Formation and Evolution of Galaxy Bulges
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GAMA: a new galaxy survey

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Abstract. The case is outlined for a new galaxy survey, including spectroscopy with AAOmega and sub-arcsecond multi-band imaging, that bridges a crucial gap between the SDSS and VVDS surveys. The science focus is to study structure and the relationship between matter and light on kpc-to-Mpc scales. The range of scales probed will enable direct constraints on the Cold Dark Matter model by: (1) measuring the halo mass function down to $10^{12}\mathcal{M}_\odot$ and its evolution to $z \sim 0.4$; (2) measuring the galaxy stellar mass function to very low mass limits of $10^7\mathcal{M}_\odot$ constraining baryonic feedback processes; and (3) quantifying the environment-dependent merger rate since $z \sim 0.4$. Here, we highlight the fact that the high-resolution imaging will enable the bulge-disk decomposition of ∼200 000 galaxies in u–K, providing a valuable resource for statistical studies of bulge properties.

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International surveys, such as the Two-Degree Field Galaxy Redshift Survey (2dF-GRS) and the Sloan Digital Sky Survey (SDSS) have transformed our view of large scale structure and have contributed directly towards the emergence of a concordance cosmology. These surveys have also provided a confirmation of the basic Cold Dark Matter (CDM) paradigm for the growth of structure through the comparison of robust model predictions with empirical clustering measurements on Mpc-to-Gpc scales. On smaller, sub-Mpc scales (i.e., on the scales of clusters, groups and galaxies) our theoretical understanding of the growth of structure is less well-founded and at kpc scales it breaks down almost entirely. It is on these scales (kpc-to-Mpc) where dark matter haloes virialize and merge, and where baryons decouple, collapse and eventually form complex structures such as galaxies. The kpc-to-Mpc range is therefore *the* key scale over which the baryons and baryon physics become critical to our understanding of the structures we see.

The Galaxy And Mass Assembly (GAMA) project aims to establish a definitive low-redshift survey of galaxies capable of testing CDM and the semi-analytic extensions that model the formation and evolution of galaxies over the kpc-Mpc regime. That is the focus of the three top-level science goals listed in the abstract. Here, we highlight GAMA's capability at the lower end of the above scale regime to provide a comprehensive survey of the internal stellar structures of low-redshift galaxies.

GAMA will bring together high-resolution imaging in u–i from VST, in Y–K from VISTA and spectroscopy from AAOmega, as well as HI and far-IR data, for ∼250 000 galaxies over 200 deg^2. The limiting factor is obviously the spectroscopy which sets the scope of the survey. The spectroscopic survey's selection function is preliminarily defined as $r < 19.8$, or $K_{AB} < 18.9$ with $r < 20.5$. Recently, the GAMA project has been granted 66 nights with AAOmega on the Anglo-Australian Telescope, which should under reasonable conditions allow half the target spectra to be obtained. We initially aim at 50 deg^2 at the full target density with 100 deg^2 at a reduced magnitude limit. The

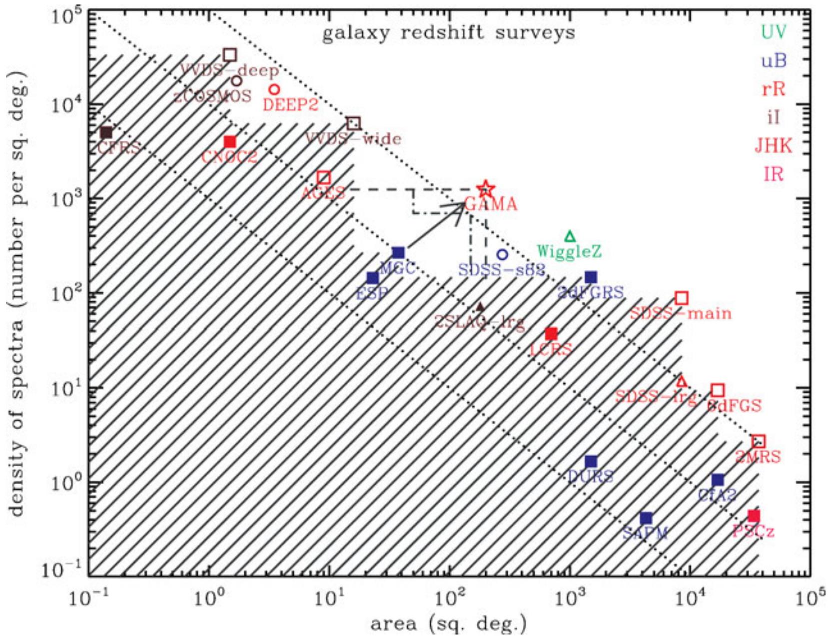

Figure 1. Comparison between galaxy redshift surveys: *squares* represent predominantly magnitude-limited surveys; *circles* represent surveys involving colour cuts for photometric redshift selection; while *triangles* represent highly targeted surveys. Filled symbols show completed surveys and the grey region shows the parameter space covered by magnitude-limited surveys. GAMA, shown by a *star*, cuts significantly into new parameter space. (The dash-and-dotted line represents the 3-year aim.) Surveys are colour coded according to selection wavelength. See www.astro.livjm.ac.uk/∼ikb/research/galaxy-redshift-surveys.html for more details.

spectral resolution used will be ∼1300 (over 370–880 nm) allowing for velocity measurements with better than $50\,\mathrm{km\,s^{-1}}$ accuracy. Apart from redshifts the spectra will also yield classifications, stellar mass and age estimates, and reveal type 2 AGN.

Figure 1 shows a comparison between redshift surveys in terms of depth (defined using target density) versus area. GAMA builds a vital bridge between the shallow but large SDSS, and the deep but narrow VVDS-type surveys.

The imaging data will be of sufficient resolution and S/N to allow the bulge-disk decomposition of the majority of our spectroscopic sample. Hence we expect to obtain high-quality measurements of structural parameters of the bulges and disks of ∼200 000 galaxies in u–K. These will be used for a number of statistical studies on the properties of bulges, including:

• A comprehensive determination of the bulge luminosity and stellar mass functions as a function of redshift (to $z \approx 0.4$), environment, and B/T. The joint r and K selection probes total stellar masses of galaxies down to near $10^7 \mathcal{M}_\odot$ at $z \geqslant 0.008$.

• Bulge demographics: a determination of the frequencies of red, high-Sérsic index (classical?) bulges and blue, low-Sérsic index (pseudo?) bulges, as a function of B/T and the properties of the disk which they 'inhabit'.

• A measurement of the colour gradients of bulges (using the multi-wavelength bulge-disk decompositions), again as a function of disk properties and redshift.

• A measurement of the joint stellar mass–size distribution of bulges, pseudo-bulges (and disks).