David W. Hogg / The growth of galaxies by merging — project summary

I propose to measure the growth rate of galaxies by merging and accretion. I will also measure the mass spectrum of mergers as a function of *(a)* the physical properties of the primary, including mass, kinematic state (bulge- or disk-dominated), and star-formation rate, *(b)* the primary's environmental density and position within its gravitationally bound group or cluster, and *(c)* cosmic time. I expect to find that the mass accretion rate is a strong function of all these. I will use my results to test physical cosmogonic models for the growth of structure and the formation of galaxies; there are now several numerical techniques that have high enough resolution in large enough boxes to make quantitative predictions for some of these measurements.

Measurements of the galaxy–galaxy merger rate can be made by a number of means. I propose to undertake a comprehensive study; I will measure the merger rate by the abundances of *(a)* pairs of galaxies with small proper separations, the abundances of *(b)* starburst and post-starburst galaxies, and the abundances of *(c)* morphological features such as tidal tails and shells. Inter-comparison of these measurements will put constraints on, *eg*, the length of time tidal features remain visible, the kinds of mass ratios that produce visible shells, and the probability that a starburst is triggered as a function of merger properties.

The morphological method of identifying mergers—in many ways the least reliable, but the most frequently used, given data sets available at the present day—requires the assembly of a statistically clean set of nearby galaxies with high-quality imaging presented uniformly and in a manner that is amenable to comparison with higher redshift observations. I will create a digital, multi-wavelength, statistically complete atlas of galaxies, producing electronic images, a printed book, digital files with calibrated data, and an open-source code-base.

Intellectual merit — The cosmogonic scenario of gravitational growth of structure in a cosmological-constant dominated universe with plenty of cold dark matter (ΛCDM) is now extremely well-tested (by, *eg*, cosmic microwave background and galaxy–galaxy clustering measurements) on scales larger than a few Mpc. The mass assembly history of galaxies provides the first testing ground with both precise measurements and precise predictions for ΛCDM on smaller scales. More generally, if we are to understand our place in the Universe, we must understand the formation of galaxies like the Milky Way and the Milky Way itself. This formation process is fundamentally one of merging and accretion.

Broader impacts — I will produce a new galaxy atlas, filled with beautiful and information-packed images, superior to all existing galaxy atlases in wavelength coverage, dynamic range, physical and angular resolution, selection function, and associated physical data.

The atlas will impact research and education at every level; its statistical uniformity will make it a quantitative research tool, its high-resolution, multi-wavelength underlying data will make it an essential educational and research tool at the graduate level, its detailed and uniform true-color and informative-color visualizations will make it an unequalled educational tool at the undergraduate and high-school level, and its beauty and scientific authenticity will make it irresistable to amateur astronomers, science buffs, and geeks of all ages. Furthermore, the associated on-line content, digital data archives, and open-source software (with which all the images will have been created) will provide the curious and self-motivated with a playground for data analysis, visualization, and discovery, with our archived data and, in many cases, their own home-taken data.