# Constraining the Evolutionary Mass Function and Star-Formation Activity in Galaxies from the Spizer Wide-Area Infrared Extragalactic Survey (SWIRE)

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**Abstract.** The Wide-area Infrared Extragalactic (SWIRE) survey is a *Legacy* Program of the *Spizer Space Telescope (SST)* exploiting 851 hours of observatory time to conduct a set of large-area (currently foreseen $\sim$ 49 square degrees split into 6 high Galactic latitude fields) imaging surveys, achieving $5\sigma$ sensitivities of 4.3/6.5/33/36 $\mu$Jy at 3.6/4.5/5.8/8.0 $\mu$m with IRAC and 0.19/15/40 mJy at 24/70/160 $\mu$m with MIPS. SWIRE will allow studying evolved galaxies (from IRAC data) and actively star-forming galaxies and quasars (from MIPS) over co-moving scales up to several hundreds Mpc and down to substantial cosmological depths ($z \simeq 2.5$ for luminous sources). Thanks to the large total survey area, SWIRE will provide a complement to smaller and deeper observations in the Spitzer Guaranteed Time and the Legacy Program, by allowing direct comparison of local and high-z galaxy samples and the investigation of the effects of environment on galaxy evolution.

## 1 Introduction

There have been reported indications that galaxy evolution might depend on the environment, in particular that it might have been faster in cosmic time within high density condensations (galaxy clusters) than in the field (e.g. Treu et al. 2000, also Stanford et al. 1998, Franceschini et al. 1998). Indeed, old red galaxies appear to cluster much more strongly than the younger blue galaxy population. Furthermore, some discrepant published results on the high-z galaxy redshift distributions and cosmological evolution based on deep surveys in different sky regions are interpreted as due to cosmic variance affecting the typically small survey areas. So any conclusions based on deep investigations of small fields have to be considered as tentative until they are proven in representative cosmic volumes.

It is also clear that any self-consistent picture of galaxy formation has not only to account for the evolution with cosmic time of the volume emissivity and luminosity functions of young stars in galaxies, as inferred from directly detected stellar light, but it needs also to match the evolutionary galaxy mass function, which is essentially unaffected by the dust extinction and therefore a particularly robust physical parameter.

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A powerful alternative to the time-expensive spectroscopic investigations for the study of the evolutionary mass function exploits broad-band observations of the spectral intensity of galaxies in the restframe near-IR and its weak dependence on the age of the contributing stars (compared with that of the optical SED). The photometric estimate of the stellar mass in high-redshift galaxies is a particularly attractive approach to recover the history of star formation, in consideration of the relatively simple and fairly well understood underlying physics, as opposed to the extremely more complex and less known physical processes ruling star formation and emission by young stars within dusty media.

The recently launched Spitzer IR Space Telescope is allowing to image with unprecedented sensitivity in the 3−10 $\mu$m spectral domain. This is being achieved with the Infrared Array Camera (IRAC), one of the three Spitzer science instruments, providing simultaneous 5.12×5.12 arcmin images at 3.6, 4.5, 5.8, and 8 $\mu$m, using two InSb and two SiAs 256x256 detector arrays. The availability of data in this region of the e.m. spectrum will allow accurate photometric estimates of stellar masses in galaxies to redshifts $z>2$ (Section 3).

At the same time, deep sky probes with the *SST*'s Multiband Imaging Photometer (MIPS) at 24, 70, 160 $\mu$m will detect dust re-radiation from primeval and actively star-forming galaxies and will measure with high accuracy the rate of star-formation in high-z galaxies (Section 4).

The recent December 2003 NASA Press Release (www.spitzer.caltech.edu/ Media/releases/ssc2003-06) has provided in-orbit demonstration of the capability of the observatory to fully accomplish the tasks of deep cosmological survey originally planned. It turns out in particular that the imaging sensitivities in the critical wavebands at 3.6, 4.5 and 24 $\mu$m are significantly better than expected.

The Spizer Wide-Area Infrared Extragalactic Survey (SWIRE), part of the *SST* Legacy Program, will survey the emissions of evolved stellar populations and dust re-radiation from star-forming galaxies with enough cosmic volume and galaxy statistics to cover the whole range from rich galaxy clusters to the cosmic voids.

## 2 The SWIRE Legacy Program

SWIRE, the largest among the six Spitzer Legacy programs, is a wide-area imaging survey designed to trace the evolution of dusty, star-forming galaxies, evolved stellar populations, and active galactic nuclei (AGNs) as a function of environment, from redshifts $z\sim3$ to the current epoch.

SWIRE will provide an unprecedented view of the evolution of galaxies, large-scale structure, and AGNs. The key scientific goals of SWIRE are (1) to determine the evolution of actively star forming and passively evolving galaxies in order to understand the history of galaxy formation in the context of cosmic structure formation; (2) to determine the evolution of the spatial distribution and clustering of evolved galaxies, starbursts, and AGNs in the key redshift range $0.5<z<3$ over which much of cosmic evolution has occurred; and (3) to determine the evolutionary relationship between normal galaxies and AGNs and