# Spectral Metadata

The keywords listed below are required, recommended or optional for all FITS files headers: either the primary (P) or extension (E) HDUs, for all files that contain spectra. Recommended keywords, if absent, will be computed and inserted prior to ingest; suggested keywords would be beneficial to archival users if present. Headers must also include the basic structural FITS keywords and the list of common keywords.

The following table(s) of HLSP metadata, to be included in science products, are color-coded:

| | |
|---|---|
| | Required |
| | Recommended |
| | Suggested |

One-dimensional spectra are commonly organized as an image or as a table (or a table row); two-dimensional spectral images may contain multiple spectra. Spectra may be represented in a FITS IMAGE or a BINTABLE extension. These cases are discussed below.

## Metadata Common to All Spectra

| | Keyword | HDU | Notes |
|---|---|---|---|
| | APERTURE | P or E | Name of aperture used for exposure |
| | DETECTOR | P or E | ID of detector used for exposure |
| | DISPRSR | P or E | Name of dispersive element used, or 'MULTI' if more than one defined the passband. |
| | DISPR***nn*** | P or E | Name(s) of dispersive element(s) used for exposure if more than one was used, with ***nn*** (zero-padded) incrementing from 1. Note that this information can alternatively be represented in a PROVENANCE extension. See Provenance Metadata for details. |
| | XPOSURE | P or E | Effective exposure duration in seconds, exclusive of dead time |

## Metadata for Spectra Stored as Images

In this case, spectral pixel values are stored in an image array (primary or extension), and header keywords contain the parameters of the dispersion relation (i.e., mapping of pixel to wavelength). Multiple arrays would be used to contain concomitant quantities, such as variance and data quality.

| | Keyword | HDU | Notes |
|---|---|---|---|
| | BUNIT | P or E | Brightness unit for array values, e.g., erg/cm^2/s/Angstrom or Jy for flux density |
| | CD***i_j*** | P or E | Transformation matrix between pixel axis ***j*** and intermediate coordinate axis ***i***. The indicies range from 1 to the value of NAXIS. Note: if the alternative PC***i_j*** notation is used, these keywords must not appear in the header. |
| | CDELT***i*** | P or E | Increment of the world coordinate at the reference point for axis ***i***, in units of deg/pixel. Used in conjunction with PC notation for transformation matrix; ignored for CD notation. |
| | CRPIX***j*** | P or E | Location of the reference point in the image for axis ***j***, in array pixel units. |
| | CRVAL***i*** | P or E | World coordinate value at the reference location for axis ***i*** |
| | CTYPE***i*** | P or E | World coordinate type for axis ***i***. |
| | CUNIT***i*** | P or E | Physical units of CRVAL for axis ***i***. Note: units for celestial coordinate systems **must** be degrees. |
| | PC***i_j*** | P or E | Alternative to CD notation for transforming pixel axis ***j*** to intermediate coordinate axis ***i***. Must be used with CDELT***i*** and must not be present if CD***i_j*** keywords are present. |
| | RADESYS | P or E | Mnemonic for celestial coordinate reference system (typically 'FK5' or the preferred 'ICRS'), if applicable. |
| | WCSAXES | P or E | Number of axes in WCS description, which may exceed the number of pixel array axes |

## Metadata for Spectra Stored as a BINTABLE

Only the keywords common to all spectra are required. However, certain content is required or suggested for fields (columns) in the table. The following specific field names are suggested, and would appear as values of the TTYPE**n** keywords in the table header. Units should be specified, where applicable, with the TUNIT**n** keywords. Note that spectra may be organized such that the values for each field run sequentially with row number; alternatively each table row may contain a spectrum, where non-scalar table cells contain 1-D arrays.

| | Field Name | Notes |
|---|---|---|
| | FLAGS | Data quality (binary) flags, with zero indicating no anthologies |

| | | |
|---|---|---|
| | FLUX | Could also be called "FLUX_DENSITY" or something similar, depending upon the quantity stored. Flux(es) for the associated wavelength(s), in units of the value of the TUNIT keyword for this column. |
| | VARIANCE | Variance in the flux(es) at the associated wavelength(s) |
| | WAVELENGTH | Wavelength(s) for the associated flux(es), in units of the TUNIT keyword for this column. |