Seeking the hidden active galactic nucleus by powerful JWST

Chia-Chen Chien[1], Tomotsugu Goto[2], Cossas K.-W. Wu[1], Yu-Wei Lin[1],
Chih-Teng Ling[2], Seong Jin Kim[2], Tetsuya Hashimoto[3], and Po-Ya Wang[1]

Where are they ? JWST will tell us.

[1] *Department of Physics, National Tsing Hua University, 101, Section 2. Kuang-Fu Road, Hsinchu, 30013, Taiwan (R.O.C.)*
[2] *Institute of Astronomy, National Tsing Hua University, 101, Section 2. Kuang-Fu Road, Hsinchu, 30013, Taiwan (R.O.C.)*
[3] *Department of Physics, National Chung Hsing University, 145, Xingda Road, Taichung, 40227, Taiwan (R.O.C.)*

1. About active galactic nucleus

Active galactic nucleus (AGN) is an ultra-luminous region which is at the center of its host galaxy. It has been widely believed that its central engine is driven by the supermassive black hole (SMBH).

Why is AGN important ?

The evolution of galaxy is a crucial part in search of galaxy history. However, the interaction between galaxy and its SMBH remains unsolved problem.

To investigate the co-evolution of galaxy and its center SMBH, it is crucial to search for the properties of AGN and obtain a census on AGN.

How to seek ? Use mid-infrared !

A troublesome problem is that many AGNs are often obscured by dust and gas cloud, missed in UV/optical observations.

Fortunately, the obscured lights are re-emitted in the mid infrared region (Mid-IR). It supplies us a strong, powerful way to find out those obscured AGNs.

Just like playing hide-and-seek with galaxies !
But they are all good gamers…

2. JWST, the game changer

JWST provides us a clear mid-IR observation, which can help us capture AGNs undetected in previous works because of its unprecedented high sensitivity.

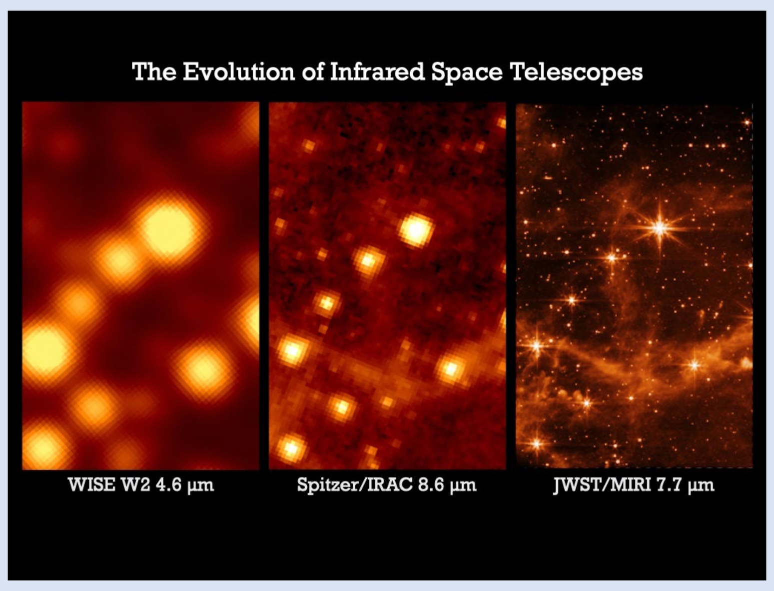


Fig.1 Quick comparison of JWST with others, JWST is approximately 100 deeper than previous infrared telescopes (Wu+23). Source: https://scitechdaily.com/comparing-the-incredible-webb-space-telescope-images-to-other-infrared-observatories/

