The morphology distribution of 800,000 SDSS galaxies based on colours and concentration index

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Deconstructing Galaxies: Structure and Morphology in the Era of Large Surveys

Abstract

Shimasaku et al. (2001) classified the visual morphology of a sample of 456 galaxies from the SDSS commissioning phase, using a 0 to 6 scale where 0 = E and 6 = Im. They correlated their morphological classes with the *u-g, g-r, r-i* and *i-z* colours, as obtained form the SDSS, and also with an index measuring the concentration of light of the galaxies, defined as the ratio of the Petrosian radii containing 50% and 90% of their total Petrosian flux in the *r* band, $\mathbf{r_{50}/r_{90}}$. Fukugita et al. (2007), using a sample of 2253 galaxies from the SDSS-DR3, assembled a catalogue of galaxies with a visual morphology classification using the same 0 to 6 scale, and updated the correlation of the previously mentioned colours with the morphological classes. Combining both studies, we have a set of five photometric characteristics of galaxies, as obtained from the SDSS, that relate with their visual morphology. Since it is not practical to obtain a homogeneous, single-person visual morphology classification of galaxy samples larger than tens of thousands, a different approach to infer the distribution of these morphology classes for a larger sample must be taken. In order to achieve this, we have reversely applied the relations described in the previous paragraph to infer the morphology class of 804,858 galaxies in the SDSS-DR7 spectroscopic catalogue from their photometric colours and concentration index. We found that, in a galaxy-by-galaxy comparison, our inferred classes are similar to the visual morphology classes to the same degree as the visual morphology of a single galaxy varies when based on the classification by different individuals.

Despite that with this result we consider our inference as successful, we conservatively conclude that our inference is best suited to assess the distribution of the morphology of large samples of SDSS galaxies, since the galaxy-to-galaxy differences are less significant with a larger sample size. We intend to use our inference to study the morphology-local density relation of large samples of galaxies in different environments, and the environmental density of galaxies of different dominant emission-line activity types.

