The Herschel Lensing Survey (HLS)
LABOCA Follow Up Observations

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INTRODUCTION

HLS is a large Herschel survey, now completed, targeting 40 massive clusters of galaxies (Egami et al 2010). We obtained deep images with PACS at 100 and 160 µm and SPIRE at 250, 350, and 500 µm. The clusters were selected as the most massive in the ROSAT X-ray all-sky survey. The goal is to use the gravitational lensing phenomenon to go beyond the instruments confusion limit and detect a large number of high redshift sources behind the lensing clusters. For the majority of our target clusters, we have well-constrained accurate mass models based on HST, Keck, and VLT observations.

The HLS is directly coordinated with a few other observing programs. The most important is the Spitzer/IRAC Lensing Survey (PI - Egami, 526 h). In addition, roughly half of the HLS clusters are imaged by HST/WFC3 through two on-going programs (PI - Kneib, 43 orbits; PI - Postman, 524 orbits).

We were also allocated time by ESO and MPI to observe 2 clusters (AC114 and Abell 2667) with APEX/LABOCA and we submitted a large program proposal to extend these observations to the 8 southernmost clusters of our sample. In this poster we present the recent LABOCA observations of A2667. Note that the "Bullet Cluster", also in our sample, was observed with LABOCA by Johansson et al. (2010) and these observations were included in the HLS paper dedicated to this cluster (Rex et al 2010).

FIR SEDs OF OPTICAL-NIR HIGH-z CANDIDATES

We obtained 2x30h of APEX/LABOCA time to observe AC114 and A2667 reaching a noise RMS of ~1.4 mJy with a 22.5" resolution.

Both clusters were studied in the optical-NIR domain based on deep HST and VLT observations, and several high-z candidates were reported by Richard et al. (2006) and Laporte et al. (2010). In A2667, Laporte et al. (2010) found ten z, J and Y drop out objects which are good candidates for redshifts >7.5. For several of them, however, the shape of the optical-NIR SED still allows for a lower redshift solution.

Two of these objects are well detected in the SPIRE bands (z1 and Y5 objects) and one (Y5) is also detected by LABOCA (see Figs. 1 and 2). Our data (Herschel+LABOCA) sample the FIR SED around its peak. They can therefore be used to efficiently constrain the redshifts of the objects. This is illustrated by the figures 1 and 2. We have fitted two kinds of template SEDs to the FIR data, namely the Chary and Elbaz (2010) templates and a simple modified black body template (Blain et al 2003). It appears that for both objects the high redshift solution is difficult to reconcile with any of the templates, while there are reasonably good fits to the low redshift solution. These preliminary results show the power of well sampled FIR SEDs in constraining the redshift.

If the low redshift solution is confirmed (this is only a preliminary analysis of an ongoing study) we would need to understand the nature of these objects and why their SEDs are so unusual in the Optical-NIR. Indeed, Laporte et al found the low redshift solution to be only marginal compared to the high-z solution because of a poor SED fit.

FIR SEDs OF SUBMM SOURCES

In the LABOCA maps we identified bright sources that seem to be relatively faint in the Herschel bands. Two examples are shown in the Figures 3 and 4. For illustration purposes we have fitted the same SED templates as above forcing the redshift to 3 and 6. Interestingly both objects show a similar SED with an apparent lack of emission at 160µm. And for both of them it seems difficult to fit a Chary and Elbaz template at low redshift when taking the upper limits into account.

We note however, that for both of them blending with nearby sources is an issue. We are currently trying to identify the possible optical-NIR counterparts of these objects to study their nature and help the deblending process.

CONCLUSION

We started to analyze 870µm LABOCA observations of two clusters of the HLS survey for which our team has already conducted very deep optical-NIR studies.
The cluster lensing allows us to detect sources beyond the confusion limit.
Combining Spitzer, Herschel and LABOCA data provides us with unprecedented coverage of the FIR SEDs. This allows us to constrain the redshifts of the sources and characterize their properties (LFIR, SFR). We will complete the analysis of the two clusters and we plan to continue submm observations of the other clusters of the sample with LABOCA (LP submitted) and SCUBA-II. We also have an ongoing IRAM large program to map some of the clusters with Plateau de Bure Interferometer (PI-Kneib). These data and their analyzes will allow us to make a significant step forward in our phenomenological knowledge of galaxies and their evolution. These will also constitute a unique database to select interesting targets for ALMA.

