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A Method for Obtaining Reliable IRAS-LRS Data via the Groningen IRAS Server

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Abstract. A method for processing IRAS-LRS data via the Groningen IRAS server is presented. This is part of an effort to search for objects with an emission feature at 21 μm from the IRAS data base. Using the GIPSY software, we are able to obtain and to select reliable LRS spectra from the IRAS database. The scientific results have been recently reported elsewhere (Henning, Chan, & Assendorp 1996).

1. Introduction

The Infrared Astronomical Satellite (IRAS) surveyed about 95% of the sky in four broad bands at 12, 25, 60, and 100 μm during a 10-month period in 1983. A Low-Resolution Spectrometer (LRS) was in operation during the mission, observing in parallel with the survey detectors. The LRS is a slitless prism spectrometer which contains five detectors: three short-wavelength (SW) detectors (7.7–13.4 μm) and two long-wavelength (LW) detectors (11–22.6 μm). The LRS aperture has a size of $15' \times 6'$. The LRS spectral elements were produced when the source crossed the $6'$ wide aperture. Since the dispersion direction is the same as the IRAS scanning direction, the output is a convolution of the source structure and the spectra. The projected detector size is $\sim$ 15–18$''$. Spectra for sources smaller than 15$''$ are not affected by the convolution (cf. Assendorp et al. 1995).

To date, we have searched the LRS spectra of all possible IRAS point sources with a 21 μm feature in the IRAS LRS data base. Our search procedure is described in detail by Henning et al. (1996). New spectra with a 21 μm feature were extracted from the IRAS data base using the Groningen IRAS server.

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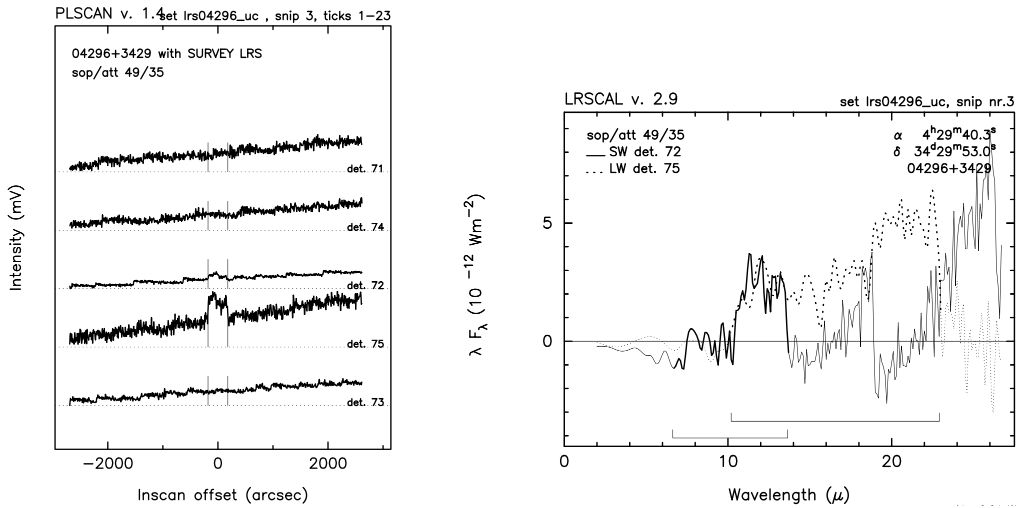

Figure 1. The PLSCAN snip-spectra (left) and the calibrated snip-spectra (right) of IRAS0496+3429 respectively.

2. How to Obtain Reliable IRAS-LRS Data

2.1. GIPSY and IRAS Data Structure

GIPSY (Groningen Image Processing System, van der Hulst et al. 1992) is the main tool for the analysis of the extracted LRS spectra in this study. Raw IRAS data in GIPSY are stored as 4-D data sets (cf. Figure 2 in Assendorp et al. 1995) in IRDS (IRAS Data Structure). The data are ordered in the following way: sample axis; ticks axis; sequence detector number axis (SDET): the detector number in the LRS are 71, 72, 73 (SW) and 74, 75 (LW); snip axis: a snip is part of a scan that has an overlap with a user-selected area of the sky.