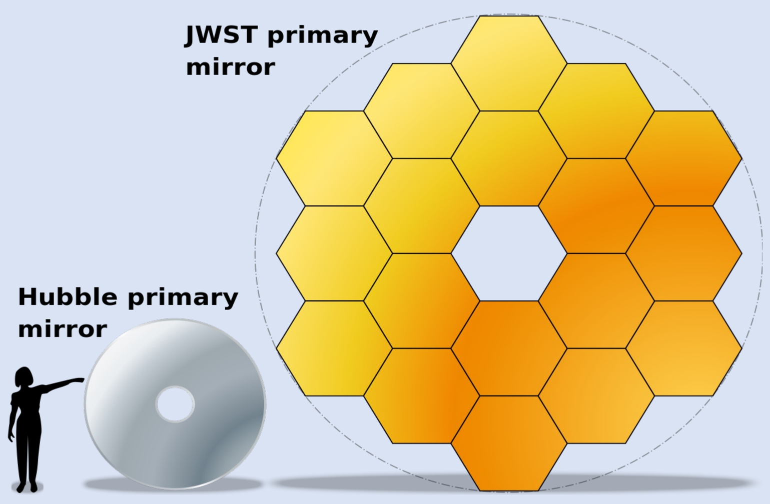


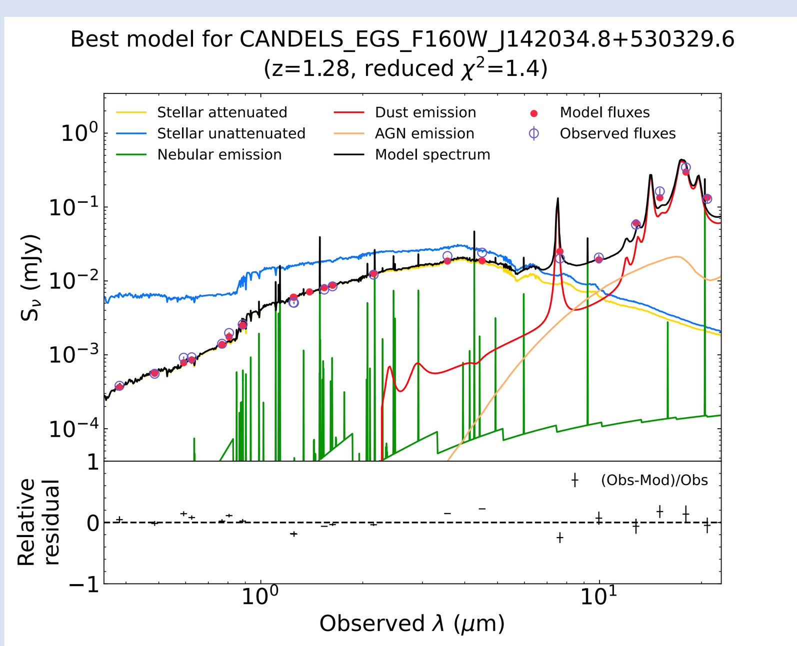
Fig.2 JWST comparison with HST
Source: https://zh.wikipedia.org/zh-tw/File:JWST-HST-primary-mirrors.svg

With comparison, we can clearly realize that JWST has powerful ability to converge more light. Fig.1 is a strong evidence to prove its ability.

We construct a HST-and-JWST-MIRI-based catalog and focus on the 6-bands of JWST-MIRI ($7.7, 10, 12.8, 15, 18, 21\ \mu m$) to investigate the AGNs.

3. SED fitting ➢ CIGALE

To determine our galaxies clearly, we compare the observed spectral energy distribution (SED) with CIGALE SED models. A example of the CIGALE SED model is shown on right-hand side. With its helps, we can quickly distinguish the major difference between AGNs v.s. star forming galaxies (SFGs).



SED fitting ➢ CIGALE

One of the galaxy type is called star forming galaxy (SFG). It has polycyclic aromatic hydrocarbon (PAH) emission in mid-infrared band as well, which is an obstacle for AGN selection. Therefore, CIGALE can help us to separate the galaxy sample more conveniently.