REFERENCES

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Richard et al. 2006, A&A, 456, 861

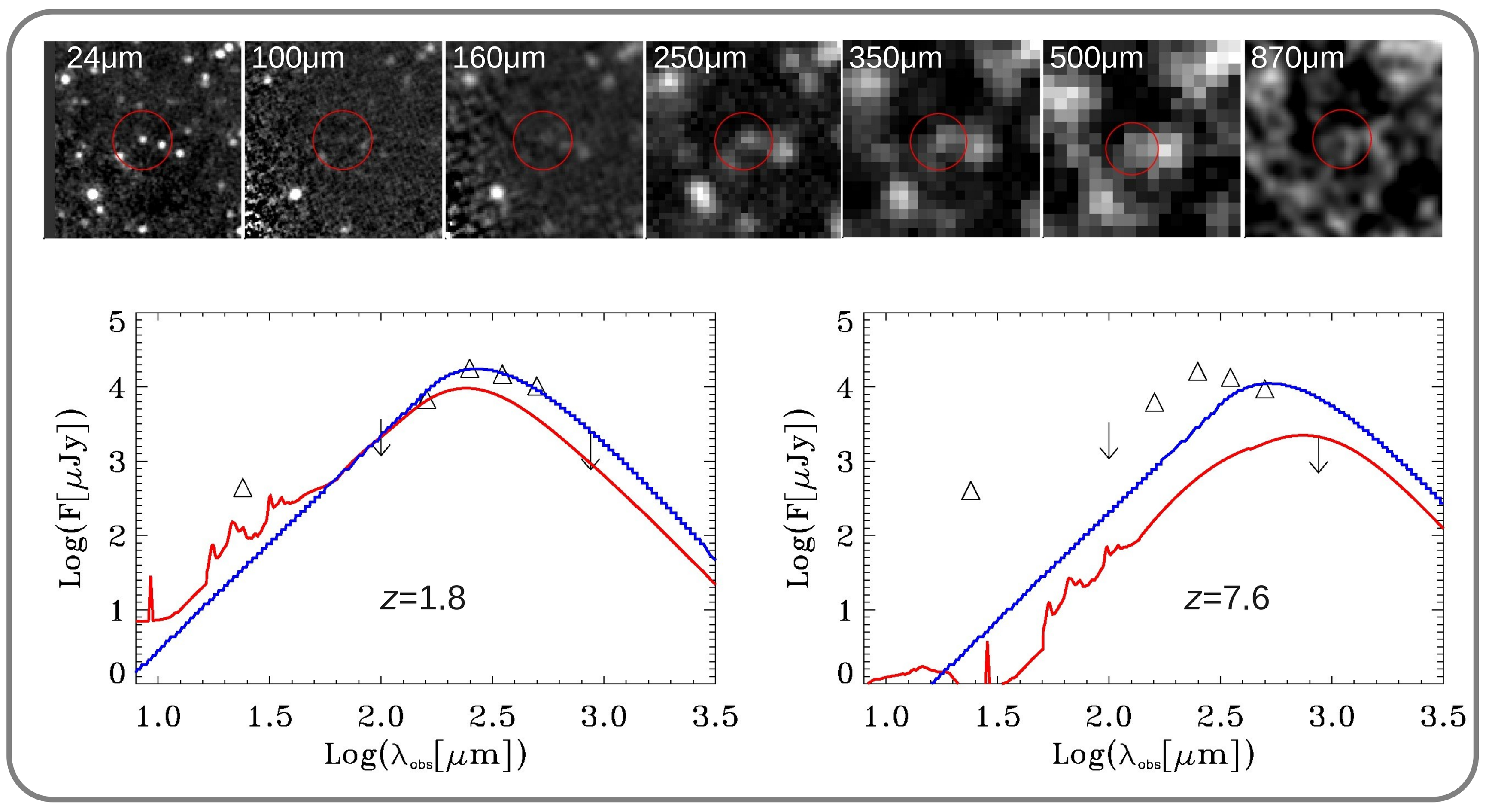

Fig. 1: This figure shows the data related to the object "z1" (Laporte et al 2010) and it illustrates how these data can be used to constrain the redshift of the source. Two kind of templates (the Chary and Elbaz (2001) templates in red and a modified black body in blue) are fitted to the data. The redshift is forced to the low redshift solution (left) and the high redshift solution (right) found by Laporte et al.

