10. Reading *FIRAS* Data

Several *FIRAS*-specific FORTRAN and *IDL* programs which aid the user in reading the *FIRAS* FITS files and the *FIRAS* native VAX binary format files have been created and are available.

A complete *IDL* package of *COBE* analysis software, *UIDL* , is available through the *COBE* home page

`http://www.gsfc.nasa.gov/astro/cobe/cobe_home.html`

The *IDL* library contains the complete set of *COBE* Guest Investigator analysis tools. A FORTRAN library is also available which contains only data I/O and coordinate conversion routines.

Appendix J contains listings of the FORTRAN programs and informational headers for the IDL programs mentioned below.

The primary and binary extension headers used to create the FITS files are included in this document as Appendix G.

10.1. Reading *FIRAS* FITS Files

The *FIRAS* project data sets are stored in FITS Binary Table format, which is easily accessible by an appropriate FITS reader, such as the Fortran FITSIO package. The Fortran program FIRAS_READ uses FITSIO calls to read in the pixel number, spectrum, and spectrum sigma fields. The fields are stored in pixel list order, *i.e.* not as a rasterized sky map, so additional calls to routines that convert pixel numbers into raster or sky coordinates would be necessary to display the data as an image.

The *UIDL* routines DATAIN and FIRASMOD also read *FIRAS* FITS files: DATAIN reads the *FIRAS* spectra, number of observations, and pixel numbers from one face of the sky cube and forms a weighted average into a single spectrum; FIRASMOD reads *FIRAS* FITS files that are not pixelized.

10.2. Reading *FIRAS* Native VAX Binary Format Files

All data in the *FIRAS* native VAX binary format files were written by VAX FORTRAN software which made use of Record Definition Language (RDL) files, which are source (text) files that define data structures in a language resembling the VAX FORTRAN Structure statement. The files are listed in Appendix H.

The Record Definition Language was developed in order to place the *FIRAS* data structures into the VAX Common Data Dictionary (CDD), so that they could be accessed using COBEtrieve, a set of database access routines built on the FORTRAN-callable forms of VAX Datatrieve routines.

In order to read a *FIRAS* native VAX binary format file, the user must first find the corresponding RDL file and translate it into a programming language that supports data structures. The translated source text must then be included into the declaration section of a program which invokes the appropriate READ statement, making the *FIRAS* data available to the program. A sample program READ_FSS, which reads *FIRAS* Sky Coadd Index Records, is given in Appendix J in both VAX FORTRAN and C versions.

10.3. Using Skycube Data

COBE skymap data are pixelized using a variation of a quadrilateralized spherical projection that was originally developed for Earth science databases (Chan and O'Neill 1975). In this "*COBE* Quadrilateralized Spherical Cube" (*CSC*), the sky is projected onto a cube (called a skycube), with faces numbered 0 through 5. Face 0 contains the North Ecliptic Pole and face 5 contains the South Ecliptic Pole. The Ecliptic plane spans the remaining faces. The reference frame for the cube is defined by axes normal to faces 1 and 0. In Geocentric Ecliptic coordinates, these directions correspond to the vernal equinox and the North Ecliptic Pole.

For the *FIRAS* instrument, each face of the *CSC* projection is divided into $32 \times 32 = 1024$ squares (res 6), yielding 6144 pixels across the sky. The projection is adjusted to form equal area pixels having a solid angle of $4\pi/6144$ sr or 6.7 square degrees. Because the 7° beamwidth of the sky horn is greater than the separation between pixels (2.6° average) this binning oversamples the sky and the pixels are not independent.

All *FIRAS* skymaps are in the *CSC* projection in Geocentric Ecliptic J2000.0 coordinates. The best photometric integrity is maintained by using the data in the *CSC* projection. All of the skymaps contain the *CSC* pixel number; the spectral skymaps also contain the ecliptic, Galactic, and equatorial coordinates of the average pointing direction of the IFGs that were combined into the spectra. The discrepancy between the average pointing position and the *CSC* pixel centers is generally small (up to a few tenths of a degree). However, the average pointing coordinates should be used instead of the *CSC* pixel centers whenever possible.

The *CSC* projection for *FIRAS* data are shown in Figures 10.1, 10.2, and 10.3. Documentation and references on the *CSC* may be found in the accompanying FITS file DMR_FIRAS_SKYMAP_INFO.FITS.