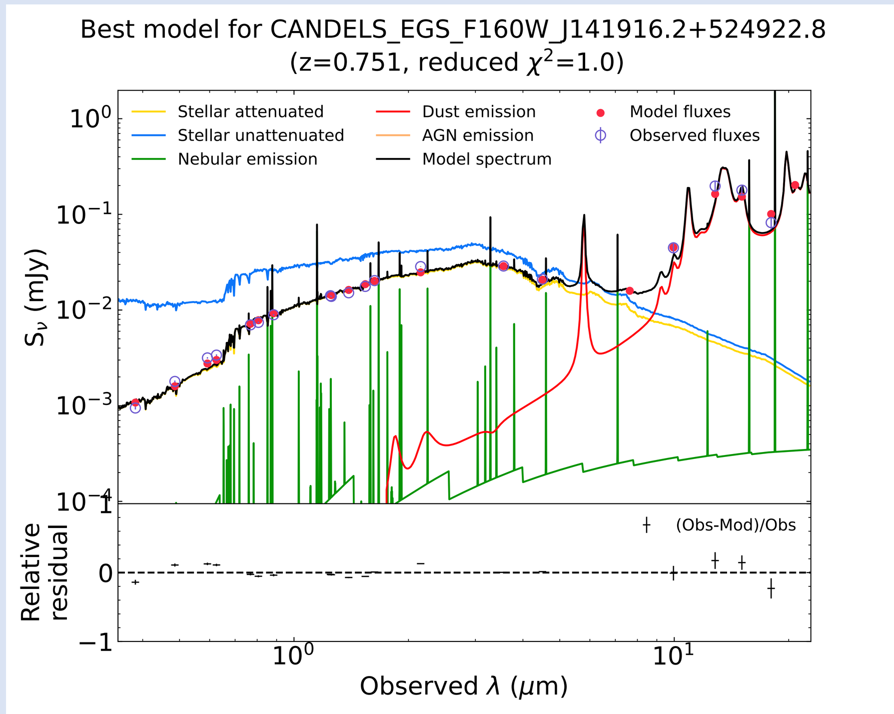


Fig.3 An example for SFG SED.