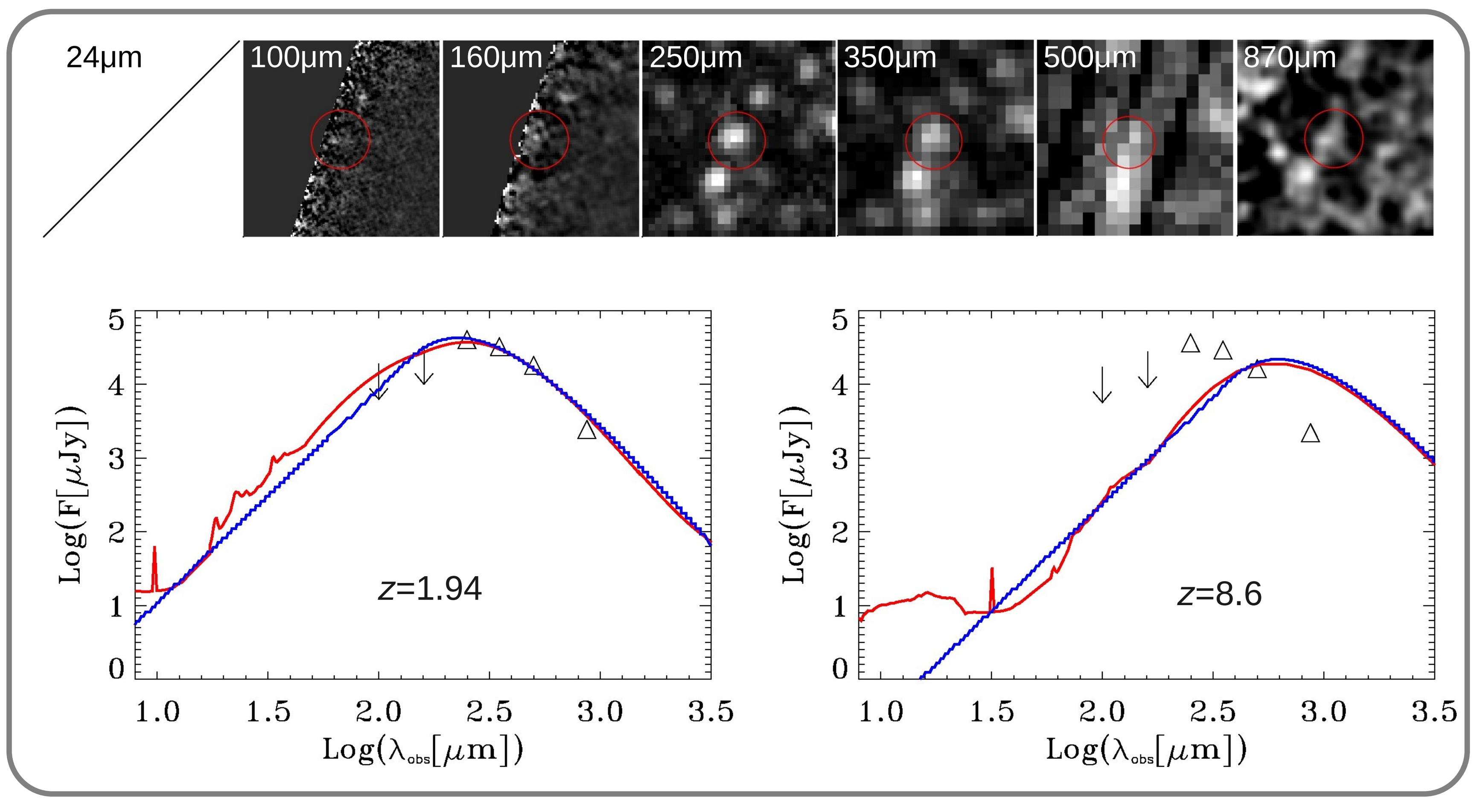

Fig. 2: Same as Fig. 1 but for the object named Y5 by Laporte et al.(2010).