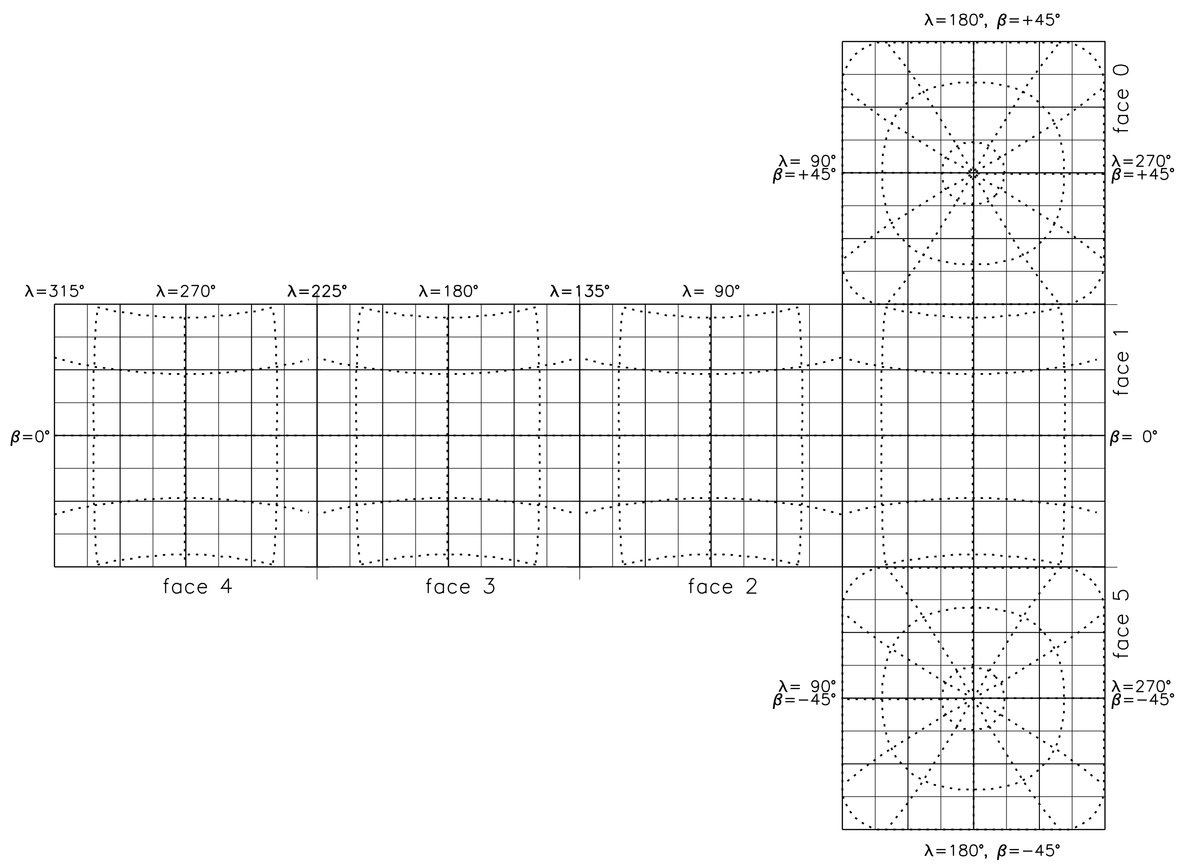

Fig. 10.1.— Unfolded, skyward-looking cube with ecliptic coordinate overlay — Dotted lines show ecliptic coordinate grid, with Δ longitude = 30°, Δ latitude = 20°, and coordinates indicated around cube face edges.

