SURVEY OF THE GALACTIC DISC FROM l = -150° TO l = 82° IN THE SUBMILLIMETER RANGE

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Abstract

We present new results about the emission of the galactic disc from l=-150° to l=82°in the submm range (λ_{eff}=380μm). Observations have been made with the AGLAE83 balloon-borne instrument launched from Brazil in November 1983. In-flight calibration of the instrument was made on Jupiter. The longitude profile obtained exhibits diffuse emission all along the disc with bright peaks associated with resolved sources. The averaged galactic spectrum is in agreement with a temperature distribution of the interstellar cold dust.

1 Introduction

The FIR emission of the Galaxy is produced by thermal radiation of dust grains mixed with the interstellar gas and heated by the stellar radiation field. Actually, most of the power radiated by stars in the inner Galaxy is converted into FIR radiation. The galactic emission in the FIR range is mostly dominated by temperature effects. Thus, observations in the submillimeter (submm) range are necessary to assess more accurately the average spectrum of the diffuse galactic emission. We report in this paper the first almost complete survey of the galactic disc (from l=-150° to l=82°) in the submm range (λ_{eff} = 380μm) performed with the AGLAE balloon-borne intrument, modified to include a new submm channel. The FIR channel (λ_{eff} = 145μm) of the previous AGLAE flights was kept.

2 Instrumentation and observational procedure

The AGLAE83 experiment is a new configuration of the balloon-borne AGLAE intrument which has been launched four times and has mapped the galactic emission in the FIR range (Serra et al., 1978, 1979; Boissé et al., 1981; Gispert et al., 1982, Caux et al., 1984, 1985). The detectors (composite bolometers) and filters are located on the cold plate of a ^4He cryostat operating at a temperature lower than 1.5K (natural pumping at balloon altitude, p < 4mb). The detectors' output signals are amplified by low noise preamplifiers located on the wall of the cryostat. The sampling and 12 bit digitization was performed on board. The whole gondola was continuously rotating at a constant angular velocity of about 2RPM. In order to cover large wings on both sides of the galactic plane, and to provide good zero level for the absolute reference of the emission, a 360° azimuthal rotation on the sky of the experiment beams was adopted. The knowledge of the direction viewed by the telescopes was obtained 32 times per turn with a monitoring magnetometer locked onto the earth's magnetic field. The digitized scientific and housekeeping data were then transmitted to the ground in real time by PCM telemetry.

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The observations presented in this paper were obtained during a twelve hour flight of the instrument launched from Sao Manuel (Brazil) on November 1st, 1983 at 0630 UT. The observational procedure allowed the coverage of the galactic plane from -150° to 82°, measurements of the sources close to the disc, and the observation of the fluxes from Venus and Jupiter in both wavelength channels. The photometric calibration was based on Jupiter (assuming a blackbody spectrum of T=125K, Wright, 1976). For the submm channel, the results obtained are in agreement to within 20% with the laboratory calibration using extended sources (blackbodies) filling the beam. For the submm channel, the rms fluctuation remaining after signal processing can be estimated, in most parts of the profile, at $\lambda I_\lambda = 3\ 10^{-7} W.m^{-2}.sr^{-1}$.

Table 1: Instrument Characteristics

Primary mirror diameter:	140mm	Beam diameter:	0.4°
Scanning velocity:	$12° s^{-1}$		
Bolometer N.E.P.:	$2\ 10^{-14} W.Hz^{-1/2}$		
Submm channel:	λ_{eff} = 380μm	$\Delta\lambda_{eff}$ = 150μm	
FIR channel :	λ_{eff} = 145μm	$\Delta\lambda_{eff}$ = 40μm	

3 Results and discussion

The results are presented as a profile of the submm brightness of the galactic disc (averaged over |b|< 1.25°), displayed as a function of the galactic longitude between l=-150° and l=82° in Figure 1. They are averaged in 1° longitude bins from -105° to 82° and in 5° bins from -150° to -105°.

