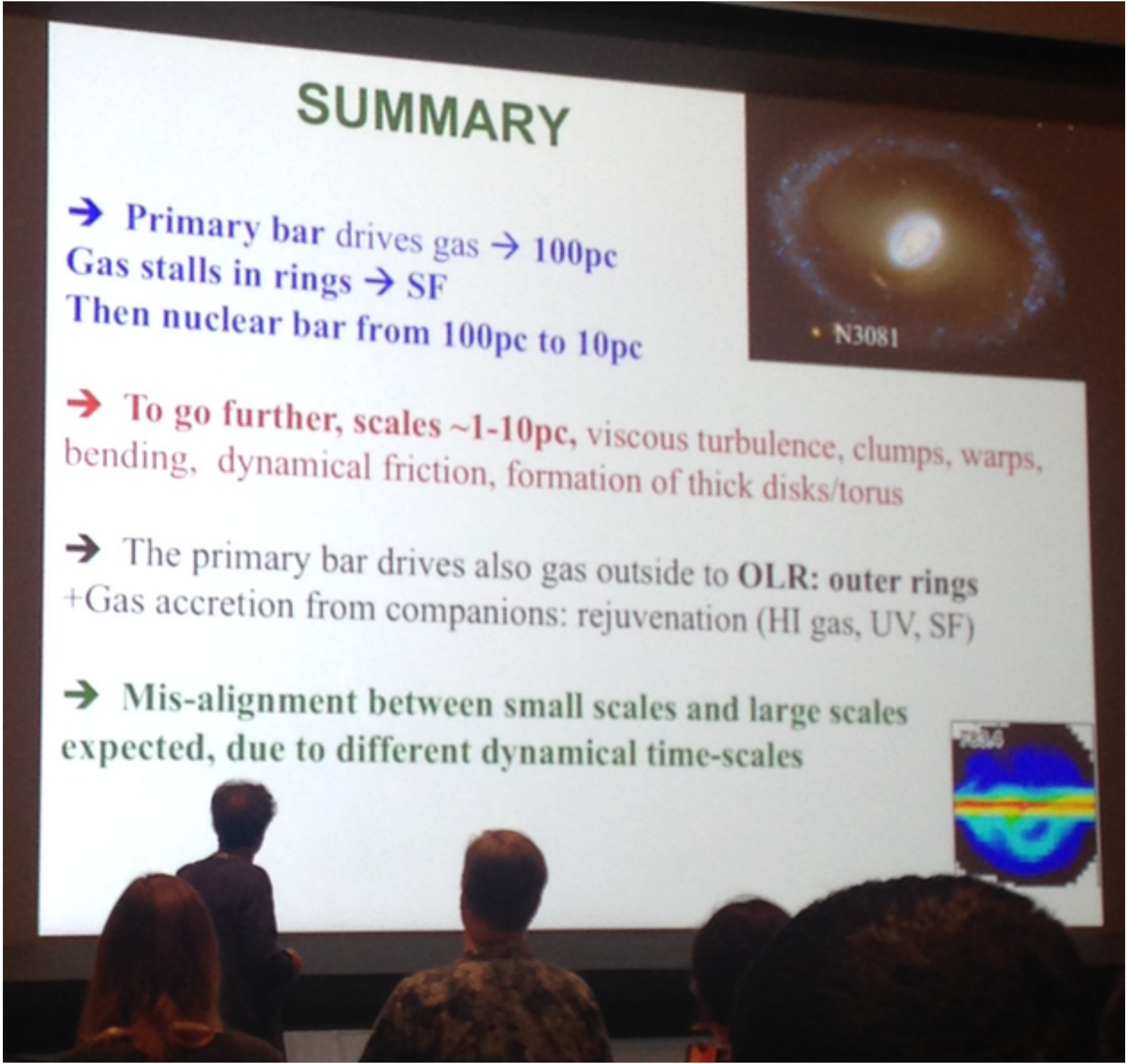
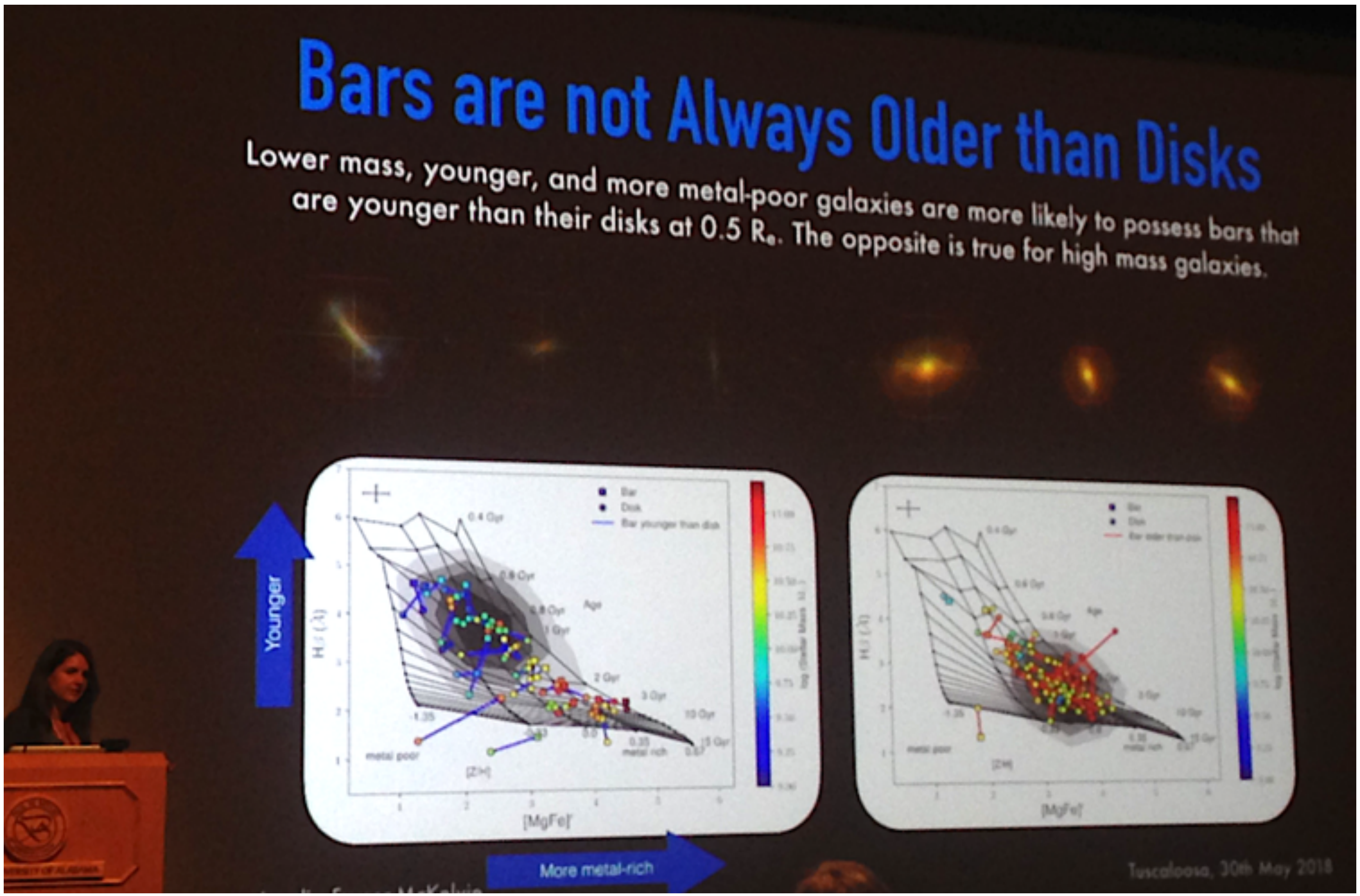
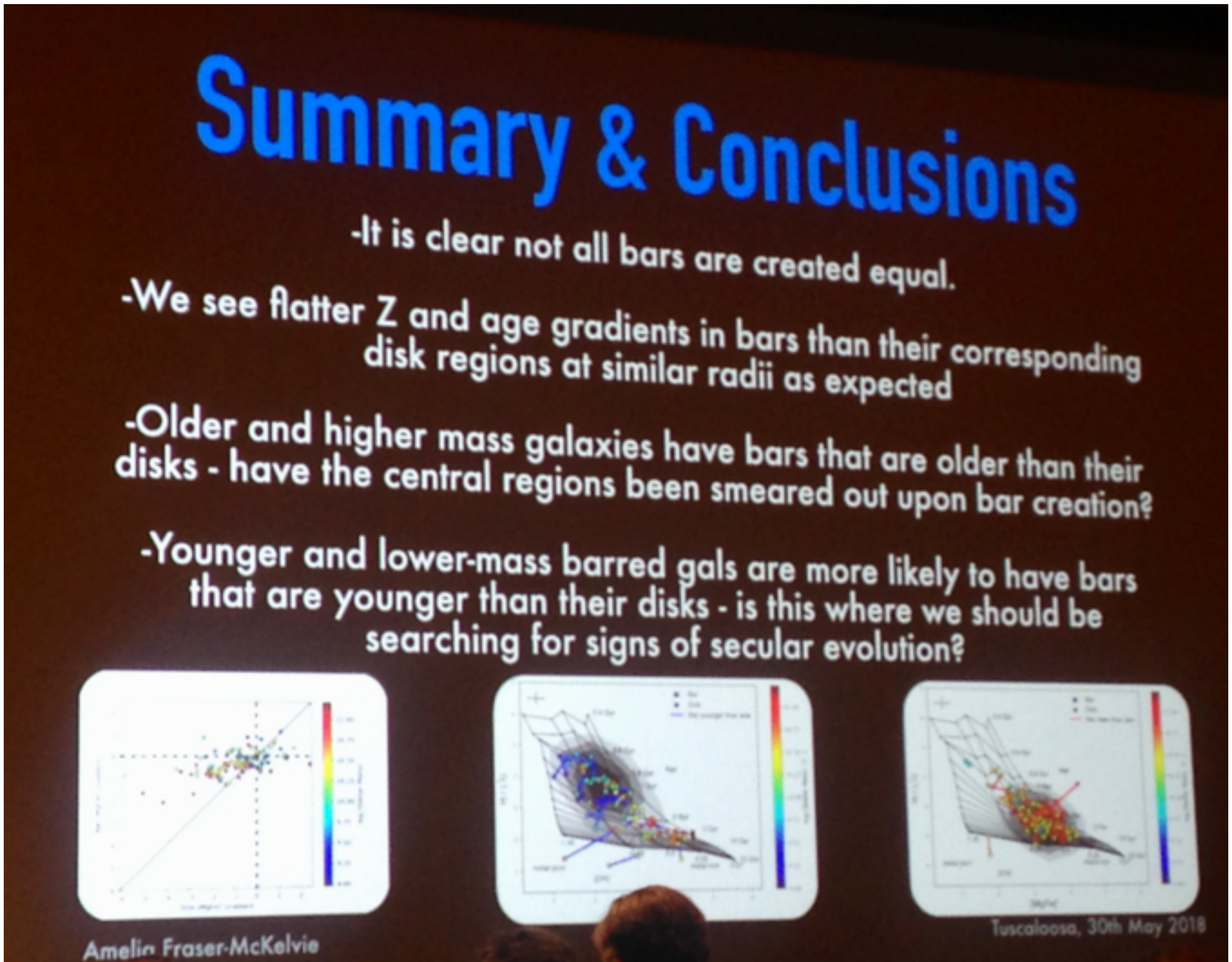

SUMMARY
→ Primary bar drives gas → 100pc
Gas stalls in rings → SF
Then nuclear bar from 100pc to 10pc
N3081
