Challenges in Panchromatic Modelling with
Next Generation Facilities
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Panchromatic modeling of the extremely luminous dust-obscured quasars at the cosmic noon

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Abstract. The massive galaxies and their central supermassive black holes (SMBHs) co-evolution scenario proposes that a gas-rich major merger can trigger the central starburst and feeding the SMBH accretion, and then star formation is eventually quenched by quasar feedback. In this evolutionary sequence, dust-obscured quasars may represent the critical transition phase between starburst and unobscured quasars. Modeling the panchromatic emission of these hidden monsters provides a unique way to explore their physical properties and therefore the co-evolution between SMBHs and their hosts. However, most of modelling methods are not suitable for the extremely luminous systems with obscured Active Galactic Nucleus (AGN) emission. Here we present two case studies of panchromatic modeling of the extremely luminous dust-obscured quasars at the cosmic noon.

Keywords. galaxies: evolution, galaxies: high-redshift, galaxies: active,quasars: general, infrared: galaxies.

1. Introduction

Recently, a new population of luminous, dust-obscured galaxies (Wu *et al.* 2012) has been successfully discovered with a so-called *W1W2*-dropout color-selected method (Eisenhardt *et al.* 2012). Several works have suggested that those dust-obscured quasars may represent a key transition phase during the evolution of massive galaxies, linking starbursts and luminous unobscured quasars (Wu *et al.* 2012, Díaz-Santos *et al.* 2016, Fan *et al.* 2016a, Fan *et al.* 2016b, Fan *et al.* 2017, Fan *et al.* 2018b). Modeling the panchromatic emission of these hidden monsters provides a unique way to explore their physical properties and therefore the co-evolution between SMBHs and their hosts. Here we present two case studies of panchromatic modeling of the extremely luminous dust-obscured quasars at the cosmic noon.

2. Panchromatic modeling

Sample: Our sources studied here are selected from the *WISE* All-Sky Source catalog. The basic idea of sample selection is to search for more heavily obscured galaxies at high redshift ($z > 1.5$), whose W1 (3.4 μm) and W2 (4.6 μm), sampling the rest-frame near-infrared obscuration, are faint or undetected by *WISE*, but whose W3 (12 μm) and W4 (22 μm) emission, tracing the hot dust heated by starbursts and/or AGN, are well

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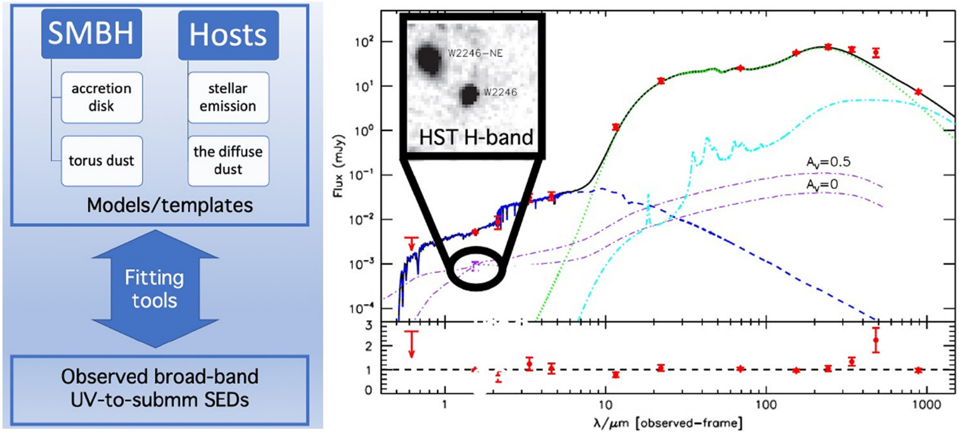

Figure 1. *left:* A schematic description of our basic idea for panchromatic modelling of the extremely dust-obscured quasars at $z \sim 3$. *Right:* An example of UV-to-FIR SED fitting of W2246-0526 at $z = 4.6$ with SED3FIT. The contribution of AGN accretion disk to the H-band has been constrained by the HST F160W image decomposition.

detected with SNR>5. Most of them are extremely luminous dust-obscured quasars at $1 < z < 4$ suggested by UV/optical spectra and X-ray data (Wu *et al.* 2012).

IR SED decomposition (Fan *et al.* 2016a): We select 22 submm-detected dust-obscured quasars with spectroscopic redshift. Their observed IR SEDs have been constructed by combining *WISE*, *Herschel* PACS and SPIRE, *JCMT* SCUBA-2 850 μm data and other available millimeter observations. We use a Bayesian SED analysis approach (Han & Han 2012, Han & Han 2014) to decompose the observed IR SEDs into two components: torus and cold dust. We can compare the different models by using the Bayes factor. One-dimensional and two-dimensional marginalized posterior probability distributions of the model parameters and the derived quantities can be obtained.

An example of UV-to-FIR SED fitting (Fan *et al.* 2018a) We construct the rest-frame UV/optical-to-far-IR SED of W2246-0526, a *WISE*-selected, hyperluminous dust-obscured galaxy at $z = 4.6$. We use the three-component SED-fitting code SEDFIT by (Berta *et al.* 2013). In the right panel of Figure 1, we present the best-fit model SED (solid line), which provides a rather good description of the rest-frame UV/optical-to-far-IR SED. The high spatial resolution HST H-band image of W2246-0526 has been decomposed with a Sérsic + PSF model. The flux of the decomposed PSF component is about six times weaker than the Sérsic component. We assume that the PSF component comes from the scattered AGN emission. AGN contamination has the negligible effect on the stellar mass measurement of W2246-0526.

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