Chapter 1

Introduction

Galaxies host a myriad of astrophysical processes that encompass various physical scales, unfold on different characteristic timescales and whose luminous evidence spread over the full extent of the electromagnetic spectrum. The distribution of energy at different frequencies, or the spectral energy distribution (SED) of a galaxy, holds the key to understanding details of the processes taking place within, and which dominate the luminous output at each wavelength. The SED of a galaxy can be approximated by two main *bumps*: the *stellar* bump, extending from the ultraviolet (UV) to the optical and near-infrared ($\lambda \sim 0.1 - 3\mu$m); and the infrared (IR) bump, encompassing the longer mid-IR and far-IR wavelengths ($\lambda \sim 3-500\mu$m). The stellar bump arises from direct starlight escaping star-forming regions. On the other hand, the IR-bump corresponds mainly to thermal continuum emission from interstellar dust grains heated to temperatures in the range of $T \sim 15 - 1000$ K, depending on the hardness and intensity of the interstellar radiation field, and the size and chemical composition of the dust grains. In normal galaxies, the origin of this thermal emission is typically star formation, where UV photons are absorbed by intervening dust grains and re-radiated at longer wavelengths. However, in galaxies harboring an active galactic nucleus (AGN), star formation is not the sole source of IR emission. A significant fraction of the IR luminosity can also be attributed to dust re-radiated emission arising from regions close to the central AGN, where optical-to-hard-UV photons emitted from the accretion disk abound.

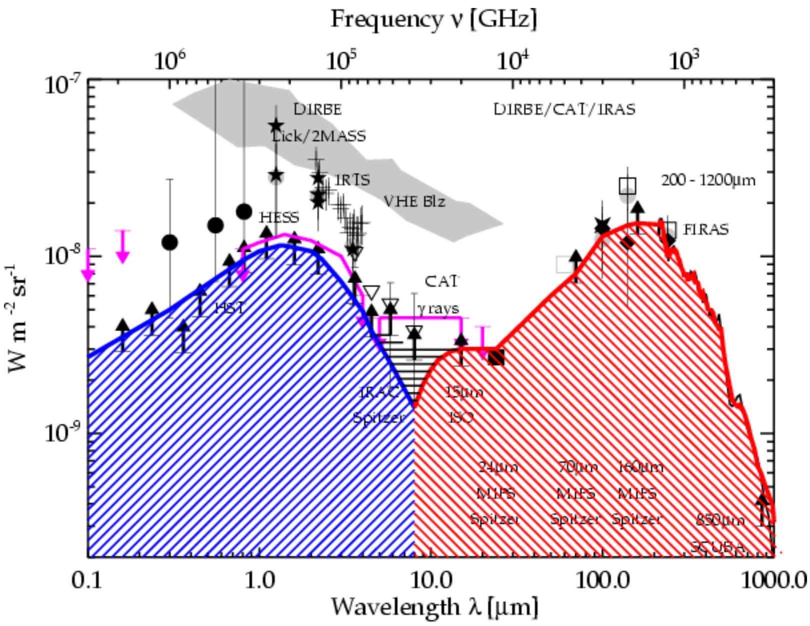

Figure 1.1 Spectral energy distribution of the Extragalactic Background Light (νI_ν vs. λ), taken from Dole et al. (2006). We can directly compare the Cosmic Optical Background (COB; blue hatched region) to the Cosmic Infrared Background (CIB; red hatched region) and see that the CIB accounts for roughly half of the total energy. Half of the extragalactic background light comes from starlight and half comes from dust-reprocessed light.

1.1 The Extragalactic Background Light and the Evolution in IR number counts

The collection of light emitted by all galaxies in the Universe makes up the Extragalactic Background (see Fig. 1.1). The SED of the Extragalactic Background can be divided into the mainly stellar Cosmic Optical Background (COB) and the reprocessed Cosmic Infrared Background (CIB) from dust emission, either from star-forming regions or AGN.

