INTRODUCTION TO FITS FILES

Cosmos Club Presentation by
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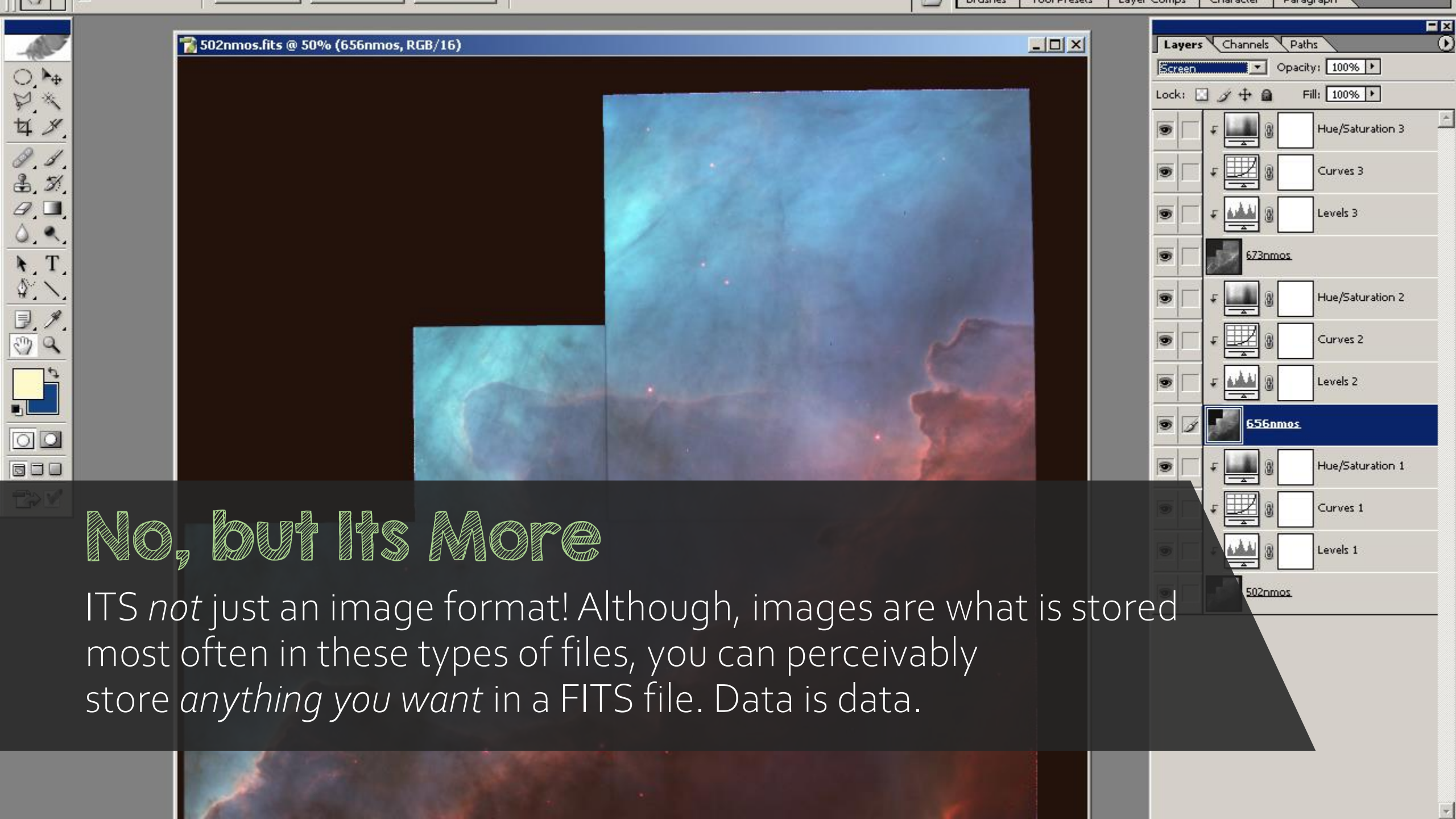
1. WHAT IS A F.I.T.S FILE?

