Analysis of AGN selected through variability in the mid-infrared in the GOODS fields

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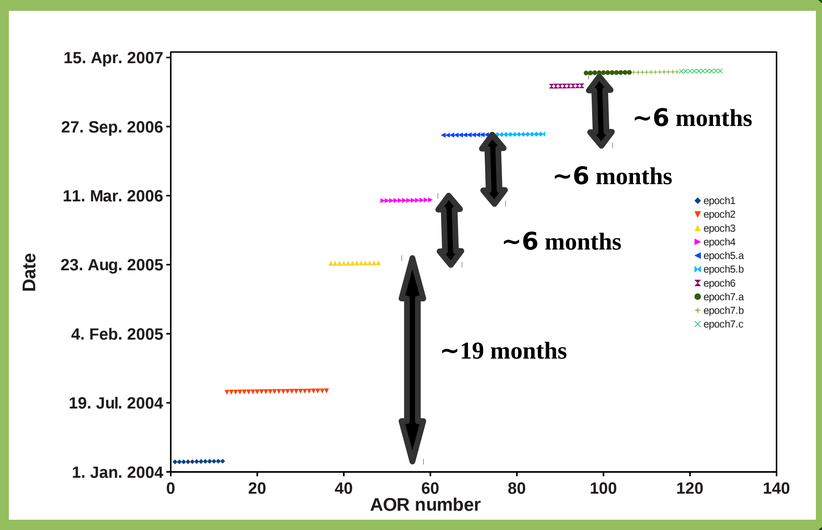
We have carried out a study of the sources presenting mid-infrared (MIR) variability analyzing the data taken in the deepest *Spitzer/MIPS 24 μm* surveys in the GOODS-S and GOODS-N fields. Here we present the results for GOODS-S. Our main goal is to select (possibly obscured) Active Galactic Nuclei (AGN) based on dust emission variability and to analyze their properties. For this purpose, we have used the *Spitzer* Heritage Archive (SHA) and downloaded all available data taken by the MIPS instrument in the GOODS-S region. These data come from different surveys: GOODS, FIDEL, and the Guaranteed Time Observer (GTO) observations. We have divided the dataset in 7 different epochs, with typical time lapses between them of several months. We have constructed stacked mosaics for the data taken in the different epochs, dividing them by depth. Then, we have built source catalogs using PSF fitting methods. By comparing the measured fluxes in different epochs, also taking into account the photometric uncertainties, and visually inspecting all candidates to avoid artifacts, we have constructed a sample of *bona fide* variable sources (with at least 5σ confidence). In GOODS-S, the sample of MIR variable sources is composed of 10 objects. A preliminary analysis of their properties points out to a heterogeneous nature. The candidates include low redshift emission-line galaxies and high-z red and disturbed systems, probably experiencing wet major mergers with significant obscured star formation and/or AGN activity.

1. The data: multi-epoch MIPS 24 μm observations in GOODS-S

We have compiled all the data taken around the GOODS South and North fields with the MIPS instrument at 24 μm by querying the *Spitzer* Heritage Archive (http://sha.ipac.caltech.edu/applications/Spitzer/SHA). These fields were observed by *Spitzer* during several campaigns from January 2003 to March 2007. We have focused our study on a 30x30 arcmin^2 region around RA= 3:32:35.89 and DEC= -27:48:39.49. We have divided these data in different epochs in order to detect variable sources. In this poster, we show the results obtained by comparing epochs 1 and 3, which include observations of a large area carried out with the same exposure time (10 seconds) and depth (80 μJy at 5σ). These data belong to the Guaranteed Time Observer program led by George Rieke. The two epochs are separated by approximately 19 months.

Up to 5 other epochs are also being analyzed, which will allow us to study variability in periods of months and even years. Note also that the GOODS fields have the deepest observations taken by *Spitzer* (through surveys such as GOODS or FIDEL). We have started our study of variable sources by analyzing the data covering the largest area (approx. 30x60 arcmin^2). Next, we will focus on just the GOODS region (around 150 arcmin^2), where ultra-deep data are available and will allow us to probe variability for very faint and/or distant objects.