The cryogenic era of the *Spitzer* Telescope has allowed us to impose strict constraints on the IR number counts of the CIB (e.g., Dole et al. 2006 and references therein). Characterizing the different contributions to the Extragalactic Background in terms of number counts, redshift distribution and luminosity functions has been the focus of many recent studies (e.g., Gispert et al. 2000; Le Floc'h et al. 2005; Dole et al. 2006). As can be seen from Fig. 1.1, the CIB accounts for roughly the same amount of energy as the COB. This finding is of paramount significance, as it means that there is as much unobscured radiated emission from galaxies as it is hidden from our view by intervening dust. Therefore, in order to constrain the global stellar budget, we need to consider not only the unobscured star formation, but also constrain how much star formation is responsible for the CIB.

How much of the IR light arises from star formation rather than AGN activity? In other words, how much of the energy enclosed by the CIB accounts for the build-up of super-massive black holes (SMBHs) and how much for the growth of stellar mass? To distinguish these two possible sources of dust emission and quantify the contribution of the CIB to the global star formation rate density (SFRD), it is crucial to constrain the SEDs of the individual IR-luminous sources that comprise the CIB. The outcome is also crucial to developing and testing galaxy formation models that seek to predict the interplay between the growth of SMBHs and the stellar bulk (Croton 2006; Monaco et al. 2007).

Locally the IR output of galaxies represents $\sim 30\%$ of their optical output (Soifer & Neugebauer 1991). Taking this into account, the roughly equal COB and CIB indicates that a shift in galaxy properties must have taken place at higher redshifts towards an enhanced IR emission. That is, to account for the total Extragalactic Background light an evolution in galaxy SEDs is necessary, with enhanced IR emission in the early Universe. Numerous IR studies have shown precisely such an evolution.

Within the local volume the galaxy luminosity function and SFRD is dominated by faint normal galaxies with bolometric luminosities $L_{bol} \lesssim 10^{11}$ $L_{\odot}$, such as the Milky Way (see Fig. 1.2). Galaxies with enhanced IR luminosities – such as Luminous and Ultra-Luminous Infrared Galaxies (LIRGs and ULIRGs with $10^{11} \lesssim L_{IR} \lesssim 10^{12}$ $L_{\odot}$ and $L_{IR} \gtrsim 10^{12}$ $L_{\odot}$, respectively; Sanders & Mirabel 1996) – are locally much less common than fainter galaxies. However, the contribution of these IR-luminous objects to the comoving energy density increases as we go out to higher redshifts, to the point where the contribution from LIRGs overtakes that of galaxies with lower IR luminosities at $z \sim 0.7$. At these intermediate redshifts, the contribution from