Definition

FITS - *Flexible Image Transport System*

FITS is the data format most widely used within astronomy for transporting, analyzing, and archiving scientific data files.



No, but Its More

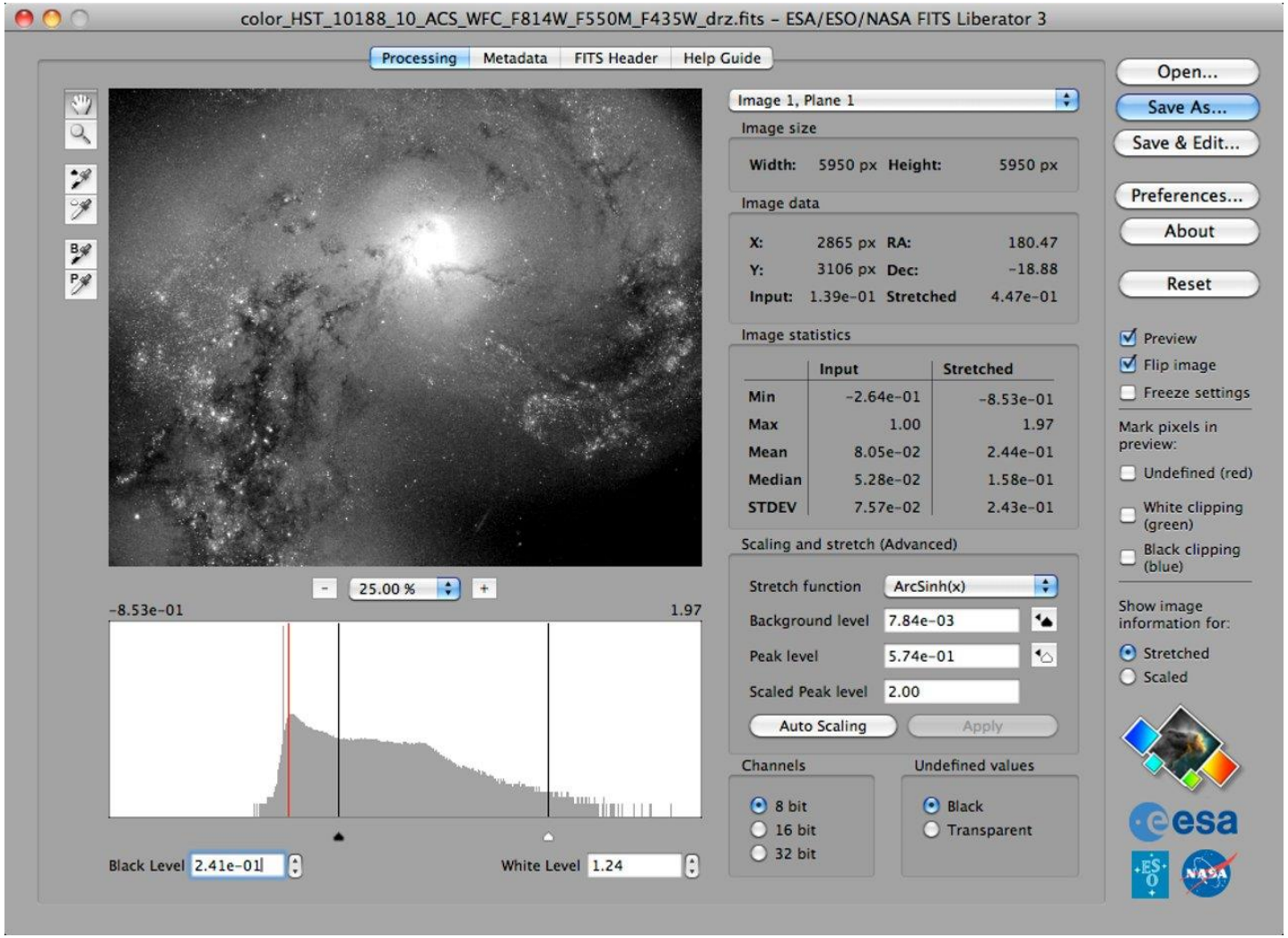
ITS *not* just an image format! Although, images are what is stored most often in these types of files, you can perceivably store *anything you want* in a FITS file. Data is data.

