JWST Imaging of J1342

Summarized by Linhua Jiang

Quasar template construction:

Minghao Yue, Yuanhang Ning, Linhua Jiang

Galaxy template construction:

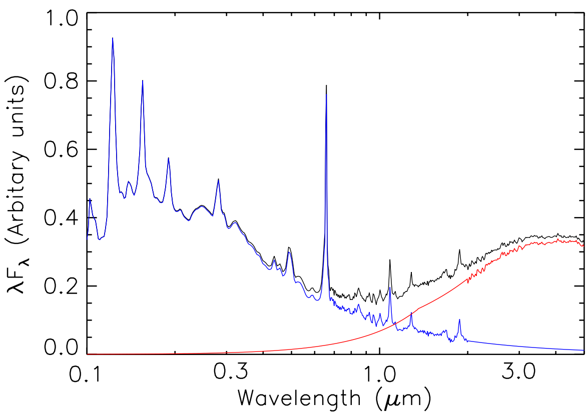
Jiangwei Lyu, George Rieke, Ian McGreer, Linhua Jiang

JWST ETC:

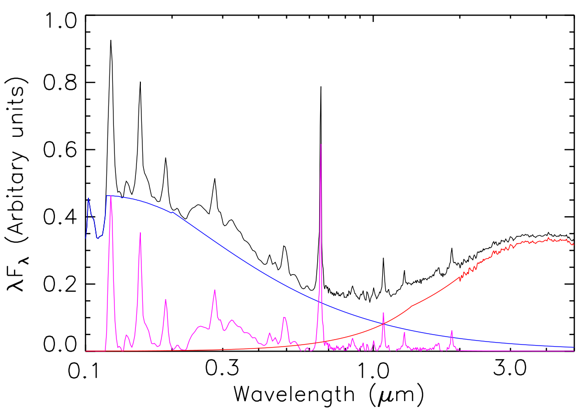
Minghao Yue, Yuanhang Ning, Linhua Jiang

1. Quasar template

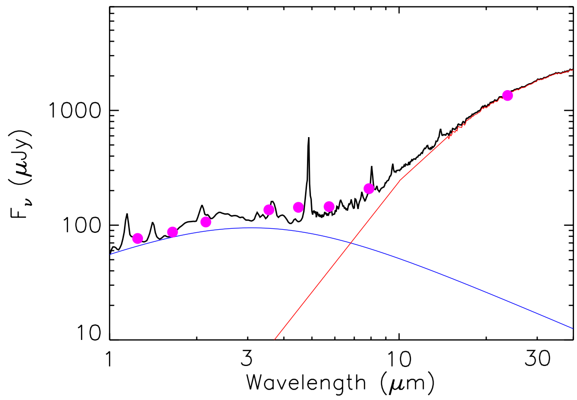
We start with the template of Hernan-Caballero et al. (2016). The paper collected the mid-IR spectra for a large sample of very luminous low-redshift (z~1.5) quasars, and made a template spectrum. In this case, the quasar component completely dominates the spectrum at the rest fame $\lambda < 4$ μm (the wavelength range that we consider), and the host galaxy contribution is negligible. The template (black in the figure on the right) consists of a component from a disk and a BLR (continuum plus lines; blue), and a dust component (mostly hot dust; red).



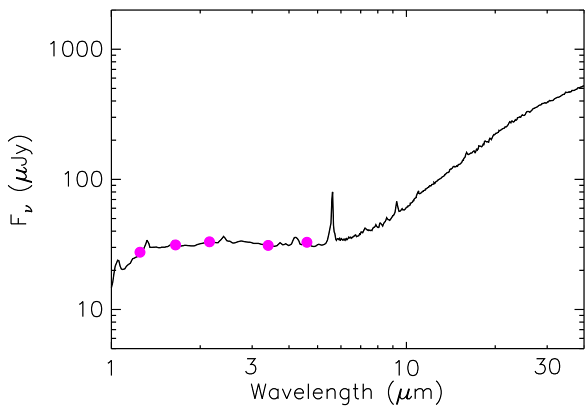
For the disk+BLR component, we separate it to a continuum component (from the disk) and a component of broad emission lines (from the BLR). We use two power-law (actually a double power-law) to describe the continuum (blue in the figure on the right). We then subtract it from the disk+BLR component and get the emission lines (magenta). The red profile is still the dust component. Now we have a quasar template.