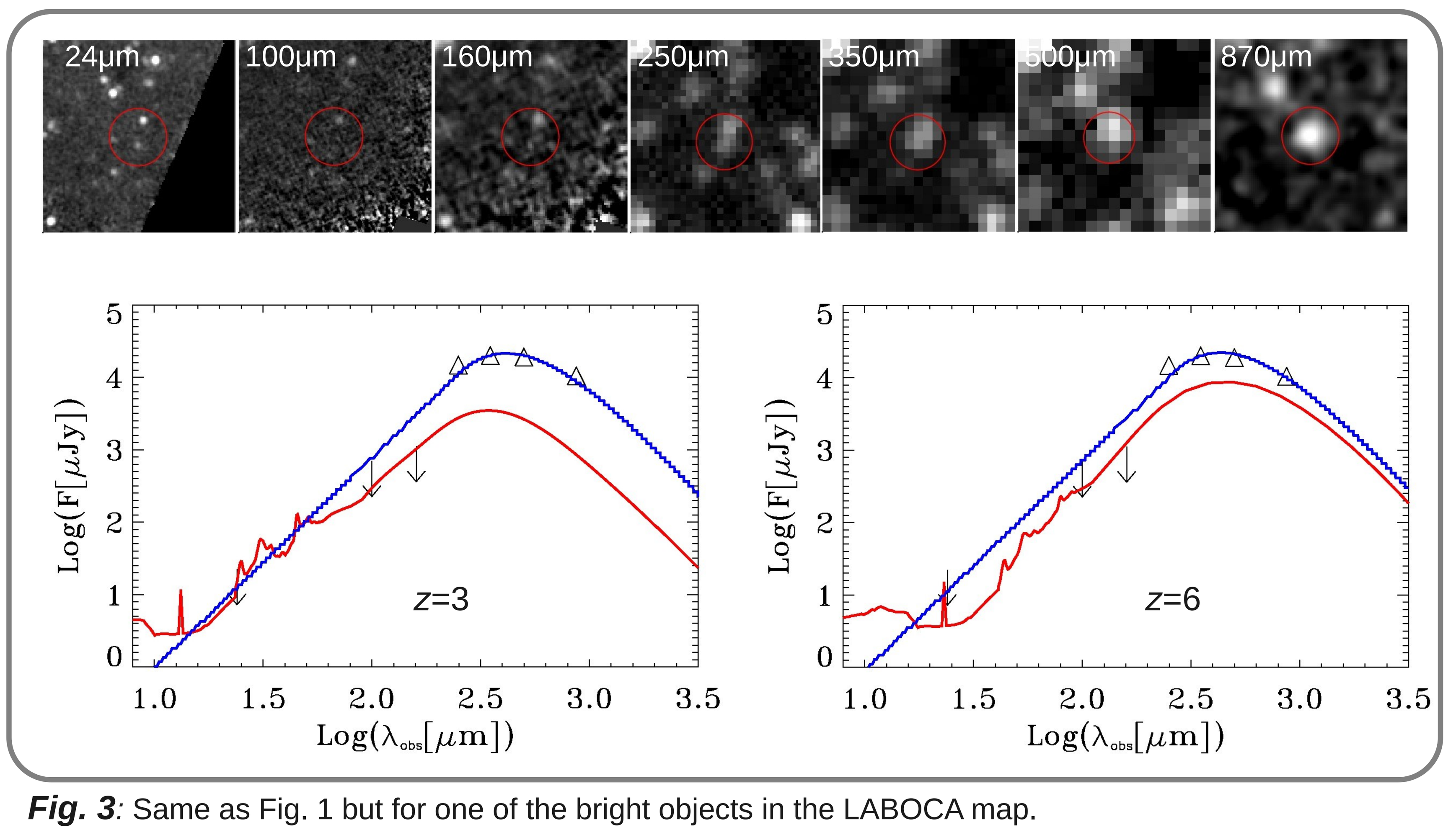

Fig. 3: Same as Fig. 1 but for one of the bright objects in the LABOCA map.