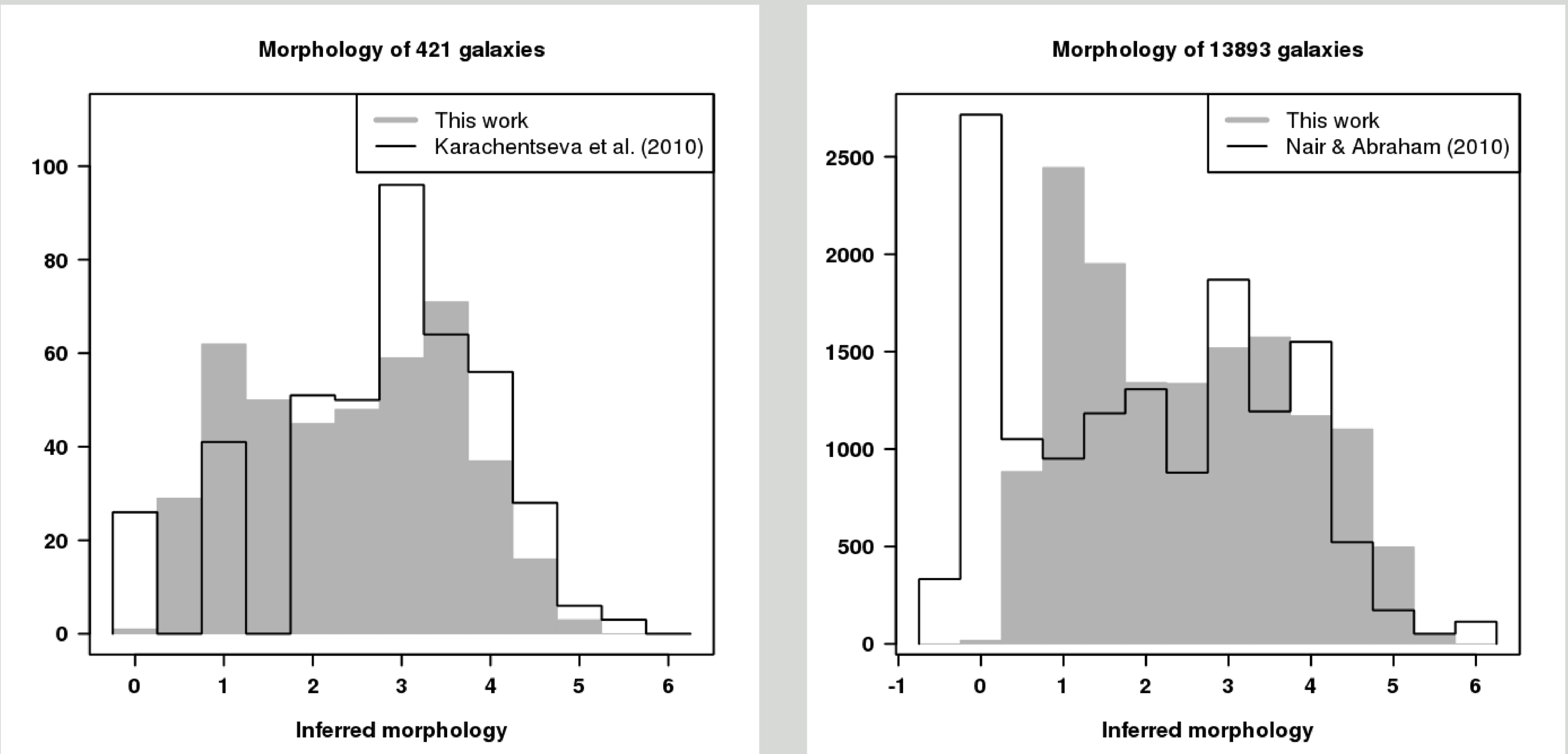
Table 1

Conversion of T-types as used in the 2MIG catalogue of Karachentseva et al. (2010) and the catalogue of galaxies by Nair & Abraham (2010) to the 0-6 range, as used in this work for our inferred morphology, for the purpose of comparison (Figure 1). The scale of our inferred morphology is based on that used by Fukugita et al. (2007) for their visual classification, so galaxies of earlier types have a lower inferred morphology (closer to 0), while later types have a higher value (closer to 6).

This work	-0.5	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
2MIG catalogue	–	-2	–	0	–	1	2	3	4	5	6	7	8	9, 10
Nair & Abraham (2010)	99	-5	-3	-2	0	1	2	3	4	5	6	7	8	9, 10

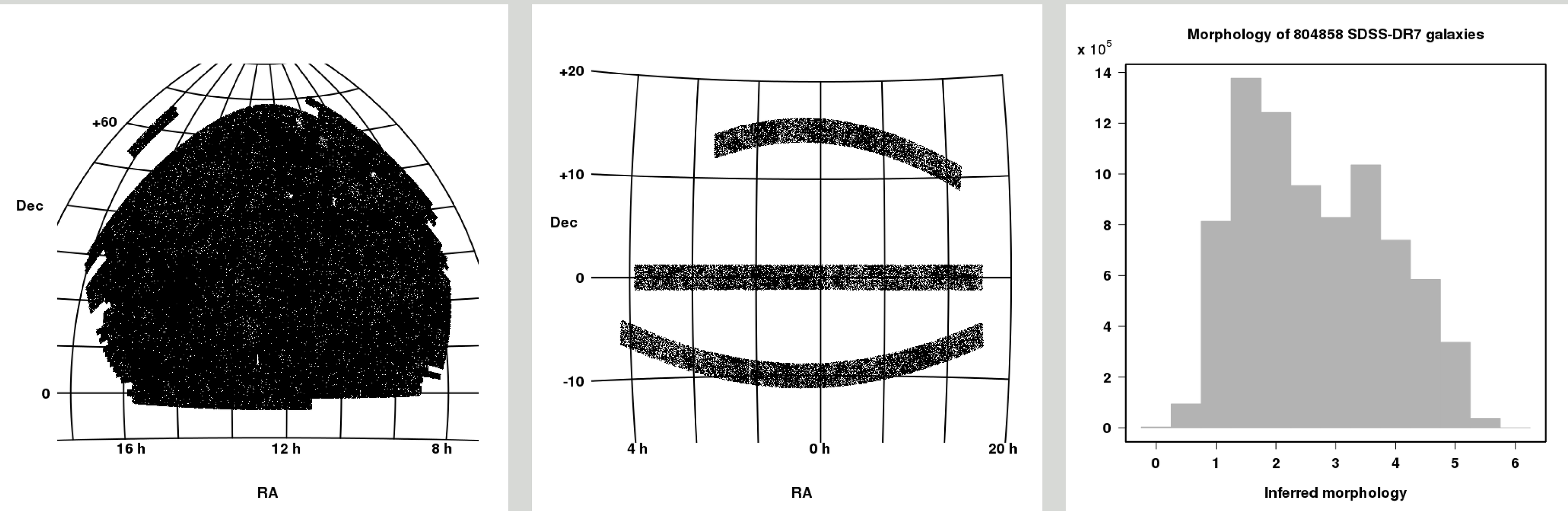
Note that 99 represents galaxies marked as without a T-type in that catalogue, and our method gives an inferred morphology to all galaxies.