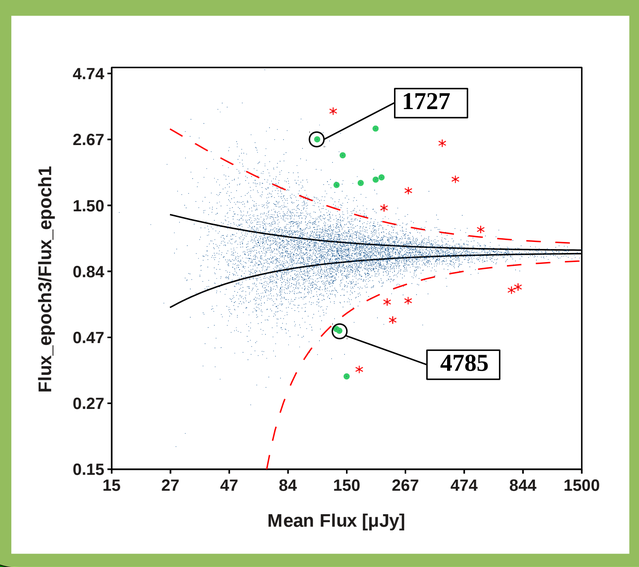


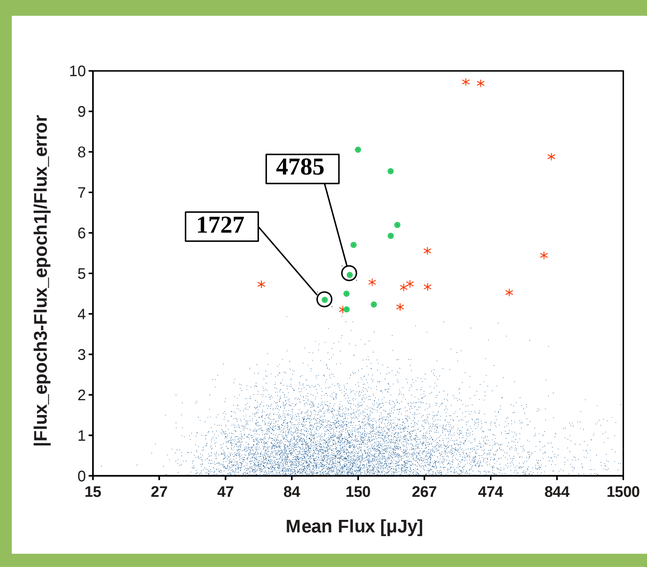
2. Selection of candidates

We have compared the fluxes for the galaxies that appear in the images of both epochs. We have obtained 23 candidates that satisfy the conditions of having at least 5σ confidence and having |Flux_epoch3-Flux_epoch1|/Flux_error > 4 (to take into account the photometric uncertainties). We inspected visually all these candidates and found that 13 of them are not real candidates because they are too close to the edge of at least one of the mosaics, so the photometry is not reliable, or are double objects, so they cannot be resolved individually. These *artificial* candidates are shown with red asterisk in the plots.

The sample of *bona fide* variable sources are shown with green circles in the plots.

The red dashed line indicates the 5σ confidence level.