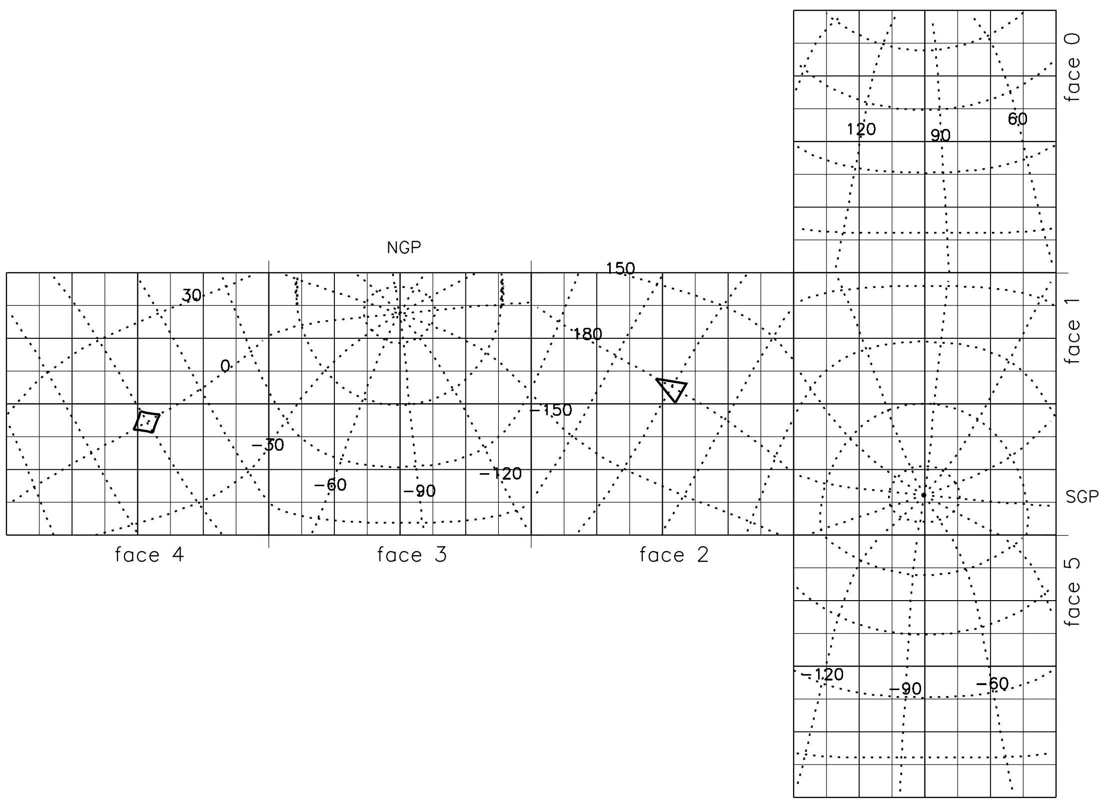

Fig. 10.2.— Unfolded, skyward-looking cube with Galactic coordinate overlay — Dotted lines show Galactic coordinate grid, with Δ longitude = $30°$, Δ latitude = $20°$. North and south Galactic poles are indicated beyond cube faces. $\diamond$ marks Galactic center and $\triangle$ marks anticenter.

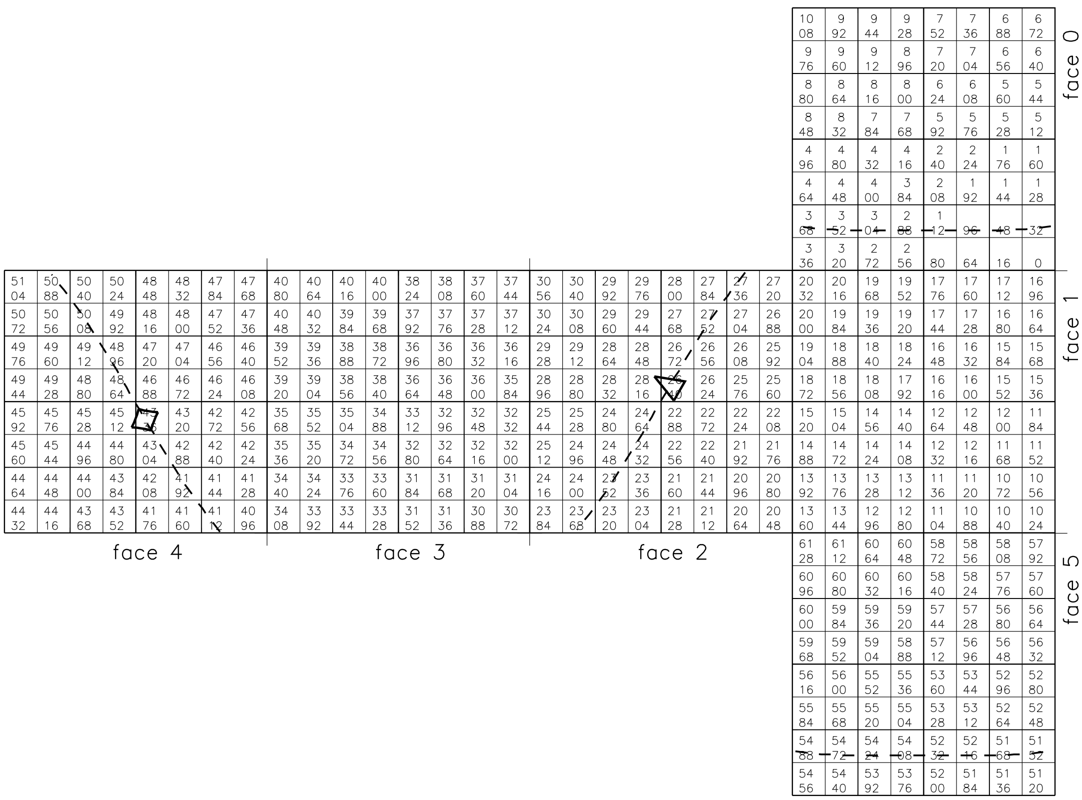

Fig. 10.3.— Unfolded *FIRAS* skycube with pixel numbering — The number in each box is the number in the lower right corner of that portion of the cube face; top row gives thousands, hundreds and bottom gives tens, units. Each face has 32 by 32 pixels. Dashed line shows Galactic plane. ◇ marks Galactic center and △ marks anticenter.