→ To go further, scales ~1-10pc, viscous turbulence, clumps, warps, bending, dynamical friction, formation of thick disks/torus
→ The primary bar drives also gas outside to OLR: outer rings
+Gas accretion from companions: rejuvenation (HI gas, UV, SF)
→ Mis-alignment between small scales and large scales expected, due to different dynamical time-scales

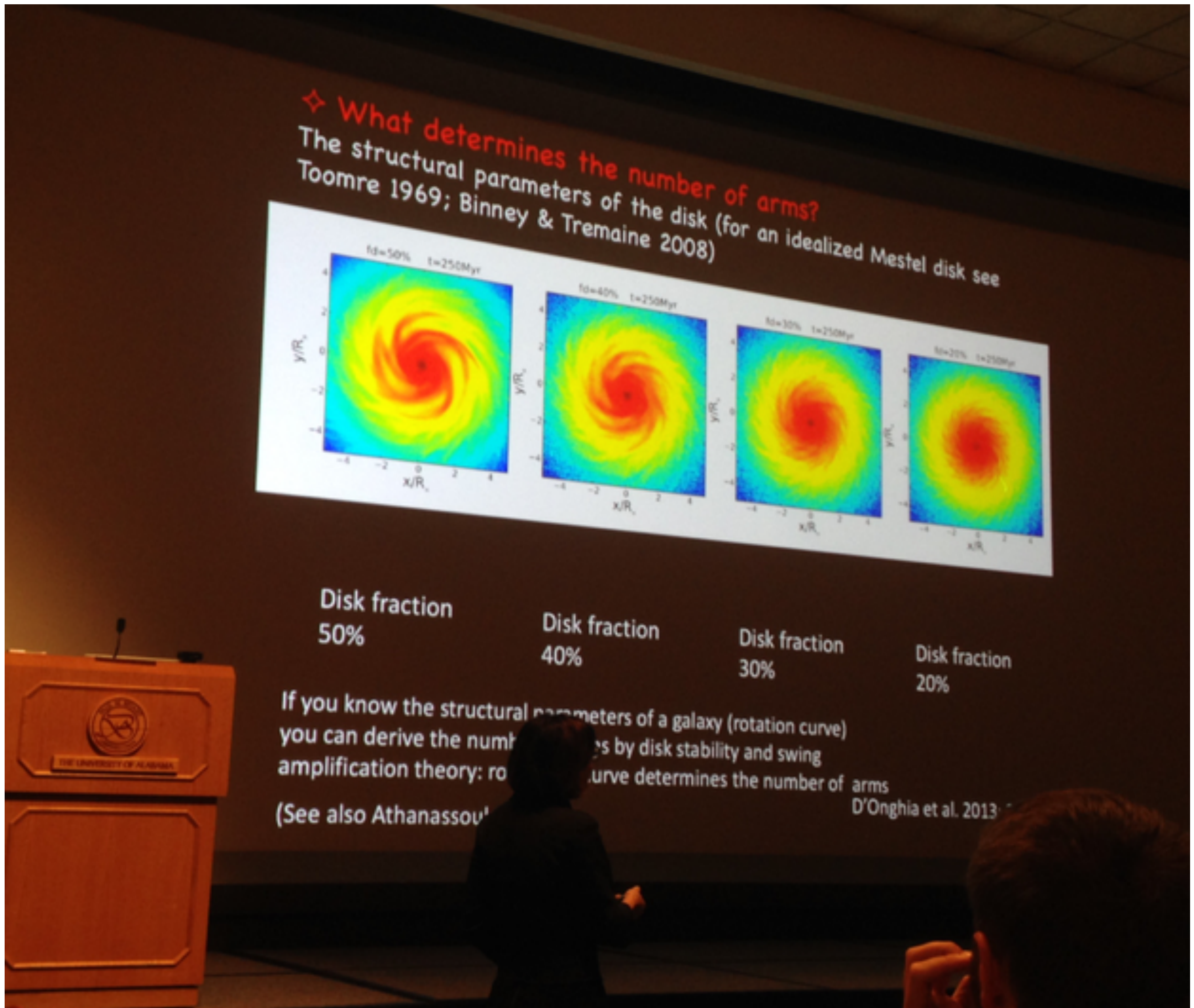
Amelia Fraser-McKelvie
The Origin of Bars in Quenched Disk Galaxies:
A MaNGA View



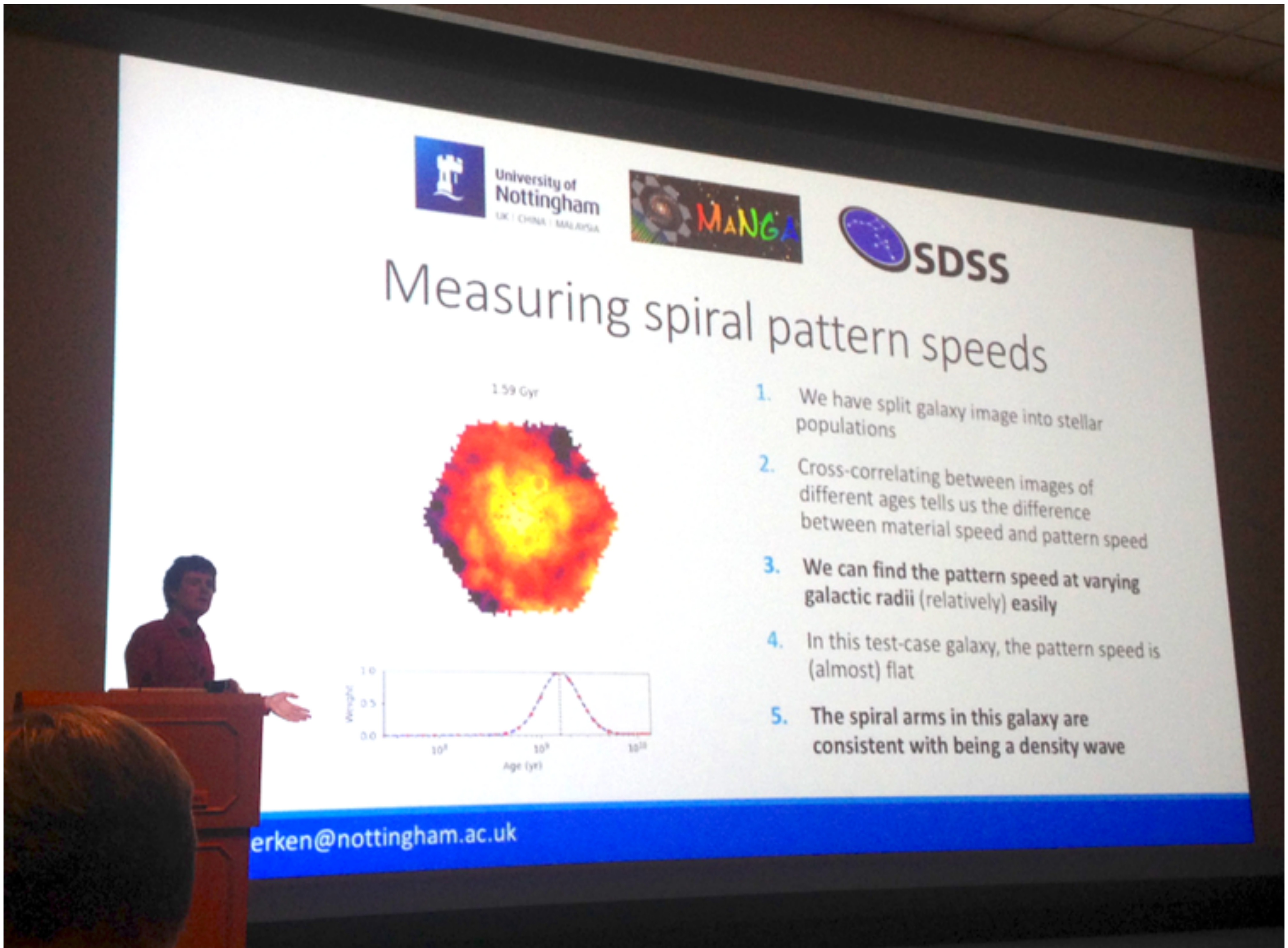
