A Clean and Complete, Visually Classified Galaxy Sample from the Galaxy and Mass Assembly (GAMA) Equatorial Regions ($0.002 \leq z \leq 0.06$)

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1. Introduction

This is a database of nearby galaxies in the local Universe, including selected properties. These galaxies are from three small regions of the sky, which have been surveyed extensively at multiple wavelengths from ultra-violet to sub-millimetre. All types of galaxies are included. The original purpose was to sample the dust and gas properties of different types of galaxies (Glass 2024, PhD thesis). The database allows astronomers to compare the properties of different galaxy populations, and to select specific galaxies for further observation.

The database contains a catalogue of 4458 galaxies within the Galaxy and Mass Assembly (GAMA) project (Driver et al. 2009) [1] Equatorial regions. These galaxies were surveyed at multiple wavelengths, including the sub-millimetre bands of the Herschel-ATLAS survey (Eales et al. 2010). A Parent Sample of galaxies is provided, with coordinates, visual morphological classifications (where ellipticity ≤ 0.7) and some property information. A catalogue of 459 galaxies containing strong Active Galactic Nuclei (AGN) is also provided, with similar information to that for the Parent Sample (except morphology classification) and the methods used to identify them as having strong AGN. Galaxies containing strong AGN were separated from the Parent Sample, to avoid issues with sub-millimetre spectrum contamination that could affect estimates of cool dust mass from spectral fitting. The galaxy sample provided is intended to be as complete as possible, allowing galaxy selection for further study to be less affected by sample bias.

The Parent Sample is primarily intended to provide clean and complete samples of Early-Type Galaxies (ETGs), including Elliptical and Lenticular galaxies. The morphology classification methods for these avoid the inclusion of galaxies with faint spiral structures. Samples for other morphological types are also included, for studies in a wider context. Whilst ETGs have been carefully considered in our work, other categories are as in GAMA II (Moffett et al. 2016), with the addition of a few faint spirals, reallocated from the ETGs categories, via our GAMA-KiDS-GalaxyZoo analysis (see Section 2 below). This Parent Sample can be used for studies of galaxy properties in different parameter spaces including morphology, and for unbiased observational target selection based on specific properties of interest.

2. Sample Build

Details of the sample build are available in Glass (2024) and Glass et al. (2025, in prep.), with the main aspects summarised here. The GAMA equatorial regions are centred on 09h, 12h and 14.5h RA and 0° DEC. The GAMA II (Liske et al. 2015) data included with Data Release 4 (DR4, Driver et al. 2024) was used as the source of galaxy properties for the sample build, along with additional visual classifications from GAMA-KiDS-GalaxyZoo (KiDS-GZ, Holwerda et al. 2024). A minimum redshift (z) of 0.002 was chosen, consistent with the minimum redshift of the galaxies in GAMA II DR4. A maximum redshift of 0.06 is consistent with limit for visual morphology classification in GAMA. Galaxies within these redshift limits were selected initially based on the following criteria:

[1] https://gama-survey.org

- GAMA survey class ≥ 1 (valid galaxy for GAMA observations)
- Effective radius > 1.2" (ensures resolved objects beyond observational seeing limits)
- Sloan Digital Sky Survey (SDSS, York et al. 2000) r-band Petrosian absolute magnitude ≤ -17.4 (corresponding to GAMA r-band apparent magnitude = 19.8, the lower limit for spectroscopic completeness, at z = 0.06)

Galaxies with AGN were then removed using a BPT diagram (Baldwin, Phillips & Terlevich 1981), a diagram using Hα and [NII]λ6584 spectral lines (WHAN diagram, Cid Fernandes et al. 2010, 2011), a diagnostic plot based on Wide Field Infrared Survey Explorer (WISE) satellite photometry (Mateos et al. 2012), and elevated continuum flux density at 20 cm from the Very Large Array VLA-FIRST survey (Becker et al. 1995). These identified a total of 459 galaxies containing AGN. Additionally, 19 galaxies with suspected sub-millimetre emission in Herschel-ATLAS photometry caused by gravitational lensing (González-Nuevo et al. 2012) were excluded. Subtraction of these galaxies created the Parent Sample of 4458 galaxies.