Four programs in GIPSY (TRACKS, PLSCAN, LRSCAL, and GDS2TEXT) have to be heavily used for processing the extracted LRS data. TRACKS is for inspecting the trajectory of snips. PLSCAN is used to find out which detectors actually crossed a source, or to make a high-resolution in-scan view of the spatial structure around a source of interest. The outputs are uncalibrated snip-spectra (see Figure 1). LRSCAL is used to calibrate the data and to match the LW and SW regions. The calibrated spectra have only three dimensions, which are wavelength, SDNET, and snip. The outputs are calibrated snip-spectra (see Figure 1) and an average spectrum. GDS2TEXT is used for converting the LRS data from an IRDS format to an one-dimensional ASCII format.

2.2. How to Produce a Good Average Spectrum

Usually, a source is observed in several LRS scans, ranging in number from 1 to 10. Plots of all the individual calibrated snip-spectra, individual PLSCAN snip-spectra, and of the default averaged spectrum of each target source are examined. If the shape of any snip-spectrum is different from the other calibrated snip-spectra, and/or PLSCAN snip-spectra, or if the signal is too weak for the purpose of examination, it is rejected. If all snip-spectra and also all PLSCAN snip-spectra of a target source were consistent with each other, a final averaged spectrum is produced.

2.3. Selection of Candidates with a 21 micron Feature

After all the averaged spectra of objects are made, the final averaged spectrum, the selected snip-spectra and/or the selected PLSCAN snip-spectra are examined again. If a feature appears around 19–21 μm and if the width (FWHM) of the feature is $\sim$3 μm, the LRS spectrum of this object is accepted as a 21 μm feature candidate. Altogether, 16 objects out of 498 sources are selected as sources which may have a 21 μm feature. In order to compare our preliminarily selected candidates with the spectra of objects which are reported to show a 21 μm feature, we also extracted the LRS data of all these sources. Typically, the shapes of all or some of the calibrated snip-spectra and/or PLSCAN snip-spectra of the newly selected sources are similar to those PLSCAN snip-spectra of already reported 21 μm feature objects.

2.4. Final Selection

IRAS survey data images. For all selected objects including those reported in the literature, we have processed the raw IRAS survey data at 12 and 25 μm in order to check whether the objects are extended or if there is evidence for other objects within $6'$. Since IRAS is a scanning instrument, an image should be made by adding adjacent scans into a two-dimensional plane. The baselines of the individual scans are usually not equal, and may have a drift over the extent of the image. In order to have a good image, the IRAS scans must be "destripped." We have done this using the program IMAGE. It turned out that several objects are located in, or at the edge of, extended regions of emission. This means that one should be very careful in interpreting the LRS spectra. Only if the source is much brighter than the background can one reliably determine the global profile and individual spectral features.

Offset LRS spectra processing. Since the LRS is a slitless spectrometer, the wavelength of the spectrum is established by the in-scan positional offset between the source and the spectrometer on the sky. For sources extended in the in-scan direction, the spectrometer projects flux from the extended wings across the wavelength scale, thus smearing positional and wavelength information. Further, the LRS samples the sky every $7''$. In fact, an error in the IRAS position of only $7''$ would result in a spectrum that is shifted by half a spectral element, about 0.2 μm, and at the wavelength extremes of the detectors the quoted flux would be incorrect. In order to investigate whether a different central position may affect the resulting LRS spectrum, we have extracted spectra for all of our samples and the reported 21 μm objects for different central positions in steps of $7''$ in declination up to the major radius of its IRAS error ellipse. After all plots of the individual offset PLSCAN snip-spectra and offset-calibrated snip-spectra were carefully examined, we found that this problem also appears in reported 21 μm objects.

After the above examination and analysis, we finally selected twelve objects as our best new candidates which probably show a 21 μm feature (cf. Figure 8 in Henning et al. 1996), to add to the objects which were already known. We summarize offset spectra processing with these rules of thumb:

- If a feature is real, it is still present or not distorted severely after the offset.
- If a feature is spurious, it disappears after the offset, or is severely distorted.
- When we consider only those sources whose signal falls entirely into the detector, the probability of misinterpreting the existence of a feature is low.
- Following-up observations to confirm a feature are necessary, and will hopefully performed with *ISO*.

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