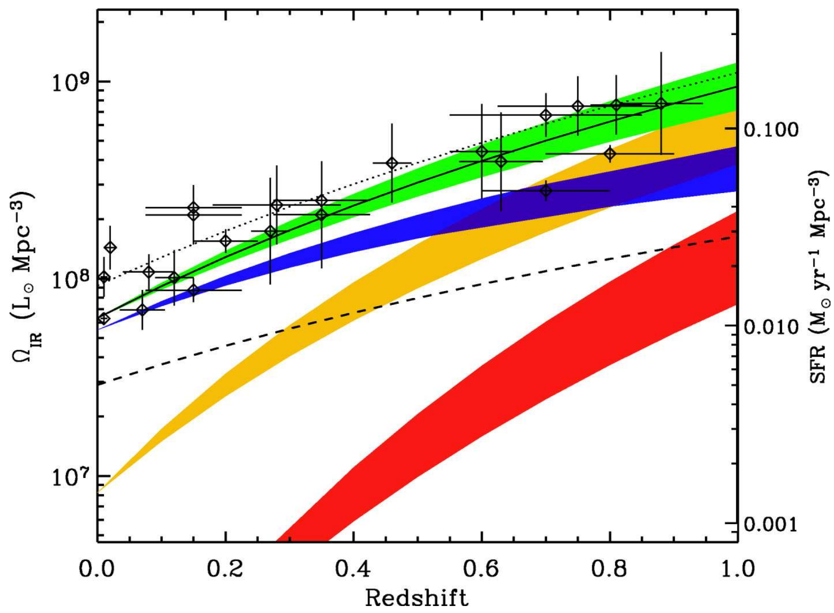

Figure 1.2 Comoving energy density as a function of redshift for galaxies based on IR luminosity, taken from Le Floc'h et al. (2005). The total contribution is denoted by the green curve. Also shown are the respective contributions from low-luminosity galaxies (i.e., $L_{IR} < 10^{11}$ $L_{\odot}$; blue), LIRGs (i.e., $10^{11} \lesssim L_{IR} < 10^{12}$ $L_{\odot}$; yellow), and ULIRGs (i.e., $L_{IR} \gtrsim 10^{12}$ $L_{\odot}$; red). At low redshifts, the comoving IR energy density is dominated by low-luminosity objects. However, the contribution from LIRGs overtakes that of the lower-luminosity galaxies at $z \sim 0.7$. ULIRGs, even though they are rare at these low redshifts, become rapidly important. The trend of their increasing contribution suggests that ULIRGs overtake that of LIRGs at $z \sim 2$ (see also Caputi et al. 2007).

ULIRGs still remains quite modest, though their contribution increments steadily with redshift from $z \sim 0$. Recent work suggests that the contribution of ULIRGs overtakes that of LIRGs at $z \gtrsim 2$ (Caputi et al. 2007). ULIRGs have thus undergone the fastest evolution in the last 8 Gyr, with their number density increasing by a factor of ~ 1000 from $z \sim 0$ to $z \sim 2$ (Chapman et al. 2005). Therefore, even though ULIRGs are quite rare in the local Universe and contribute a negligible fraction to the local SFRD, they have been found to be the major sites of massive star formation and metal production at higher redshifts (Smail et al. 2002).

1.2 Ultra-Luminous Infrared Galaxies at High Redshift: The Submillimeter Population

Most local ULIRGs are dust-enshrouded systems in the late stages of a merger (Sanders & Mirabel 1996; Veilleux et al. 2002) where both AGN and starburst activity coexist (e.g., Risaliti et al. 2006). Even though a range of dust temperatures can be ascribed to the IR bump of these objects, single temperatures of $T \sim 35-50$ K are typically a good fit to the SED at $\lambda \gtrsim 100\mu$m. At redshifts $z \sim 2$, the large IR luminous output is redshifted to longer wavelengths, making the far-IR ($\lambda \sim 70-200\mu$m), submillimeter (submm: $\lambda \sim 200\mu$m-1 mm) and millimeter (mm: $\lambda \sim 1-3$ mm) wavebands favorable regions to detect and study these high-redshift IR-luminous objects. Furthermore, the advantage of seeking sources at these wavebands is that the Rayleigh-Jeans SED is a steeply increasing function of frequency. This so-called *negative K-correction* translates into a flat or even increasing flux density with increasing redshift for a given temperature and luminosity, as we trace rest-frame wavelengths closer to the peak of the IR bump (see also Blain et al. 2002).

In the past two decades, hundreds of galaxies have been identified by submm and mm surveys at $\lambda \sim 850-125\,\mu$m (Smail et al. 1997; Barger, Cowie & Sanders 1999; Eales et al. 1999; Bertoldi et al. 2000; Cowie et al. 2002; Scott et al. 2002; Borys et al. 2003; Webb et al. 2003b; Coppin et al. 2005; Younger et al. 2007). The leading instruments for these discoveries and identifications have been the Submillimeter Common-User Bolometer Array (SCUBA; Holland et al. 1999) on the James Clerk Maxwell Telescope (JCMT)– which first gave these objects the name of *SCUBA galaxies*, the Max-Planck Millimeter Bolometer Array (MAMBO; Kreysa et al. 1998), BOLOCAM at the Caltech Submillimeter Observatory (Glenn et al. 1998) and more recently, the AzTEC camera (G. W. Wilson et al. 2008, in preparation) also on the JCMT. These submm observations preferentially pick out extremely luminous objects with cold dust temperatures, sufficient to boost the far-IR region of the thermal dust SED bump.

These submillimeter galaxies (hereafter, SMGs; see review by Blain et al. 2002) comprise the bulk of the 850μm number counts (Borys et al. 2003; Knudsen et al. 2006) and their discovery rapidly held the promise of characterizing the contribution of individual galaxies to the CIB. However, the submm emission arises from thermal dust continuum emission and as such, the observed featureless spectrum reveals little about the astrophysics of these objects. For this reason, follow-up observations of this galaxy population have since been crucial to determine redshifts, luminosities and understand numerous details on the physical conditions within SMGs.