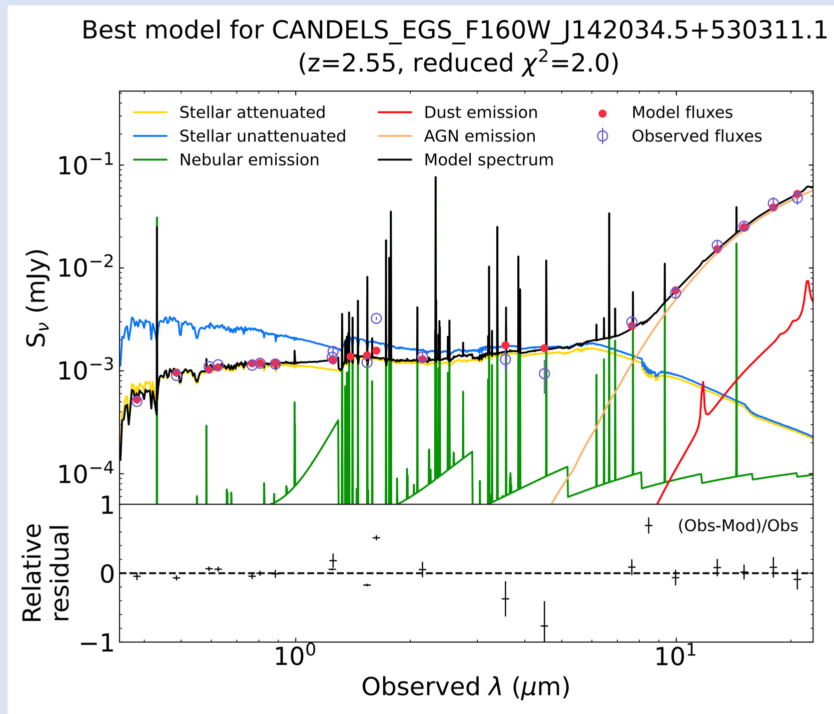


Fig.4 An example for AGN SED

4. Results & conclusions

AGN contribution: $f_{AGN} = \frac{L_{AGN}}{L_{AGN}+L_{dust}}$

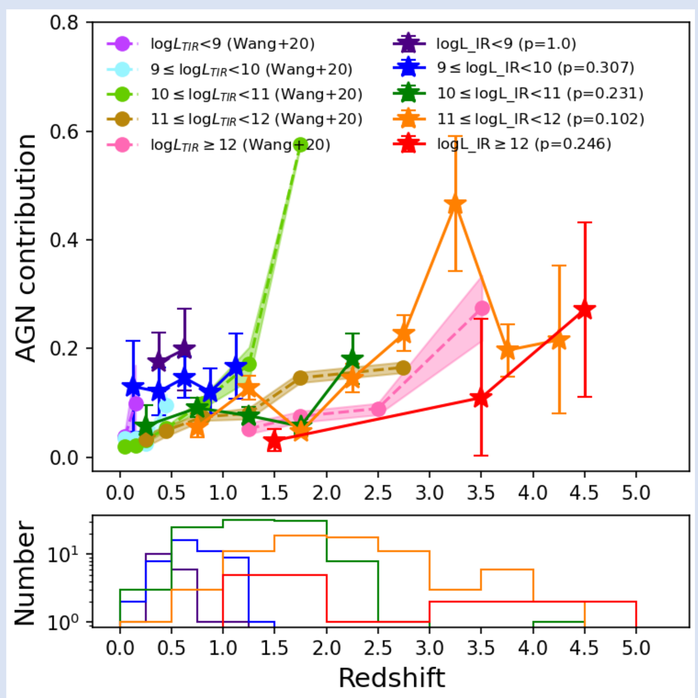


Fig.5 AGN contribution as function of redshift

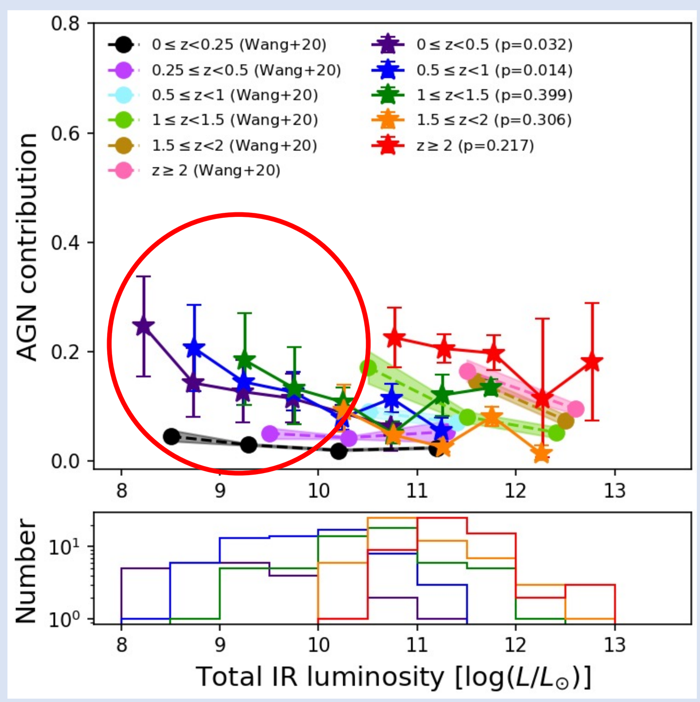


Fig.6 AGN contribution as function of TIR

AGN number fraction: $f_{num} = \frac{N_{AGN}}{N_{total}}$

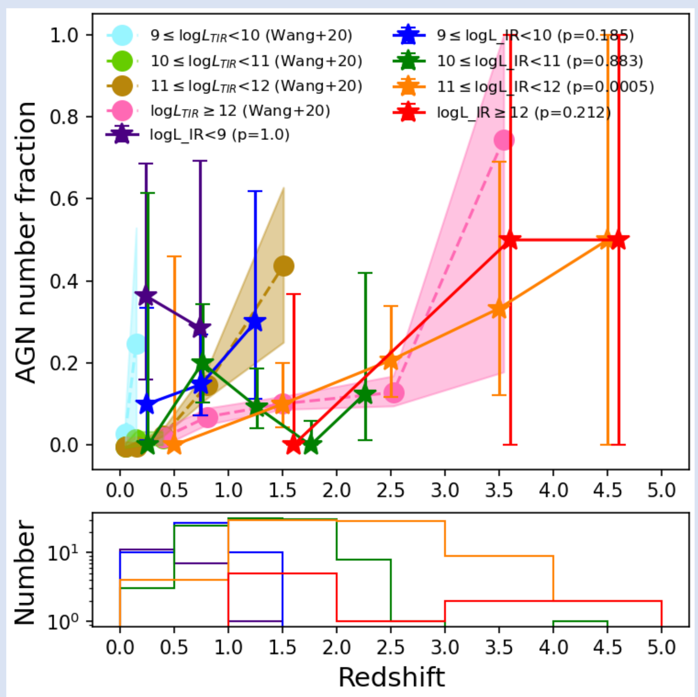


Fig.7 AGN number fraction as function of redshift

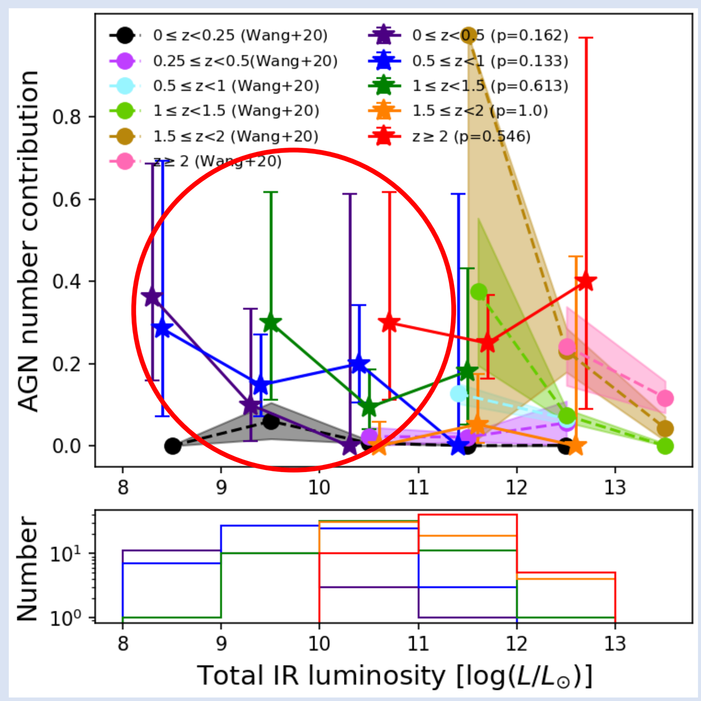


Fig.8 AGN number fraction as function of TIR

We found the trend that luminosity contributed by AGN (called AGN fraction or AGN contribution) become larger as redshift increases (shown in Fig.5), which may infer that AGNs are more active in the high-z Universe. Moreover, our results is consistent with Wang+20.

However, AGN number fraction didn't show such this trend as the result in Wang+20. This result might infer that our sample is not large enough (~573 sources in this work, compared with 1671 sources in Wang+20) to statistically confirm it. Additionally, Fig.6 and Fig.7 shows that our AGNs might have less luminous luminosity (red circle in Fig.6 and Fig7), indicating that JWST captures the fainter AGNs, which is the main goal in this work.

Conclusions:

In this work, we find out 42 candidates ($f_{AGN} \geq 0.2$) and investigate their properties as mentioned above. With the powerful JWST observations, we are able to unearth the fainter galaxies than previous telescopes (e.g., Spitzer).