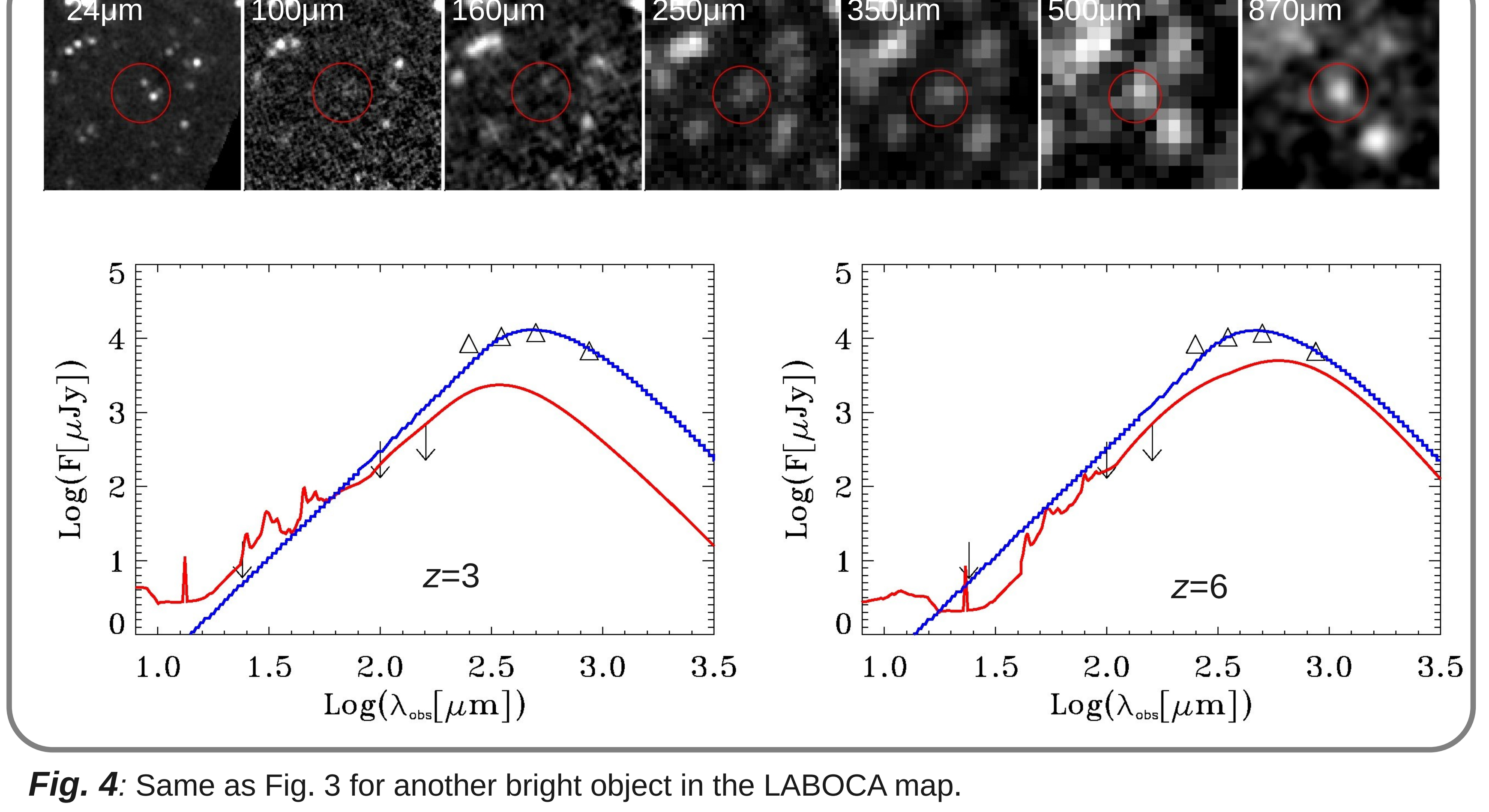

Fig. 4: Same as Fig. 3 for another bright object in the LABOCA map.