1.3 A Spectroscopically-Confirmed Sample: Radio-Identified Submillimeter Galaxies

The abundant dust that makes SMGs such prodigious submillimeter emitters, inevitably hampers the detection of rest-frame ultraviolet (UV) and optical emission from these objects. Photometric techniques that have been very successful at picking out large numbers of high-redshift galaxies (Lyman Break Galaxies or LBGs, Steidel et al. 2003; BzK galaxies, Daddi et al. 2004; BX/BM galaxies, Steidel et al. 2004; Distant Red Galaxies or DRGs, Franx et al. 2003) have thus proved ineffectual for SMGs. Despite great luminosities, the fraction of optical emission is quite modest in SMGs, $\sim 1\%$. Therefore, follow-up investigation of this optically-faint population has proved remarkably challenging. Furthermore, the large beam size $\sim 13''$ of the discovery mm and submm images do not offer sufficient angular resolution to pin-point the precise location of SMGs for follow-up observations at other wavelengths. This has hindered the progress in understanding the astrophysical details harbored within these galaxies.

Ultra-deep 1.4 GHz radio surveys with the Very Large Array (VLA) – with a $\sim$1.5$''$ beam-size – have provided the adequate angular resolution to identify radio counterparts to a substantial fraction of SMGs (e.g., Ivison et al. 1998, 2002). In this manner, $\sim 65\%$ of SMGs with $S_{850\mu m} > 5$ mJy are successfully identified with a μJy radio counterpart (see Chapman et al. 2005, hereafter C05, and references therein).

Even with precise radio locations on the sky, high S/N observations of SMGs at shorter wavelengths can remain very difficult, due to the high degree of obscuration present. However, deep near-IR imaging has resulted in the reliable identification of faint optical counterparts (Borys et al. 2004; Frayer et al. 2004; Smail et al. 2004).

With a useful sample of reliable counterparts in hand, the next crucial step in studying SMGs has been the determination of their spectroscopic redshifts. Prior to 2002, only a small number of SMGs actually had spectroscopic redshifts (Ivison et al. 1998, 2000; Barger et al. 1999b; Lilly et al. 1999). With a growing number of submm detections, a large redshift survey was clearly necessary. C05 describe the initiative of such an effort using the blue-sensitive Low-Resolution Imaging Spectrograph (LRIS-B; Oke et al. 1995; McCarthy et al. 1998) on Keck and obtained rest-frame UV redshifts for a large sample of 73 radio-identified SMGs, in the most part by identifying Lyα, and/or other emission and absorption lines. The success of these observations relied upon the surprising strength of the Lyα emission lines detected, considering the optical faintness of the population. These results indicate that Lyα photons can readily escape from SMGs, suggesting that the obscuring dust in these galaxies is not uniformly distributed, but rather clumpy in nature (Neufeld 1991; Chapman et al. 2004). The resulting redshift distribution of the SMG *radio-identified* sample revealed a median redshift of $< z >\sim 2.2$ (C05).

1.3.1 Potential Biases of the Radio-Detected Sample

A strong correlation has been shown to exist between the far-IR and radio emission in local star-forming galaxies (Helou et al. 1985; Condon 1992) and it has been further confirmed to extend to higher redshifts (Garrett 2002; Kovács et al. 2006). This relation appears to arise from an intrinsic connection between two very distinct processes that are ultimately governed by star formation: the far-IR emission is dominated by thermal dust emission arising from regions surrounding young, massive stars, while radio emission appears to be mostly due to the non-thermal synchrotron emission of cosmic rays – accelerated into the interstellar medium by supernova Type II and

Type Ib explosions – as they spiral around galactic-scale magnetic field lines. The fortuitous connection between such distinct mechanisms has been exploited to use deep radio observations as unbiased estimators of star formation of the dust-obscured high-redshift Universe (e.g., Yun et al. 2001). This has become especially useful in approaching the follow-up studies of galaxies detected at submm- and mm-wavebands, including the use of radio-to-submm spectral index technique to estimate redshifts for these objects (Carilli & Yun 1999).