Figure 1



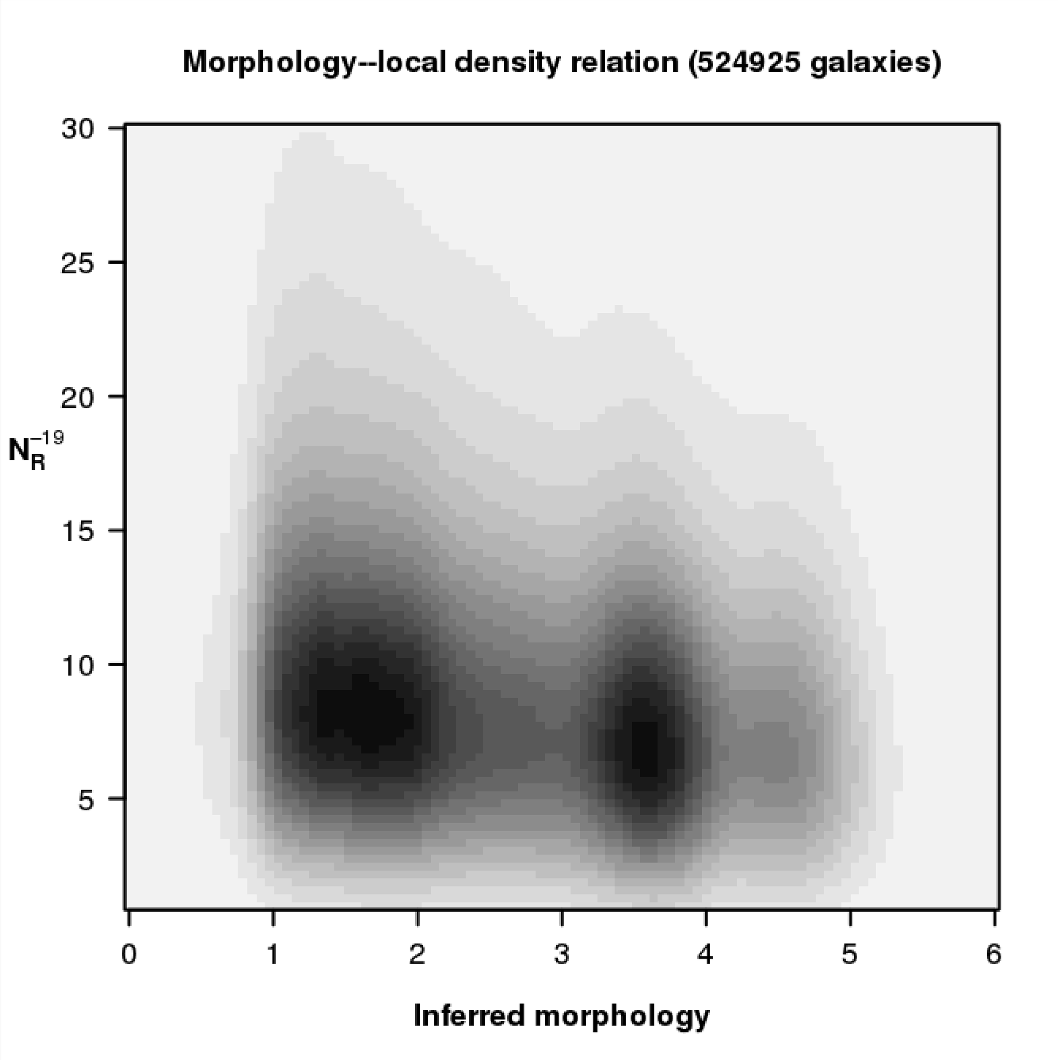
Left: Comparison between our morphological inference and the visual morphology for 421 galaxies the 2MIG catalogue. There is a very good agreement for galaxies of later types, while earlier types are difficult to compare since the 2MIG catalogue does not use intermediate classes for early-type galaxies. In general, earliest visual types translate to slightly later types in our inference, but never later than an inferred morphology of 1.5. *Right:* Comparison between our morphological inference and the visual morphology for 13893 galaxies from Nair & Abraham (2010). Again there is good agreement for galaxies of later types, while again there is a displacement of the earliest visual types to later types in our inference. In a galaxy-by-galaxy comparison we have found that the differences between our inference and the visual morphology are similar to the variations between visual classifications made by expert researchers (see Naim et al. 1995).

Figure 2



Galaxies in the northern *(left)* and southern *(center)* Galactic caps for which we have a morphological inference, a total of 804,858. Galaxies were selected from the spectroscopic catalogue of the SDSS-DR7. *Right:* Distribution of our morphological inference for these galaxies.