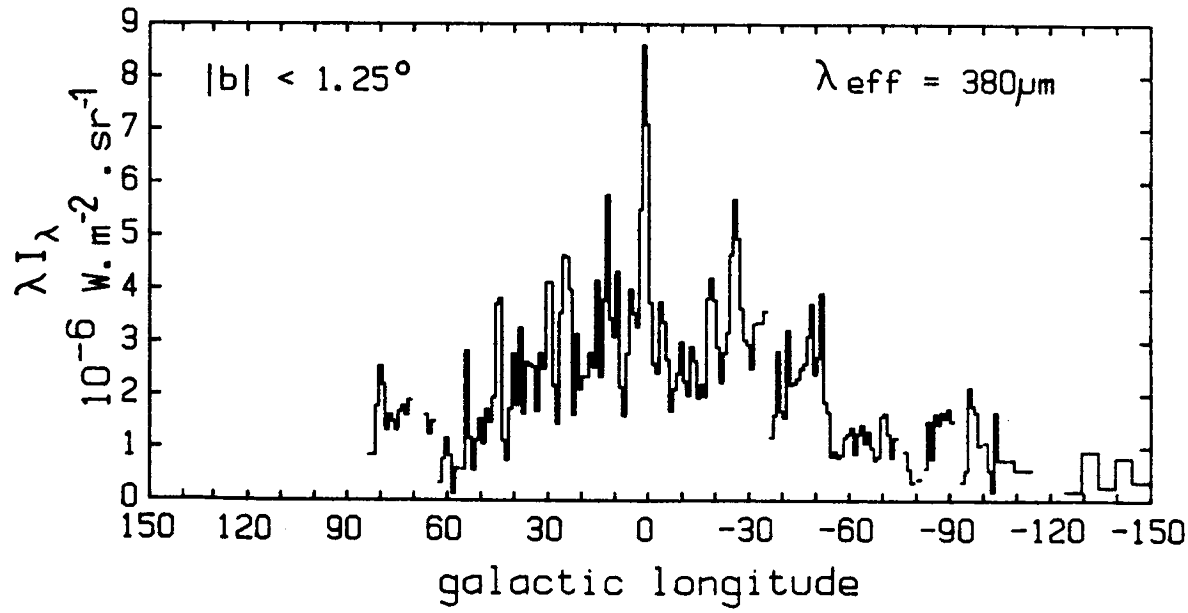

Figure 1. Longitude profile of the averaged submm brightness of the galactic disc.

This submm profile reveals, as in the FIR, a diffuse emission all along the galactic disc and the presence of resolved bright sources. Most of them are related to FIR sources associated with HII region and molecular cloud complexes. Emission peaks in the tangential direction of spiral arms are very apparent in the submm, as they were in the FIR profile (Caux et al., 1984). The FIR profile displays more contrast than the submm one, as would be expected because of the steeper dependence on temperature of the FIR intensity. The longitude profile (averaged over 1°x2.5° bins) of a color index defined as the ratio of the fluxes measured in the two channels (145µm/380µm) and expressed in terms of λI_λ is displayed in Figure 2. No obvious large scale galactic effects are apparent in the longitude interval -80°< l < 60°, and the mean value of this ratio is the same for positive longitudes as for negative longitudes.

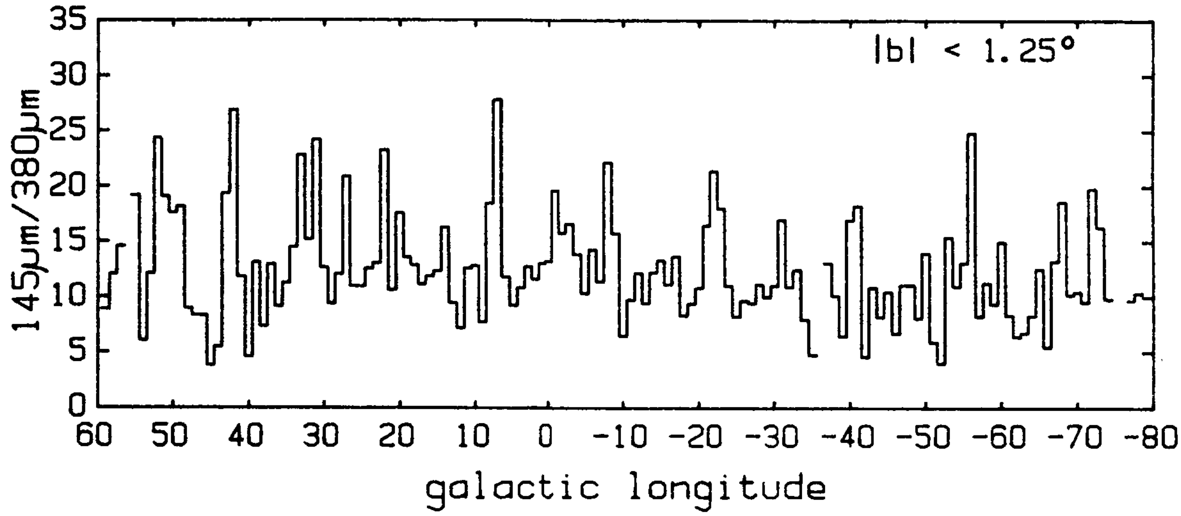

Figure 2. Longitude profile of the averaged ratio 145µm/380µm. The right scale shows the equivalent temperature (computed assuming a blackbody spectrum modified by a λ^{-2} emissivity law) corresponding to the 145µm/380µm ratio values.

