Buried AGNs in nearby ULIRGs

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Ultraluminous Infrared Galaxies (ULIRGs)

$L(\text{IR}) > 10^{12} L_{\odot}$

Powerful energy source is hidden behind dust

Compact cores (<500pc) are dominant

Very compact starburst or AGN?
AGNs in ULIRGs are buried

AGNs obscured by torus-shaped dust
Detectable via optical spectroscopy

ULIRGs have a large amount of nuclear gas and dust

Buried AGNs are elusive
Infrared 3-4 um spectroscopy

IRCS on Subaru 8.2m telescope

Optically non-Seyfert ULIRGs (LINER,HII-region type)

Methods:

1. Spectral shape (PAH vs dust absorption)

2. Geometry of energy sources and dust
PAHs are excited in starburst PDRs but destroyed near an AGN.

1. 3-4 um spectral shape

- **starburst**
  - 3.3um PAH
  - EW(PAH)~100nm

- **Buried AGN**
  - Featureless
  - 3.4um/3.1um
  - EW(PAH)<<100nm

- **composite**

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**Notes**

- PAH: Polycyclic Aromatic Hydrocarbon
3-4 um

starburst

Buried AGN

AGN/SB composite

IRAS 11095-0238
3.3um PAH

IRAS 08572+3915NW
3.3um PAH (r)

IRAS 00188-0856
3.3um PAH

IRAS 14060+2919
3.3um PAH

IRAS 12127-1412NE
3.05um 3.4um

IRAS 17044+6720
3.3um PAH

Strong PAH

Abs. feature

Low EW(PAH)

Bare 3.4um

Ice 3.1um

Bare 3.4um

Subaru
2. dust/energy-source geometry

(a) starburst

Mixed dust model

\[
\frac{1 - \exp(-\tau_\lambda)}{\tau_\lambda}
\]

Dsut absorption feature: \textit{weak}

\[
\text{Tau}(3.1) < 0.3
\]

\[
\text{Tau}(3.4) < 0.2 \text{ (Imanishi & Maloney 2003 ApJ 588 165)}
\]

(b) Buried AGN

Foreground screen dust model

\[
\exp(-\tau_\lambda)
\]

\textit{strong}
3-4 μm

Starburst

Buried AGN

composite

PAH strong (starburst): Dust absorption weak

PAH weak (AGN): Dust absorption strong
Results

Buried AGN signatures:

17/27 (63%) LINER ULIRGs (statistically complete)

3/13 (23%) HII-region ULIRGs (complete at RA=10-22hr)

Powerful buried AGN fraction: LINER > HII
Our line-of-sight obscuration: Non-Sy >> Sy2

Sy2: Abs weak

Non-Sy: strong

Amount of nuclear dust: Non-Sy >> Sy2
Buried AGNs: both warm/cool FIR colors

pure buried AGN

IRAS 12127–1412NE

F25/F60=0.16 (cool)

NLR

larger dust column

warm

cool FIR color

cool ≠ starburst
Summary

1. Buried AGNs fraction: LINER > HII-region

2. Nuclear dust amount: non-Sy ULIRGs > Sy2 ULIRGs

Optical Sy (non-)detectability depends on the amount of nuclear dust

It is important to understand optically-elusive buried AGNs in ULIRGs.