The Near-Infrared View of Galaxy Evolution

Andrea Cimatti

INAF - Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125, Firenze, Italy

Abstract. Near-infrared surveys provide one of the best opportunities to investigate the cosmic evolution of galaxies and their mass assembly. We briefly review the main results obtained so far with the K20 and other recent near-IR surveys on the redshift distribution, the evolution of the luminosity function and luminosity density, the nature of old and dusty EROs, the evolution of the galaxy stellar mass function, the properties of the galaxies in the "redshift desert" and the nature of luminous starbursts at $z \sim 2$.

1 Introduction

Despite the detection of objects up to $z \sim 6.5$ and the impressive success of the ΛCDM scenario to account for the properties of the cosmic microwave background, one of the main and still controversial questions remains how and when galaxies assembled their mass as a function of the cosmic time. The hierarchical scenario predicts that galaxies built up their present-day mass through a progressive assembly of smaller sub-systems driven by the merging of dark matter halos.

With ground-based observations, one of the most solid approaches to address the problems of galaxy formation and evolution is to study samples of field faint galaxies selected in the near-infrared, particularly in the K-band (2.2μm) [3,23]. Firstly, since the rest-frame near-IR luminosity is a good tracer of the galaxy stellar mass [5], K-band surveys allow to select galaxies according to their mass up to $z \sim 1.5$ ($\lambda_{rest} \sim 0.9 - 1.0\mu$m). At higher redshifts, the K-band starts to sample the rest-frame optical and UV regions, and space-based observations at $\lambda_{obs} > 2\mu$m are needed to cover the rest-frame near-infrared (e.g. SIRTF, ASTRO-F). Secondly, the similarity of the spectral shapes of different galaxy types in the rest-frame near-IR makes the K-band selection free from strong biases against or in favor of particular classes of galaxies. In contrast, the selection of high-z galaxies in the observed optical bands is more sensitive to the star formation activity than to the stellar mass because it samples the rest-frame UV light and makes optical samples biased against old passive or weakly star-forming galaxies. Last but not least, near-infrared surveys are less affected by dust extinction than optical surveys.

Motivated by the above considerations, several near-infrared surveys have been undertaken during the last decade [12,10,6,18,24,17,15,19] (Fig. 1). Spectroscopic surveys are particularly relevant thanks to their capability not only to derive the redshifts, but also to unveil the nature and the spectral properties

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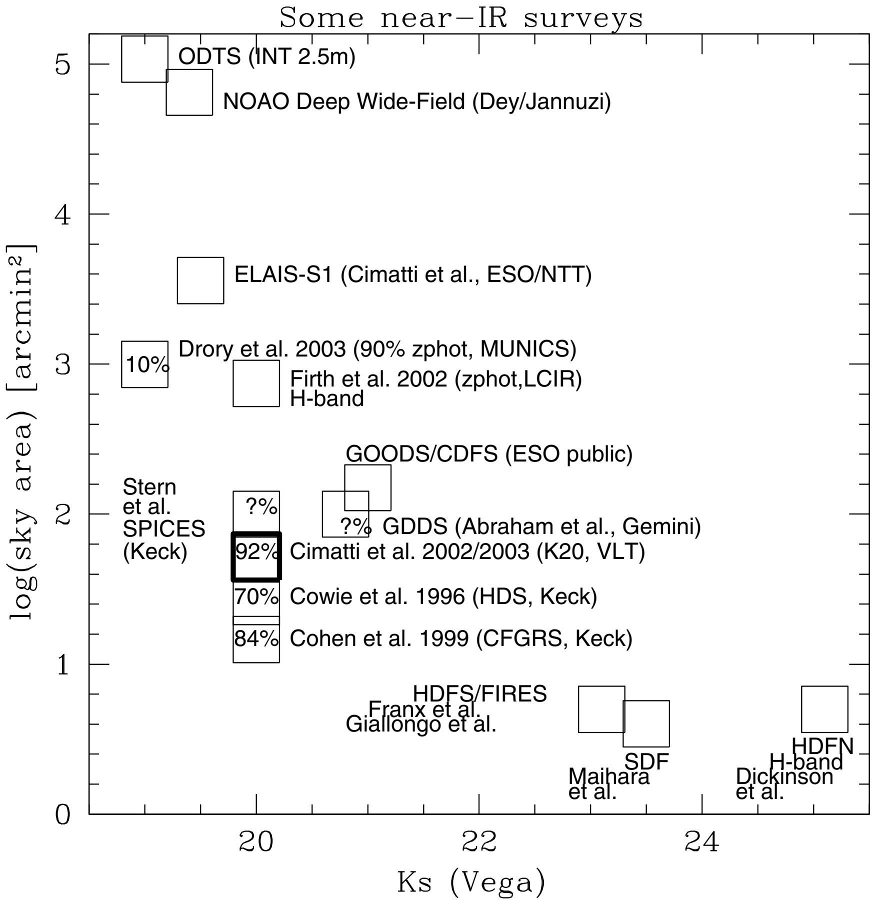

Fig. 1. Some imaging and spectroscopic near-infrared surveys. The redshift completeness is shown for spectroscopic surveys.

of the targeted galaxies. Since near-IR multi-object spectrographs are not fully available on 8-10m-class telescopes, most spectroscopy of K-selected galaxies has been done in the optical. The most crucial probes of massive galaxy evolution are galaxies with the very red colors expected in case of passive evolution at $z > 1$ (e.g. $R - K_s > 5$, usually called Extremely Red Objects, EROs). However, for the typical limiting fluxes of near-IR surveys ($K_s < 20 - 21$), they have very faint optical magnitudes ($R \sim 25 - 26$) already close to the spectroscopic limits of 8-10m-class telescopes. In addition, for $z > 1$ their main spectral features (e.g. the 4000 Å break and H&K absorptions) fall in the very red part of the observed spectra, where the strong OH sky lines and the CCD fringing and low quantum efficiency make spectroscopy even more demanding.