Visual morphologies were taken initially from GAMA II (Kelvin et al. 2014, Moffett et al. 2016). However, these morphologies were derived using SDSS images, and resolution limits can mask faint spiral structure present in ETGs. Visual feature classifications from KiDS-GZ were therefore used to identify ETGs with faint spiral structure, and move them to a spiral classification. This process was only found to be reliable with galaxy ellipticities ≤ 0.7, so only galaxies meeting these criteria are assigned a visual morphology classification. The remainder are allocated a "high-ellipticity" classification, which also addressed difficulties in identifying apparent spiral features at high ellipticity. The ellipticity threshold is consistent with the accepted limit for intrinsic flattening amongst elliptical galaxies. Numbers of galaxies classified per morphological type are as follows:

Classification	No.
Ellipticals	608
Lenticulars	461
Spirals	1016
Sd-Irregular	1481
Little Blue Spheroids (LBS)	156
High-Ellipticity	726
Not Classified	10
Total	4458

Two catalogues in FITS and CSV format are provided. Further details including column names, descriptions and formats can be found in individual description documents. The files provided are as follows:

- DHWG_Parent_Sample_4458.fits (the Parent Sample, FITS format)
- DHWG_Parent_Sample_4458.csv (the Parent Sample, CSV format)
- DHWG_Parent_Sample_4458_Description.txt (Parent Sample description file)

- DHWG_AGN_459.fits (AGN removed to create the Parent Sample, FITS format)
- DHWG_AGN_459.csv (AGN removed to create the Parent Sample, CSV format)
- DHWG_AGN_459_Description.txt (AGN description file)

All samples were built using Python, making use of ASTROPY.IO.FITS for reading in and outputting tables in FITS format, and ASTROPY.TABLE for cross-matching tabular data or selecting galaxies based on specific property limits. Code for these operations can be made available on reasonable request to

the authors. Example code is included within this document for adding other galaxy properties from GAMA catalogues, e.g. stellar masses, star formation rate, emission line intensities.

3. Example of Data Use

To illustrate the separation of morphological classifications by galaxy property in the Parent Sample, Figure 1 shows the variation of galaxy colour (from SDSS photometry) versus stellar mass for different morphological types separately. Ellipticals mostly occupy a relatively tight parameter space often referred to as the "red sequence", except for a population of spheroids at lower stellar mass which are bluer and at greater stellar mass than most LBS. Lenticulars follow a similar trend where stellar masses are similar. Spirals, Sd-Irr and LBS follow a separate trend, referred to as the "blue cloud", with some overlap into parameter spaces for ETGs referred to as the "green valley". The contours represent density of data points, increasing towards the centre of the data peaks.