We use the template to fit the observed SED (use J1148 at z=6.42 as an example; magenta points; see the figure on the right). The emission lines are scaled to match the observed emission lines (we have its near-IR spectrum). We then simultaneously fit a double power-law (4 parameters), an emission line component (fixed; 0 parameter), and a dust component (1 parameter: normalization). We got very good fitting results, see the figure, black: total spectrum, red: dust, blue: continuum. We did not show emission lines for purpose of clarity.



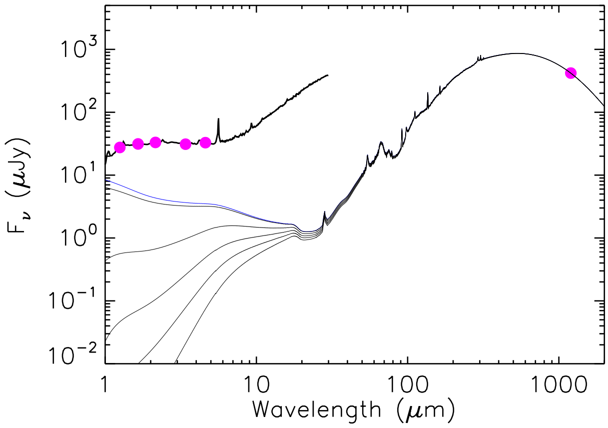
For J1342, unfortunately, there are no data points available to constrain the hot dust component. We make an assumption that its hot dust to optical flux ratio is the same as the ratio of J1148. With this assumption, we can fully constrain the model SED in the wavelength range that we consider. The figure on the right shows the model SED for J1342. We understand that the hot dust abundance can vary a lot, but this will not significantly affect our JWST ETC calculations.

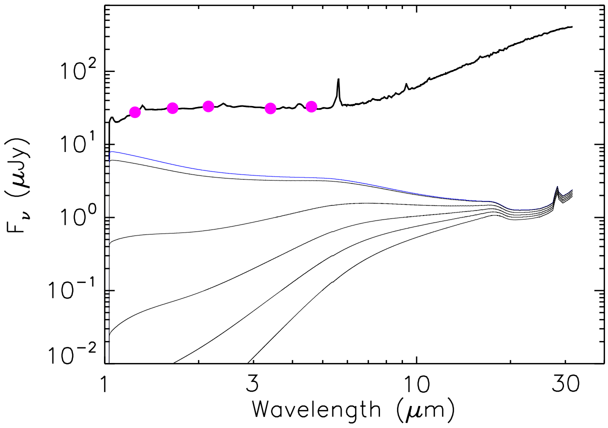


2. Galaxy template

It is not straightforward to construct a host galaxy template for these quasars. Basically, they are starburst galaxies. For example, from submm/mm observations, we know that J1148 has a SFR of ~1000 Msun/year (like other luminous z~6 quasars). Apparently, they suffer from large dust extinction (like starburst galaxies), otherwise their UV emission should be as bright as quasar itself (we have upper limits for J1148 from HST observations).

We start with the template built by Jianwei Lyu and George Rieke, based on the Haro 11 SED. The SED was scaled to match the observe 1.2mm flux (blue SED in the figure below). Then the Calzetti 2000 extinction law was applied to the original SED, so that the rest-frame 4400A (B band) flux is 1/10, 1/30, 1/100, 1/300, and 1/1000 of the quasar flux (five black SEDs in the figure). In the following JWST ETC calculations, we mostly focus on the SEDs that are 1/30 and 1/100 of the quasar flux.





3. JWST ETC

We upload the model SEDs to the JWST ETC website to do calculations (Now we can do it on our computers). Our main purpose is to find the faintest host galaxy that we can detect. Basically, we use different combinations of input parameters and do image decomposition.

- Galaxy parameters. Flux at rest-frame 4400A is 1/30 and 1/100 of the quasar flux. Size: semi-major and semi-minor are [0.3”,0.2”] and [0.1”, 0.06”]. Sersic index n: 0.5 and 2.
- PSF star. In the wavelength range that we consider, SEDs of any stars are very different from quasar SEDs. This is critical, because usage of very wide filters is not recommended (see below).
- Filter choice. We have confirmed that wide filters are not good for host galaxy detection, due to two reasons. PSF shape varies with wavelength, and PSF star SEDs are very different from the quasar SED. So, for NIRCam, we recommend F182M and F210M from SW, and F250M, F335M, F410M, F480M from LW. We don’t recommend any bands bluer than F182M to detect host galaxies. Generally, we need deeper SW images, so it’s good to choose 2 SW bands and 4 LW bands. For MIRI, we only have two choices, F560W and F1130W. I think it’s good enough, because we already reach the peak of the galaxy to quasar ratio.
- Results: Details are from Minghao and Yuanhang.