The local apparent variations of this ratio are associated with bright sources and reflect temperature effects. Our submm channel records the emission by dust at about 10-30K while the emission in the FIR channel is dominated by dust with temperatures ranging from 15K to 45K (see Figure 5 in Pajot et al., 1986b). Thus the peaks of the 145µm/380µm ratio are related to sources of warm dust. The average value of the color index in the longitude interval -80° < l < 70° is about 12 and leads to a typical dust temperature of 20K, assuming a blackbody spectrum modified by a λ^{-2} emissivity law. This temperature is only indicative. In fact, it can be seen on Figures 3a and 3b that the spectra of the inner Galaxy and galactic center respectively, are characteristic of a temperature distribution in the 100µm-1mm range.

For all points plotted on these spectra, the emission is averaged in the same way and reflects all the emission of the given region. Assuming a blackbody spectrum modified by a λ^{-2} emissivity law, we have computed the variation with temperature of the ratios (in λI_λ) for each pair of effective wavelengths used in the FIR and submm ranges to plot the spectra of Figure 3a and 3b. The ratios obtained with the measured fluxes in the average galactic spectrum correspond to typical dust temperatures given in Table 2. Note that the different typical temperatures displayed in Table 2 reflect a true distribution of the interstellar dust temperature, and not only uncertainties in the determination of galactic fluxes at a given wavelength: an error of ± 20% in the 145μm/380μm ratio or the 60μm/100μm ratio leads to a temperature variation of only ± 1K.

Table 2: typical temperatures deduced from the spectrum of the inner Galaxy

wavelengths	60/100	60/145	100/145	60/380	100/380	145/380
ratios	0.42	0.51	1.22	6.1	14.6	12
T (K)	24	24	23	22	21	20

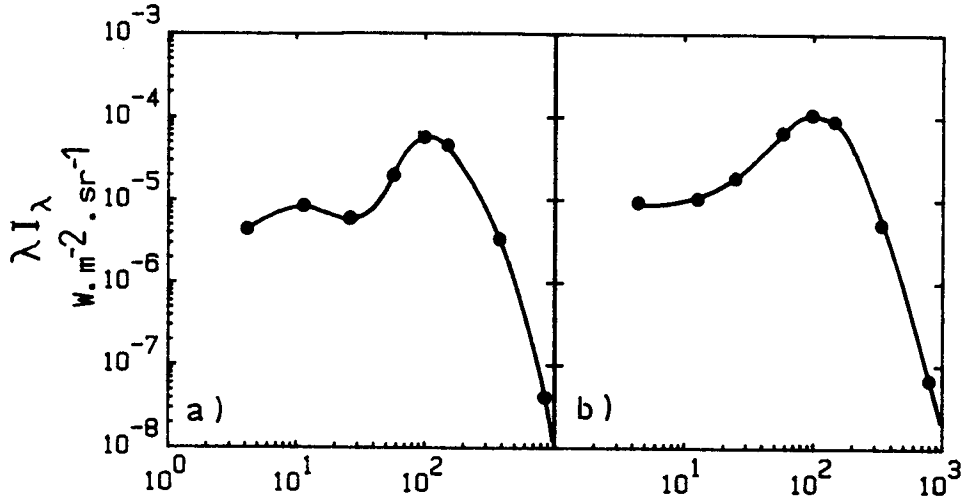

Figure 3a and 3b. Spectra of the averaged inner galactic emission, 3°<l<33°, |b|< 1.25° (3a) and galactic center region, |l|< 1.5°, |b|< 1.25° (3b). Data points on the two spectra are from: Pajot et al., 1986: 900μm, this work: 380μm and 145μm, IRAS data corrected for the zodiacal light emission (Caux et al., in preparation): 100μm, 60μm, 25μm and 12μm, Price, 1981: 4.4μm.

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