Beyond the radio-identified sample of SMGs – with median flux densities of $< S_{1.4GHz} > \sim 75\mu$Jy – approximately $\sim 30\%$ of SMGs with $S_{850\mu\mathrm{m}} > 5\,\mathrm{mJy}$ remain without evident radio-counterparts at the sensitivity of current radio surveys (C05). To understand the inevitable selection biases we need to consider what objects are not represented within the radio-identified sample.

The lack of a radio counterpart in these SMGs can be attributed to higher redshifts ($z \gg 3$, C05; Younger et al. 2007): though submm observations benefit from negative K-correction, radio observations do not. Therefore, it is expected that with increasing redshift, the radio-to-submm flux ratio of the galaxy progressively decreases until the radio flux falls below the sensitivity of available radio instruments. It has also been suggested that radio-undetected SMGs may lie at similar redshifts as the radio-detected population, but that they have somewhat lower IR luminosities and colder characteristic dust temperatures, a combination which would result in similar observed 850-μm fluxes, but lower (and ultimately, undetectable) radio fluxes (Chapman et al. 2004). It is a priori impossible to distinguish between these two scenarios. The IR bump in the SED of dusty galaxies is thermal in origin, which implies that the observed submm- and radio-fluxes depend on $\mathrm{T}/(1+z)$ and so are affected exactly in the same manner by either increasing the redshift of the object or by reducing the dust temperature.

Despite these selection biases, the radio-identified sample presents a unique opportunity to study SMGs. They provide a large sample of objects with spectroscopically-confirmed redshifts, which are essential to undertake follow-up observations in order to build a steadily growing picture of the intrinsic nature of SMGs: their luminosities, their masses and their powering sources, among others.

1.4 Submillimeter Galaxies: Ultra-Luminous Monsters at High-Redshift

Detailed follow-up observations of SMGs have revealed total IR luminosities of $L_{8-1000\mu m} \gtrsim 10^{12} - 10^{13}$ $L_\odot$ (C05), placing them under the ULIRG luminosity class (Sanders & Mirabel 1996). With substantial stellar masses $M_{stellar} \sim 10^{11}$ $M_\odot$, derived from photometry (Borys et al. 2005) and high SFRs $\gtrsim 100 - 1000$ $M_\odot$ yr^{-1} from optical (C05), near-IR (Swinbank et al. 2004) and X-ray work (Alexander et al. 2005a), SMGs are the likely progenitors of today's most massive galaxies ($L \gg L^*$; Lilly et al. 1999; Smail et al. 2004). As such, they are likely responsible for a large fraction of the stars that we see today.

Central to the study of SMGs is the source of their colossal bolometric luminosities. Deep optical and near-IR imaging has shown that SMGs typically display disturbed morphologies suggestive of merging or interacting systems (Smail et al. 1998, 2004), similar to what is observed in local ULIRGs. These results have prompted the idea that SMGs may be the high-z analogs of these extreme local objects, likely hosting similar astrophysical processes (e.g., C05). Local ULIRGs have been shown to be powered by intense and compact nuclear activity, either starburst in nature or arising from an embedded AGN, though in most instances being a composite of both power engines especially so as luminosity increases. In the case of SMGs, their submm selection suggests that if they are star-forming systems, then with SFRs ~ 1000 $M_\odot yr^{-1}$ they would make a significant contribution to the global SFRD at $z = 2 - 3$ (C05). However, near-IR long-slit spectroscopy of SMGs by Swinbank et al. (2004) shows that these objects often – in $\sim 40\%$ of cases – exhibit broad Hα lines (FWHM $\gtrsim 1000$ km s^{-1}), revealing kinematic evidence of the large gas velocities within the broad-line region of a central AGN. Furthermore, ultra deep X-ray studies using the unique 2-Ms *Chandra* Deep Field-North (CDF-N) Survey suggest that $\sim 28 - 50\%$

host an obscured AGN (Alexander et al. 2005a), albeit under large columns of obscuring material ($N_H \gtrsim 10^{23} - 10^{24}$ cm^{-2}). These results all hint that star formation and AGN activity coexist within many SMGs, implying that we are witnessing the coupled growth of the stellar spheroid and a central SMBH (Alexander et al. 2008a).