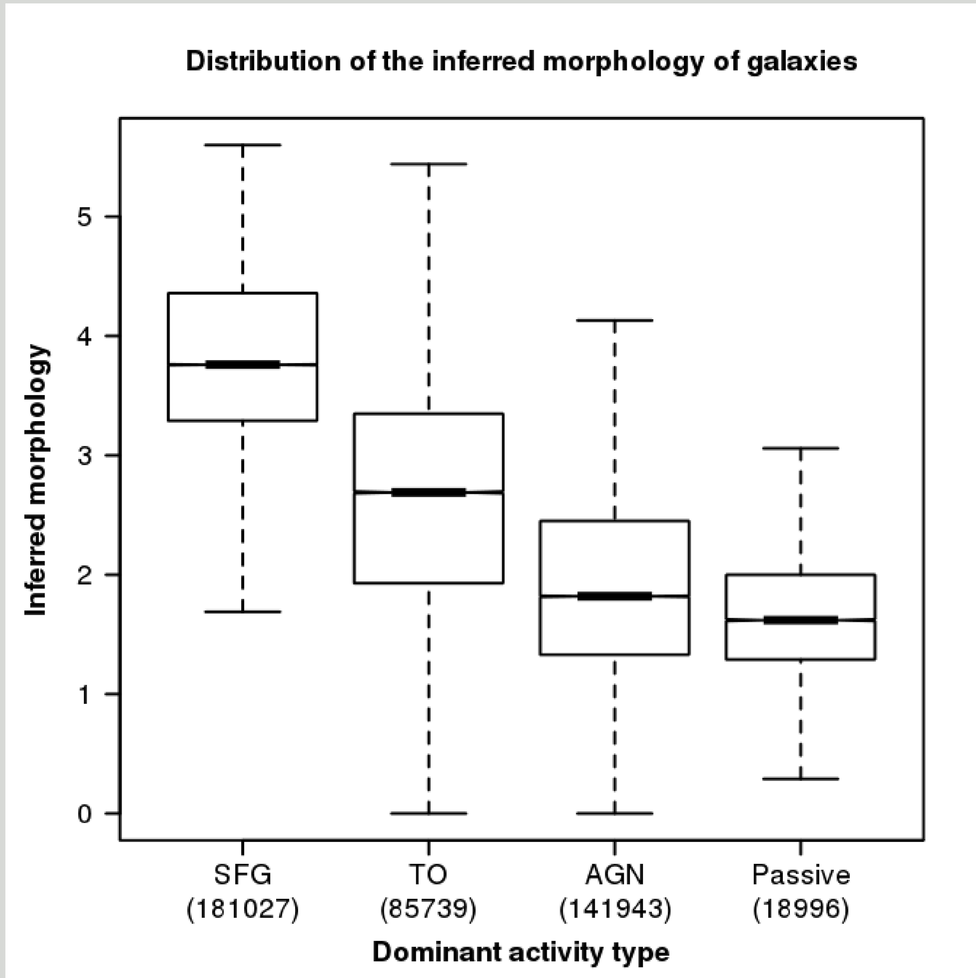
Figure 3



We used our inference to test the morphology–local density relation for 524,925 galaxies for which we have our own measurement of their environmental density, based on work by Wing & Blanton (2011). For each galaxy, we counted neighbouring galaxies around 1.5 Mpc projected on the plane of the sky, accounting only for galaxies with photometric redshift in a range equivalent to ± 2500 km/s around the spectroscopic redshift of the target galaxy. The resulting number is represented as $\mathbf{N_R^{-19}}$ (or simply N). The figure shows that galaxies of earlier types have a larger N than galaxies of later types, confirming that this relation holds for a general definition of environmental density not limited to clusters of galaxies or any other special type of environment.

Figure 4

Distribution of our morphological inference for galaxies with different dominant emission-line activity. The activity classes were defined using diagnostic diagrams that use emission-line ratios, such as the BPT and NII diagrams. The figure shows that there are significant differences in morphology for different dominant activity types, with Star Forming Galaxies (SFGs) being of later types than Transition Objects (TO), and these in turn being of later types than galaxies with a dominant AGN.



Passive galaxies (galaxies with no detection of any of the emission-lines needed to clasify them according to the diagnostic diagrams) appear to be of slightly earlier types than AGN-dominated galaxies. This suggests a strong relationship between the dominant activity type and the morphology of galaxies, with SFGs being predominantly later types and AGNs and passive galaxies being mostly earlier types.

References and Acknowledgments

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