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The Nature of the Faint Far-Infrared Extragalactic Source Population: Optical/NIR and Radio Follow-up Observations of ISOPHOT Deep-Field Sources using the Keck, Subaru, and VLA Telescopes

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Abstract. We report on optical and near-infrared (NIR) follow-up spectroscopy of faint far-infrared (FIR) sources found in our deep FIR survey by Kawara et al.

1. Introduction

Deep surveys at FIR and submillimeter wavelengths have been carried out in order to investigate the nature of dust-enshrouded galaxies at high redshift. As a contribution to this field, our group made a deep FIR survey using the ISOPHOT camera on board the *Infrared Space Observatory* (ISO) satellite (Kawara et al. 1998; Matsuhara et al. 2000). Mapping at 90μm and 170μm of two $44' \times 44'$ fields in the Lockman Hole (LH_EX and LH_NW), a region exhibiting the lowest H I column density in the sky (Lockman et al. 1986), resulted in the detection of 36 sources with $f_{90} > 150$ mJy and 45 sources with $f_{170} > 150$ mJy. Given the relatively large size of the ISOPHOT beam at 170μm ($\sim 90''$), we have obtained opt/NIR images and spectra using telescopes on Mauna Kea and 6cm radio continuum maps using the VLA (Yun et al. 2002) to identify the most likely source of the 170μm emission. Here we report our initial identifications of the brightest of the ISOPHOT 170μm sources.

2. Results and Discussion

Redshifts of 35 FIR source candidates were determined using optical spectra obtained with ESI on Keck II during three observing runs in 2000 March and 2001 January. Infrared luminosities, $L_{\rm ir}(8 - 1000\mu m)$, were then estimated by using the ISOPHOT fluxes and assuming an SED similar to that of Arp 220. We found one hyperluminous infrared galaxy (HyLIG: $L_{\rm ir} > 10^{13} L_{\odot}$) at $z = 1.6$, 11 ultraluminous infrared galaxies (ULIGs: $L_{\rm ir} > 10^{12} L_{\odot}$) at $0.3 < z < 1$, 12 luminous infrared galaxies (LIGs: $L_{\rm ir} > 10^{11} L_{\odot}$), and 11 galaxies with $L_{\rm ir} <$

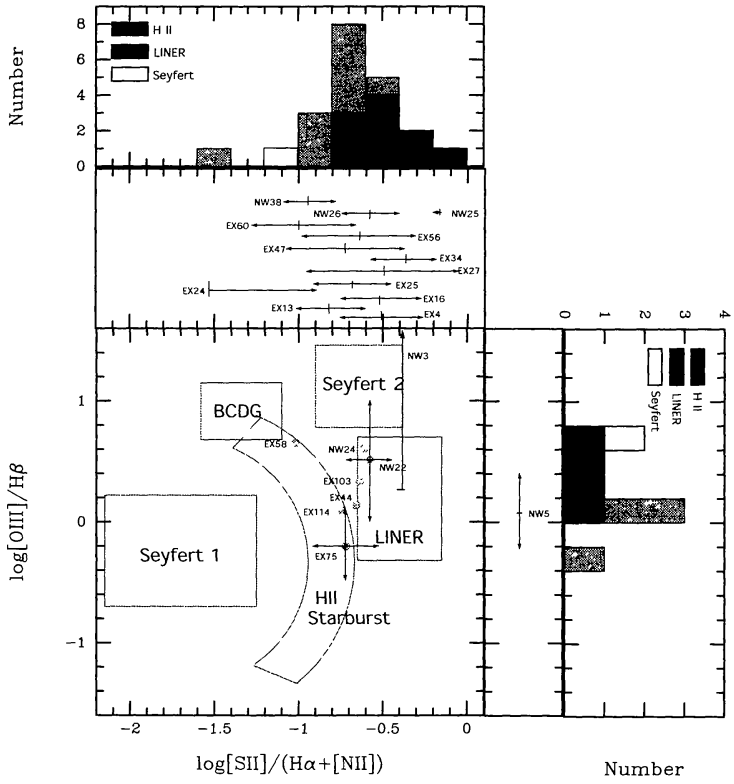

Figure 1. Low-resolution emission line diagostics of ISOPHOT source candidates.

$10^{11}L_{\odot}$. Except for one LIG at $z = 0.365$, all of the galaxies with $L_{\rm ir} < 10^{12}L_{\odot}$) are at $z < 0.3$. The mean redshift for all sources is 0.31 ± 0.31.

The low-resolution ESI spectra were used to determine the optical spectral-type of the candidate ISOPHOT sources. Following procedures used by Murayama & Taniguchi (1998), the spectra were classified into four types – AGNs, LINERs, H II-type, and early-type (without emission lines). The HyLIG at $z = 1.6$ was found to be a quasar. One ULIG had an early-type spectrum and 10 ULIGs are H II galaxies. Among the remaining 23 lower-luminosity sources, there was one early-type galaxy, one Seyfert 2, 10 LINERs and 11 H II galaxies. Thus, based on our low-resolution ESI optical spectra most of the ISOPHOT 175μm sources appear to be powered primarily by star formation, consistent with the conclusion reached from an analysis of ISOPHOT number counts by Matsuhara et al. (2000) that most of the ISOPHOT sources are star-forming galaxies at $z < 1$.

References

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