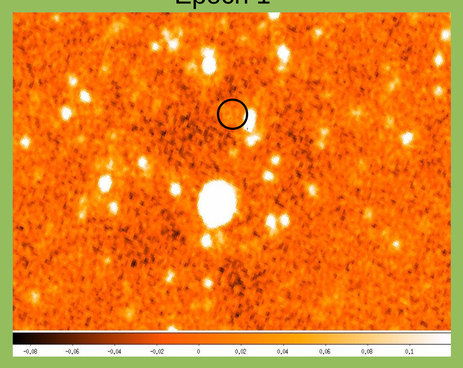




Example of two variable sources

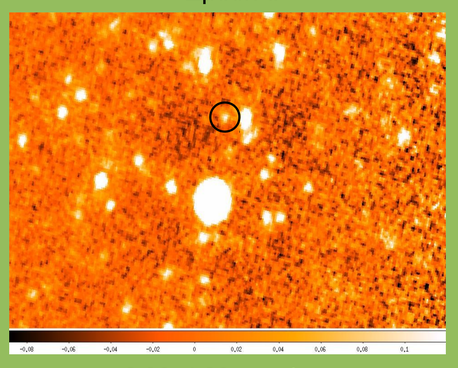
Source 1727

Epoch 1



2.90x4.80 arcmin

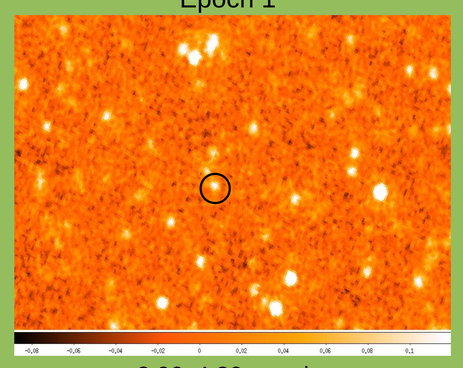
Epoch 3



2.90x4.80 arcmin

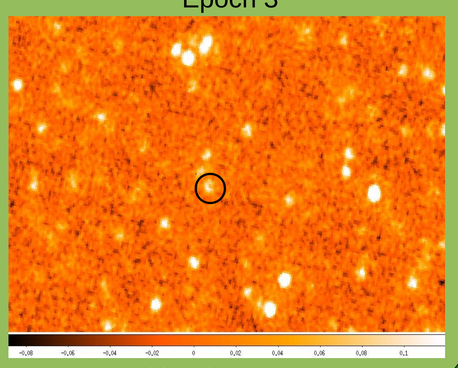
Source 4785

Epoch 1



2.90x4.80 arcmin

Epoch 3



2.90x4.80 arcmin

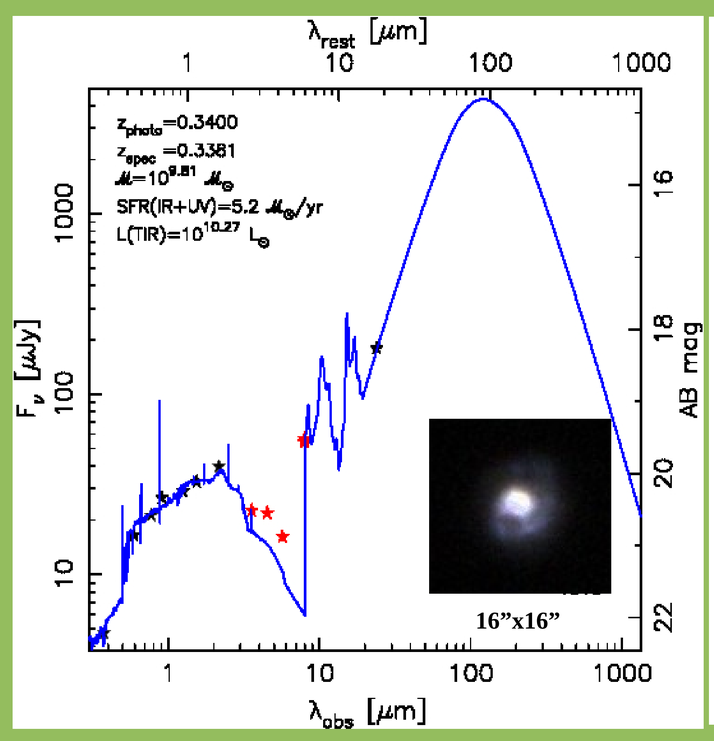
3. Characterization of MIR variable sources

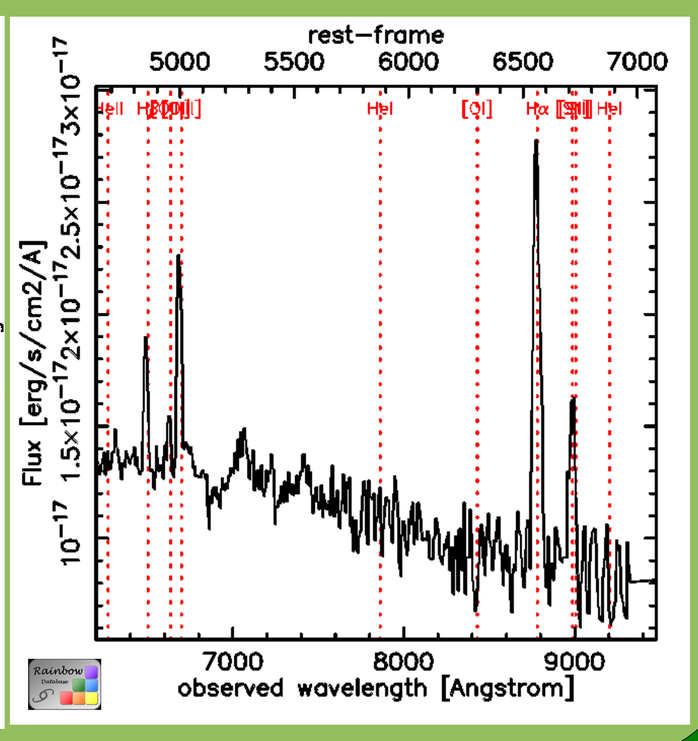
We show one of the selected MIR variable sources. We have searched for their main properties in the Rainbow Cosmological Surveys database in GOODS-S (https://rainbowx.fis.ucm.es, Pérez-González et al. 2005, 2008, Barro et al. 2011ab).

Source MIPS-J033206.57-275038.2 (ID: 4785) is a nearby galaxy (z=0.33381) with moderate mass (M=$10^{9.5}$ $M_\odot$). The HST/ACS RGB image of the source, shows a disturbed galaxy with a very bright emitting knot and a more diffuse halo surrounding it, maybe indicating a merger.

The spectral energy distribution is typical of a spiral galaxy with large amounts of dust emitting in the MIR. If this MIR emission is linked to star formation, the SFR would be approximately 5 $M_\odot$/yr, but the variability points out to the presence of an obscured AGN.

The optical spectrum of the source, obtained by the VVDS (Le Fevre et al. 2005), shows prominent emission lines such as Hα, [OIII], or [SII]. These spectroscopic data were obtained with medium/low resolution, so line widths cannot be measured reliably, but a comparison with similar sources points out to a typical AGN narrow-line region. The line ratios would also indicate the presence of an AGN, according to the position of this sources in a BPT diagram (Baldwin et al 1981).





REFERENCES:Baldwin et al. 1981, PASP 93, 5; Barro et al. 2011, ApJS 193, 13; Le Fevre et al. 2005 AA, 439, 845; Pérez-González et al. 2005, ApJ 630, 82; Pérez-González et al. 2008, ApJ 675, 234; Pérez-González et al. 2011, ApJS 193, 30; Sarajedini et al 2011, ApJ 731,97.