MULTISPECTRAL ANALYSIS OF IRAS SKY FLUX MAPS

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ABSTRACT. We have tested the performance of principal components analysis and a single-pass clustering algorithm to identify different components of the cosmic dust. Applying these techniques on a training set of 2500 points extracted from the PL51 *IRAS* maps we recognized two main components with temperatures of 180 K and 28 K.

1. INTRODUCTION

Even the first results of the *IRAS* mission (Hauser et al. 1984; Low et al. 1984) revealed a variety of components of different temperatures. The maps of the extended sources are the result of the superposition of radiation coming from these different components, i.e., in the optically thin case we get

$$F(\lambda) = \sum c_j \, B(l, T_j) \qquad \lambda = 12, 25, 60, 100 \, \mu \qquad (1)$$

where $F(\lambda)$, c_j, B, and T_j are the measured flux, the column density, the emissivity, and the temperature of the dust particles, respectively.

2. PRINCIPAL COMPONENTS ANALYSIS

The 12, 25, 60 and 100 μ colors of each pixel of the *IRAS* maps define a point in a four-dimensional parameter space. As an example of our multispectral studies we investigated the *IRAS* field PL51 (RA = 4h; dec = +30°) in more detail. We have extracted by random sampling a training set of 2500 points from the original Sky Flux Maps. Principal components analysis separates the observed data into the linear combinations of the eigen vectors of the correlation matrix of the data. (For further details see Murtagh and Heck 1987.) Factor analysis keeps only those eigen vectors which have eigen values above a certain threshold. Table 1 summarizes the results. The first factor almost fully explains the 25 μ flux which is heavily dominated by the Zodiacal Light. The second factor, in contrast, describes the effect of galactic dust which produces most of the 100 μ emission.

TABLE 1A

eigen value	cum. percent.
2.4818	62.0
1.3910	96.8
.1003	99.3
.0268	100.0

TABLE 1B

variable	1.factor	2.factor
F12	.9637	.2089
F25	.9917	.0458
F60	.3625	.9044
F100	−.0409	.9819

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3. CLUSTER ANALYSIS

The c_j column densities may have some grouping tendencies in color space. We utilize a commonly used method, a single pass clustering algorithm (see Murtagh and Heck 1987). We set $k = 10$ for the number of clusters and performed the algorithm in the space defined by the factors obtained in the previous paragraph. The clusters localized by this algorithm are displayed in a factor-factor plot shown in Figure 1. The basic features on this plot are the two "fingers" pointing upwards and nearly horizontally. These "fingers" may be identified with the effect of Zodiacal Light (dominating $f1$) and the galactic radiation (dominating $f2$). To obtain information on the temperatures of these components we divided the fluxes at 12, 25, 60, and 100 μ by $F = F12 + F25 + F60 + F100$. Figure 2 displays the $F25/F$ by $F60/F$ plot where the plotted cluster members are coded by the serial number of their clusters. The wedge-like distribution of the plotted cluster symbols points to the 180 K and 28 K values on the dust law $\alpha = 1$ radiation curve (Leene 1988) suggesting that a mixture of these radiations is responsible for the 12, 25, 60, and 100 μ maps of PL51.

```
                                                         .6           (180)
       99                                                          +  +   +
       999                                                            λλ      +(140)
       99999                                          5    (250)+     2λλ        +(120)
 1.75  9999        4 4                                                λλλ9
       9999             8  8                               .4    +        λλλ7
F      9999                       8                                       77773        (100)+
A      λλλ99    1                                    F25/F     +(350)  373433
C      λλλλ91 1               8                                           3334            (90)+
T   0  λλλλλ1                                                             68 86    8
O      λλλλ7    1   33                   88                    .2           8  8          (80)+
R      λλλλ77  333 3      66                                                 5
       2777771 3333 366      6                                                           (70)+
1      22777773333333 6      6                                  (35)+     +   +(45)       +(55)
 -1.75 22777                                              0
       2222
       22                                                     .08       .24       .4     .56
   0       4.5         9       13.5                                        F60/F
               FACTOR 2
```
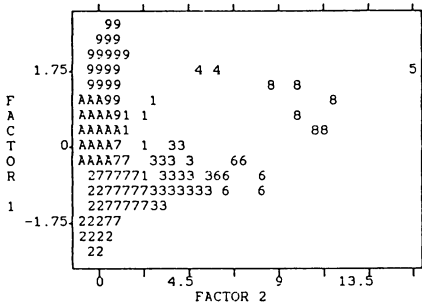
Figure 1. Plot of clusters on the factor plane found by the clustering algorithm. The cluster members are coded by the serial number of the respective cluster. (A denotes cluster 10.)
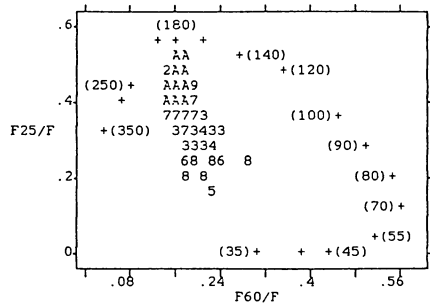
Figure 2. Distribution of cluster members on the $[F25/F; F60/F]$ plane. The coding of clusters is the same as on Figure 1. The loci of dust law $\alpha = 1$ radiation of different temperatures are marked with crosses. The numbers in parentheses are the respective temperatures. Note that the wedge-shaped distribution of symbols points towards the 28 K and 180 K temperatures.

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