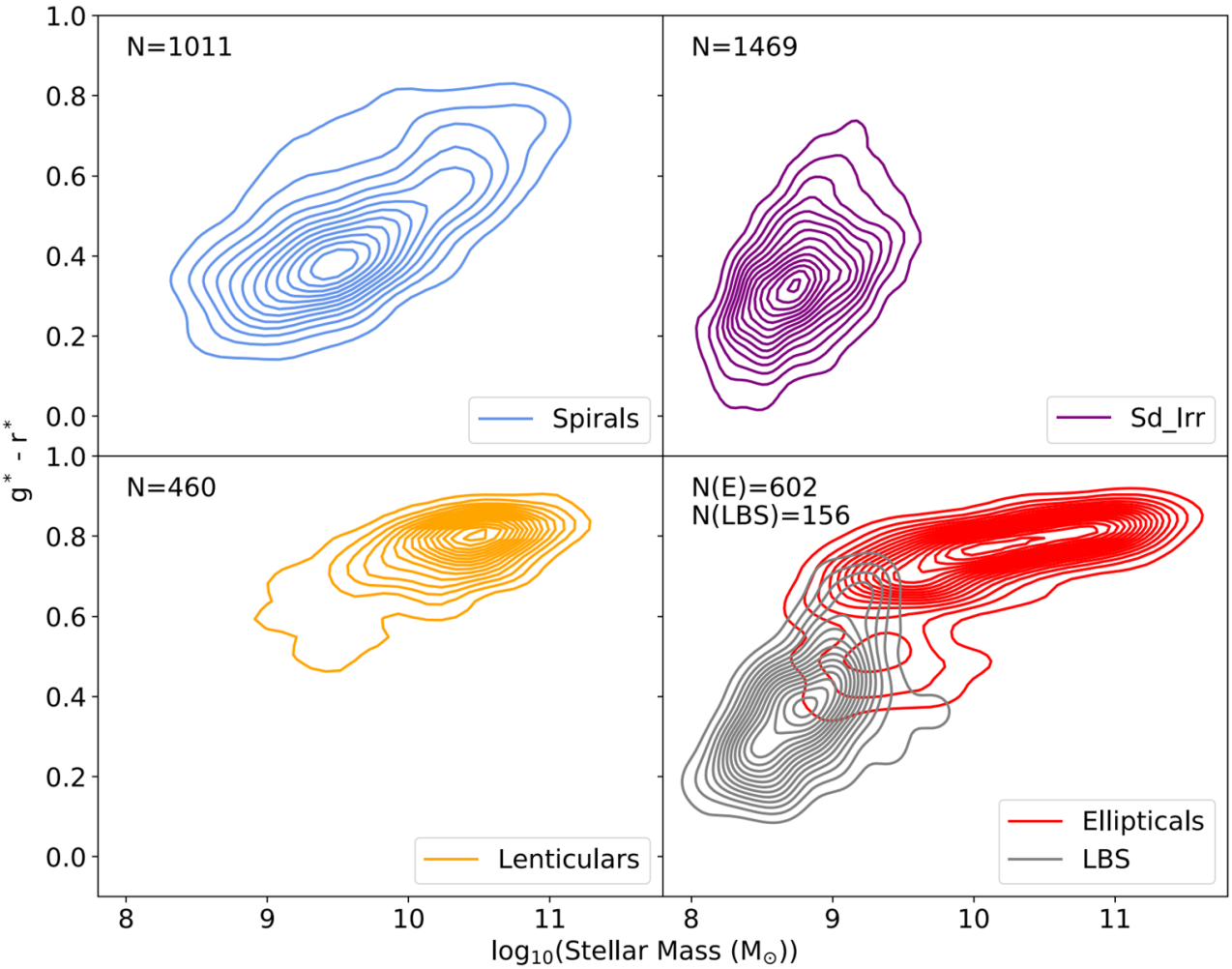

Figure 1: Optical g – r colour from SDSS photometry (* = corrected for Galactic extinction) versus MAGPHYS (da Cunha et al. 2008) estimates of stellar mass from GAMA II. Morphological classifications from the Parent Sample are shown. Numbers of galaxies (N) shown are those with valid detections (>3σ in g- and r-band photometry). Contours represent density of data points, increasing towards the centre of the data peaks (Glass 2024).

4. Use of This Database

While the Parent Sample and AGN sample are made publicly available for anyone to download and use, this is at the users' own risk. The authors do not guarantee that they are free from errors. If you make use of the samples, please acknowledge Glass (2024), referenced below, or this University of Lancashire database.

5. References

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Example Python code for cross-matching the Parent Sample catalogue with GAMA catalogues

```
from astropy.io import fits
from astropy.table import Table
from astropy.table import join, setdiff
import matplotlib.pyplot as plt

# Read in the relevant fits files and put them into astropy Tables

hdulist = fits.open('DHWG_Parent_Sample_4458.fits')
t_Parent = Table(hdulist[1].data)
hdulist.close()
print('Length of parent sample catalogue:', len(t_Parent))
print(' ')
print('Catalogue entry for a single galaxy (example of filtering):')
print(t_Parent[t_Parent['CATAID'] == 272990])
print (' ')

hdulist = fits.open('SersicCatSDSSv09.fits')
t_Sersiccat = Table(hdulist[1].data)
hdulist.close()
print('Length of SersicCatSDSSv09:', len(t_Sersiccat))

# Cross-match with the SersicCat data of interest (referenced by column name, must
include CATAID)
# This uses an inner join, which is the default for the join command.

t_working = join(t_Parent, t_Sersiccat['CATAID', 'GALINDEX_r', 'GALINDEXERR_r'],
keys = 'CATAID')
print('Length of t_working:', len(t_working))
```