With a mean redshift of $< z > \simeq 2.2$, the redshift distribution of radio-identified SMGs coincides with the global peak epoch of quasar activity (C05). The observational evidence connecting individual SMGs and AGNs, plus the coincidence of their redshift distributions strongly suggests that an evolutionary connection exists between these two populations. Such a connection is reminiscent of the merger–ULIRG–quasar evolution scenario first proposed by Sanders et al. (1988). Within this scenario, a merger between two gas-rich galaxies ignites intense star formation, which is initially obscured and likely corresponds to a dust-obscured ULIRG/submm-bright phase. As the central SMBH grows, feedback outflows carve channels through the dust obscuring material until the system becomes visible, entering the optically-bright quasar phase (see also Croton et al. 2006; Chakrabarti et al. 2006).

1.5 Aims of this Thesis

SMGs comprise an enigmatic galaxy population of which we are only now learning some of its detailed astrophysics. Reproducing the space number density of such starbursting monsters ($\sim 10^{-6}$ Mpc^{-3}; C05) at the high redshifts they occupy poses severe constraints to theoretical models of galaxy formation (Granato et al. 2000; Baugh et al. 2005). Attempts to match model predictions to the properties of SMGs have included deviating from the commonly adopted Salpeter initial mass function (IMF; Salpeter 1955) and invoking a top-heavy – in particular a $flat$ – IMF, in order to reconcile the stellar masses and SFRs at $z \sim 2$ with the masses of local massive ellipticals (e.g., Baugh et al. 2005). However, subsequent detailed work in the near-IR and X-ray has unveiled AGN signatures in a significant number of SMGs (Swinbank et al. 2004; Alexander et al. 2005a; Takata et al. 2006). This implies that a fraction of the total luminous output in SMGs may be due to AGN activity. Disentangling the AGN contribution would potentially lead to lower SFRs and lower inferred stellar masses.

It is in the midst of these possibilities that I have undertaken the study of these galaxies. The focus of the research presented in this thesis is to increase our understanding of the detailed astrophysics hosted by SMGs. In particular, to investigate the contribution of AGN activity to the bolometric luminosities of SMGs (Chapters 2-3). We examine AGN signatures in the rest-frame optical spectra of individual SMGs (Chapter 4) and use integral field spectroscopic techniques to resolve for the first time the kpc-scale distribution of ionized gas in order to distinguish the AGN and extended emission regions and to revisit SFRs and dynamical masses uncontaminated by the AGN contribution (Chapter 5).

Near-IR and X-ray observations provide complementary insights into the emitting regions of SMGs and can be very useful at disclosing the presence of an AGN. In the near-IR, rest-frame optical emission lines may reveal kinematics or line ratios typical of ionized gas close to a central AGN. At the high X-ray energies direct continuum emission from hot gas close to an AGN can be detected at very high obscurations. Each of these approaches has its caveats: on the one hand, geometrical effects may hamper near-IR insight to the broad-line region of the AGN by intervening obscuring material; while on the other hand – considering that Alexander et al. (2005a) find that the majority of AGNs in SMGs are heavily obscured, with column densities of $N_H \gtrsim 10^{23}$ cm^{-2} – the presence of Compton-thick AGNs ($N_H \gtrsim 10^{24}$ cm^{-2}) without an X-ray AGN signature remains an important consideration (Alexander et al. 2008b). Furthermore, the number of SMGs with the necessary ultra-deep X-ray observations to reveal the presence of highly obscured AGN remain small ($\simeq 20$; Alexander et al. 2005a).

The presence of AGNs in SMGs suggests that AGN and starburst activity generally coexist within this population. This implies that part of the bolometric luminosity in SMGs may be reflecting SMBH growth rather than stellar buildup (Borys et al. 2005; Alexander et al. 2005a). Alexander et al. (2005a) report X-ray luminosities and spectral indices that suggest that even in the presence of an AGN, only $\lesssim 10\%$ of the far-IR luminosity in SMGs can be attributed to them, supporting the claim that SMGs are dominated by star formation. However, the possibility of a small fraction of luminous, but Compton thick, AGN lurking within the SMG population remains an important consideration to take into account (see Coppin et al. 2008). At this stage, there is clearly uncertainty as to whether star formation or AGN activity is truly responsible for the bulk of the luminosity in the ensemble of the SMG population.