Amelia Fraser-McKelvie
The Origin of Bars in Quenched Disk Galaxies:
A MaNGA View

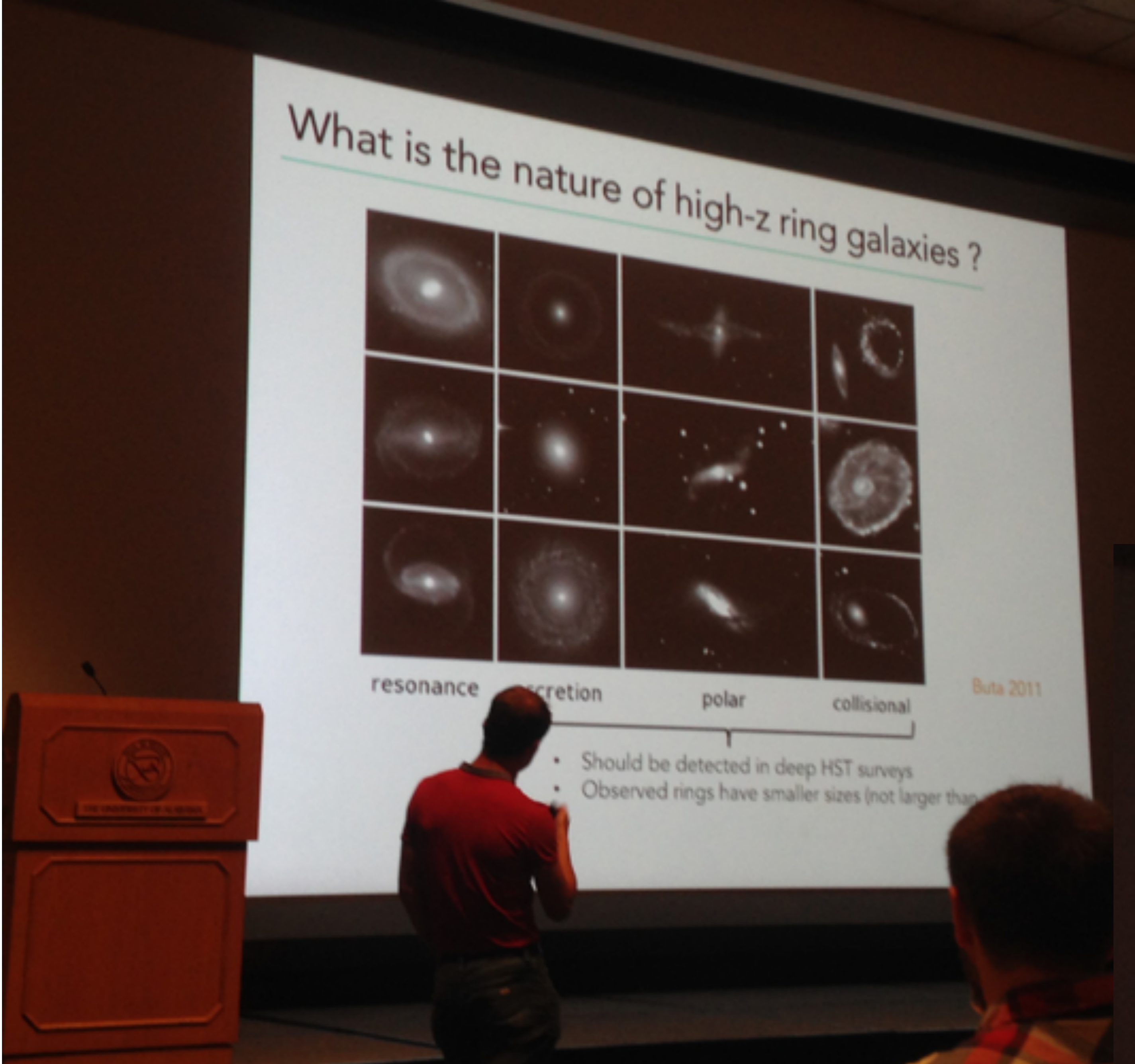


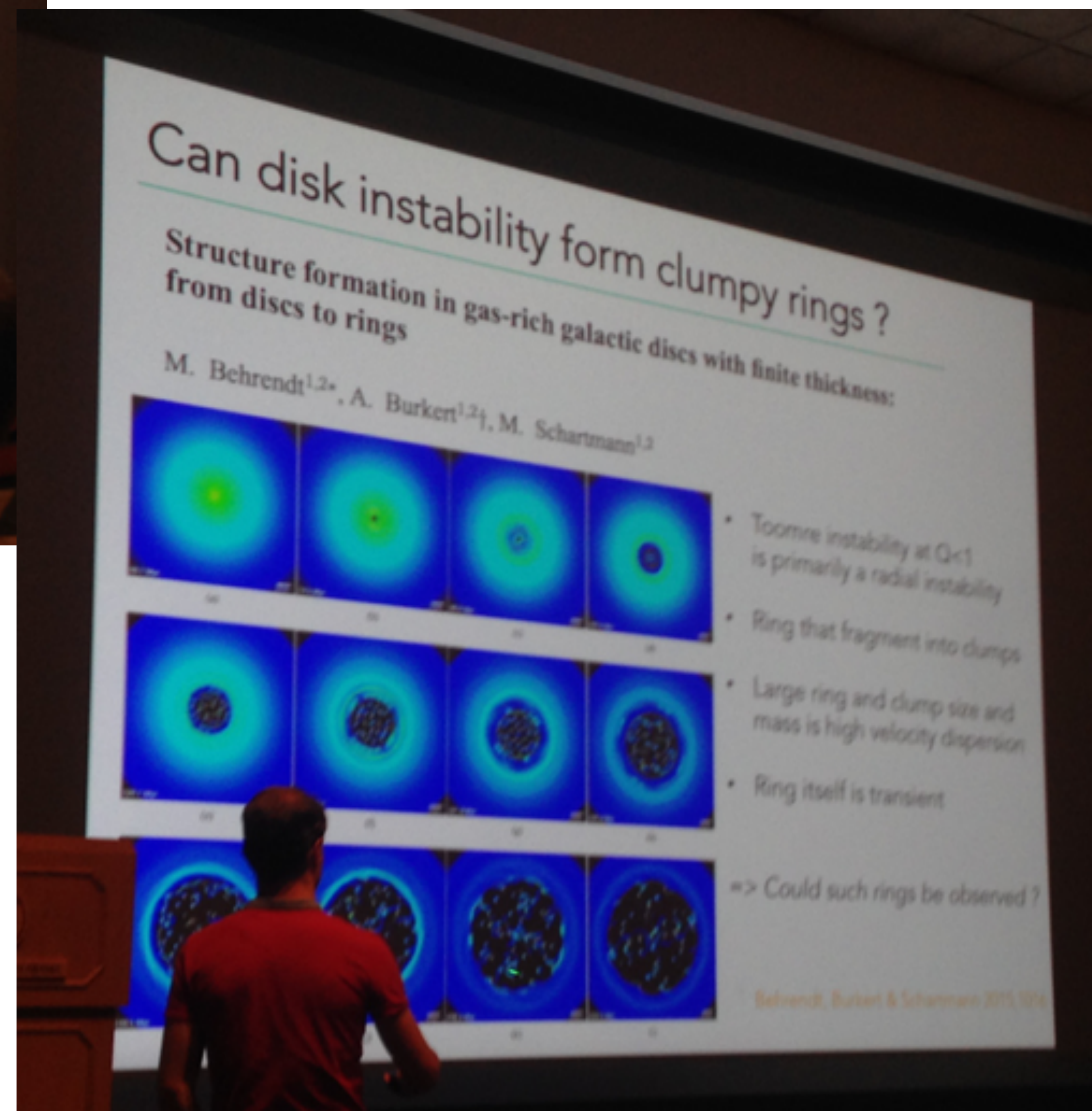
Elena D’Onghia, “Formation and Evolution of Spiral Structure in Disk Galaxies”



Tom Peterken, "A new technique to measure pattern speeds of spirals in MaNGA"




What is the nature of high-z ring galaxies ?
resonance
polar
collisional
Buta 2011
Should be detected in deep HST surveys
Observed rings have smaller sizes (not larger than


Can disk instability form clumpy rings ?
Structure formation in gas-rich galactic discs with finite thickness: from discs to rings
M. Behrendt[1,2]*, A. Burkert[1,2]†, M. Schartmann[1,2]
Toomre instability at Q<1 is primarily a radial instability
Ring that fragment into clumps
Large ring and clump size and mass is high velocity dispersion
Ring itself is transient
=> Could such rings be observed ?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P-3


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