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A mid-infrared search for primeval galaxies using the Infrared Space Observatory (ISO)

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When and how did galaxies form? This is indeed one of the most important problems in astrophysics. Deep surveys of the universe have been providing us very important information about formation and evolution of galaxies and active galactic nuclei. In particular, near infrared deep surveys are able to trace the rest-frame optical light of high-redshift galaxies and thus are very useful in studying infant phase of the galaxies. The recent success in near infrared deep surveys have urged us to perform deep surveys at mid infrared because such surveys will have a chance to find very high-redshift galaxies as well as unknown reddened populations in the universe.

Motivated by this urgency, we have performed a very deep survey at $7 \mu\text{m}$ using ISOCAM (the infrared camera of ISO). We have made 13.4 hours integration (target dedicated time) of a tiny sky area ($3 \text{ arcmin} \times 3 \text{ arcmin}$) in the Lockman HI hole which is the best sky for any deep survey programs because the HI column density due to HI gas in our Galaxy is the lowest across the whole sky. Our deep survey has reached to the detection limit [$3 \sigma(\text{rms})$] of $10 \mu\text{Jy}$ per beam ($6 \text{ arcsec} \times 6 \text{ arcsec}$), giving rise to the detection of more than 50 sources. Here we describe the nature of $7 \mu\text{m}$ sources above a $5 \sigma_{\text{rms}}$ significance (14 sources). Among them, 13 objects have also been observed in the near infrared (NIR: $\sim 2 \mu\text{m}$). The majority of the $7 \mu\text{m}$ sources (11 objects) have NIR counterparts, which are considered to be galaxies with intermediate redshifts. It is, however, remarkable that two $7 \mu\text{m}$ sources have no NIR counterpart. These objects may be heavily reddened populations which have not been detected by existing optical and NIR deep surveys.