GAMA-SIGMA: Exploring Galaxy Structure Through Modelling

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• Do galaxies form in two phases: bulge → disk?

• Are ellipticals and bulges essentially the same?

• How is stellar mass distributed between structures?

• How does environment shape galaxy structure?
Galaxy and Mass Assembly
The Sérsic Profile

\[ \Sigma(r) = \Sigma_e \exp \left[ -\kappa \left( \left( \frac{r}{r_e} \right)^{1/n} - 1 \right) \right] \]


Jose Luis Sérsic, 1963
The Sérsic Profile

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Exponential (e.g. – disks)

Gaussian (e.g. – stars)

de Vaucouleur (e.g. – ellipticals/bulges)

Jose Luis Sérsic, 1963

Sérsic Motivation

Sérsic photometry accounts for “missing” light in the wings of galaxies not usually picked up by other aperture definitions.
How do you model these galaxies quickly and accurately?
GAMA-SIGMA

→ Written in R
→ Each galaxy: 20 sec!

- Magnitude
- Sérsic Index
- Half-Light Radius
- Position Angle
- Ellipticity
- PSF
Example Profile
Example Profile: $u \rightarrow K$
Increasing $n$, Decreasing $r_e$

$u \rightarrow K$: $\lambda/1+z$

~150,000 galaxies in each band

SDSS $\rightarrow$ ugriz

UKIDSS $\rightarrow$ YJHK

Global Distributions
Volume Limited Sample

- \( M_r < -18 \)
- \( 0.013 < z < 0.1 \)
- \( nQ > 2 \)
- Coverage = ugrizYJHK + NUV/FUV

\[ \rightarrow \] \ (~7,500 galaxies)
Classifications

Driver et al. (2011; in prep)

- $M_r < -18$
- $0.013 < z < 0.1$
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→ ~7,500 galaxies
Vol. Lim. Results

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  + NUV/FUV

→ ~7,500 galaxies

Stability of elliptical shape at all $\lambda$

Size evolution of ellipticals and disks $u \rightarrow K$

Stability of ellipticity for all morph. types
Halo Masses: Aaron Robotham

Halo Masses

- $10^{14} < M_{\text{H}} / M_{\odot} < 10^{15}$
- $10^{13} < M_{\text{H}} / M_{\odot} < 10^{14}$
- $10^{12} < M_{\text{H}} / M_{\odot} < 10^{13}$

Graph: Normalised Density vs. Redshift, showing distributions for different halo mass ranges.
Is structural decomposition required?
How do you morphologically classify these galaxies automatically?
All vs All (Updated)
Automated Classification

\[ u-r = -2.29 \log_{10}(n_r) + 2.71 \]

Blue

Disks

Red

Spheroids

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Lee Kelvin
Automated Classification
Automated Classification

G00252005  G00054957  G00417433  G00055009
G00091399  G00550225

G00054455  G00376990
G00543489  G00210375

G00251143  G00509726
G00507974  G00376028

G00574008  G00278847  G00375793  G00085960  G00239692  G00202443
Automated Classification
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G00252005 | G00054957 | G00417433 | G00055009 | G00091399 | G00550225
---|---|---|---|---|---
G00054455 | G00376990 | \( u-r = 2.29 \log_{10}(n_r) + 2.71 \) | G00543489 | G00210375
---|---|---|---|---|---
G00251143 | G00509726 | G00507974 | G00376028
---|---|---|---
G00574008 | G00278847 | G00375793 | G00085960 | G00239692 | G00202443
Stellar Mass Distribution

Stellar Masses: Ned Taylor

G00252005  G00054957  G00417433  G00055009  G00091399  G00550225
G00054455  G00376990  G00251143  G00509726  G00543489  G00210375
G00574008  G00278847  G00375793  G00085960  G00507974  G00376028

23%  4%  6%  56%  4%  8%
• Do galaxies form in two steps: bulge → disk?
  → ...
• Are ellipticals and bulges essentially the same?
  → Structural decomposition required!
• How is stellar mass distributed between structures?
  → ~2/3 in spheroidal dominated types
• How does environment shape structure?
  → More massive clusters host earlier type galaxies
Summary

- SIGMA → measurements of ~150,000 galaxy structural params
- Single Sérsic → Recovers “missing” light in the wings of galaxies
- Multi-λ → Important in probing different stellar populations
- Morphology → Automation possible, essential for large surveys
- Structural Decomposition → Essential next step
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- SIGMA \rightarrow\ measurements of \sim 150,000 galaxy structural params
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- Morphology \rightarrow\ Automation possible, essential for large surveys
- Structural Decomposition \rightarrow\ Essential next step

Measuring the energy output of the nearby Universe with GAMA

Simon P. Driver and the GAMA team