1.5.1 Mid-IR View of SMGs

The mid-IR emission of galaxies provides with a distinct insight that can unveil many astrophysical details of the radiation field harbored within and consequently about the nature of the dust-embedded power engine, be it AGN or star formation activity. With the advent of the *Spitzer* Space Telescope and with the unprecedented sensitivity of the onboard Infrared Spectrograph (IRS), the possibility has been opened to explore the mid-IR region of galaxies at high redshift.

In Chapters 2-3, I present an observing program that we have completed with *Spitzer* IRS to study the mid-IR properties of the largest sample of SMGs to date, with 24 radio-identified SMGs spanning the redshift range of $z \sim 0.6-3.2$. At mid-IR wavebands, emission arising from the dust itself provides an indirect insight into the illumination of the interstellar medium in SMGs and suffers from modest obscuration. It provides access to a number of mid-IR features, including silicate absorption, the emission from Polycyclic Aromatic Hydrocarbons – generally associated with intense star formation– and the warm/hot dust continuum emission – typically enhanced in the presence of an AGN. These features can be used to unveil details on the nature of the dust-enshrouded power engine: in particular, dust obscuration by silicates along the line of sight indicating the spatial extent of the mid-IR emission, the PAH-to-continuum strengths indicating the relative contributions from AGN and starburst activity, and the PAH relative strengths indicating properties of the ambient radiation field.

1.5.2 Long-Slit Near-IR Spectroscopy of SMGs

In Chapter 4 I discuss near-IR observations of five radio-identified SMGs at $z \sim 2$ with the Near-Infrared Spectrograph (NIRSPEC; McLean et al. 1998) on the Keck II Telescope, as part of a continuing program to build a large sample of SMGs with deep rest-frame optical spectroscopy (Swinbank et al. 2004). With these observations, we exploit line diagnostic in the rest-frame optical to: probe for the presence of AGNs through detection of broad emission lines; gauge metal enrichment; and measure offsets between the redshifts of UV and optical emitting gas.

Even with knowledge of the rest-frame UV redshifts from C05, acquiring spectroscopic redshifts for SMGs in the near-IR is extremely important. UV lines are typically subject to offsets that can reach up to $few \times 1000$ km s^{-1} with respect to Hα and molecular CO lines (Greve et al. 2005; Swinbank et al. 2004; Takata et al. 2006) and which arise from galactic outflows and winds that have been found to be significant in SMGs and other high-redshift galaxy populations (Adelberger et al. 2003). Even though these offsets provide valuable information about the winds in SMGs and their effect on potentially enriching the surrounding inter-galactic medium, rest-frame optical lines provide a more accurate redshift for the bulk of the gas in the interstellar medium and for the depth of the potential well of the galaxy.

1.5.3 A Near-IR Integral Field Spectroscopic View of SMGs

The absolute strengths and widths of rest-frame optical lines provide with powerful means of assessing SFRs, dynamical masses and the nature of the energy power sources. However, the presence of an AGN may enhance observed line kinematics, modify line ratios and boost absolute line emission fluxes. Having access only to the integrated flux over the portion of the galaxy that falls within the slit, NIRSPEC spectra face difficulties in disentangling the independent contributions from the AGN component and the star-forming regions, likely leading to incorrect and probable overestimates in SFRs and dynamical masses.

In Chapter 5 I present the integral field observations of Hα emission for three SMGs with the OH-Suppressing Infrared Imaging Spectrograph (OSIRIS; Larkin et al. 2006) on the Keck II Telescope, used in conjunction with Laser-Guide Star Adaptive Optics (LGS-AO; Wizinowich et al. 2006; van Dam et al. 2006). The recent advent of OSIRIS provides a unique opportunity to probe the spatially-resolved two-dimensional spectra of the extended near-IR emission in SMGs, allowing us to discern between compact AGN and extended starburst components. Taking advantage of the kpc-scale spatial resolution we revisit estimates of dynamical mass and SFRs for the SMG population as represented by our sample. These estimates, critical for imposing constraints in current models of galaxy formation, had been in the past inevitably hampered by AGN contamination of emission lines in long-slit spectroscopic studies. Furthermore, we explore the dynamics of gas in the inner galaxy halo to improve our understanding on the internal dynamics of this enigmatic galaxy population.