Why tho? Why not JPEG? Or PNG?

1. Cant do science otherwise
2. Metadata Storage
3. Extensions

This is a picture of M41 Messier. It is a normal photo, showing loads of stars in the clusters, but unfortunately that's it. It doesn't give any other info about the object.

How does it look like when you open it in software like DS9 or FITS Liberator?



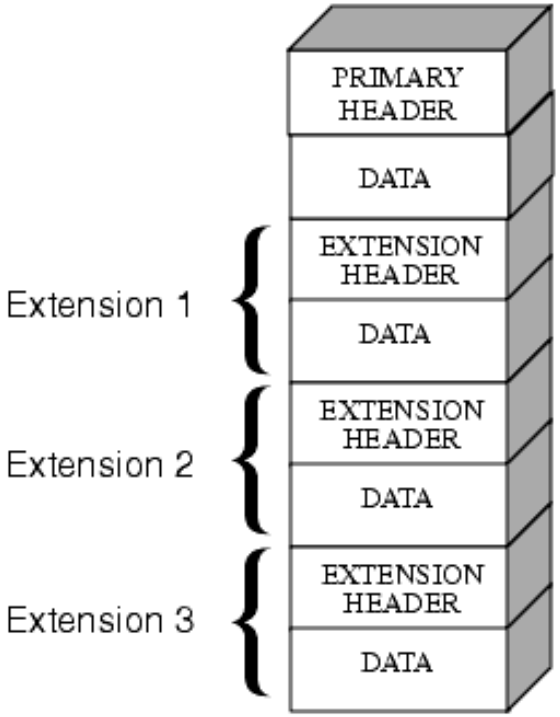

2. A LOOK INSIDE
FITS FILES

What is a file format anyway?

The **file format** is the structure of a file that tells a program how to display its contents. For example, a Microsoft Word document saved in the .DOC file format is best viewed in Microsoft Word. Even if another program can open the file, it may not have all the features needed to display the document correctly.

Programs compatible with a file format can give an overview of a file but may not be able to display all the file features. Also, with some programs opening a file format that is not supported may give you garbage.

What is inside FITS Files?



Header Data Units

A FITS file contains a sequence of logical header/data units (HDU) which all start with a set of header records describing the following data records. The logical record length of a FITS file is always 2880 bytes of 8 bits.

Both header and data sections start in a new logical record. FITS headers are encoded in ASCII as 80 character card images each starting with an 8 character keyword defining the type of information contained on the card.

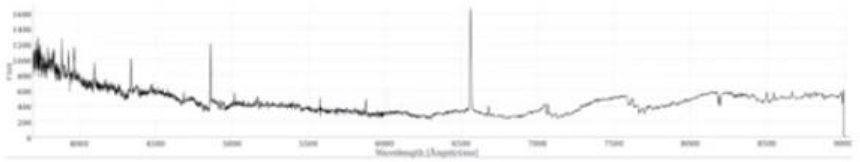
Header Units

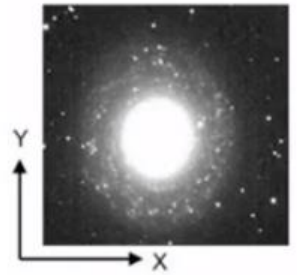
- Every HDU consists of an ASCII formatted `Header Unit' followed by an optional `Data Unit'. Each header or data unit is a multiple of 2880 bytes long. If necessary, the header or data unit is padded out to the required length with ASCII blanks or NULLs depending on the type of unit.
- Each header unit contains a sequence of fixed-length 80-character keyword records which have the general form:

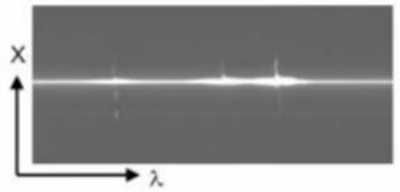
- KEYNAME = value / comment string

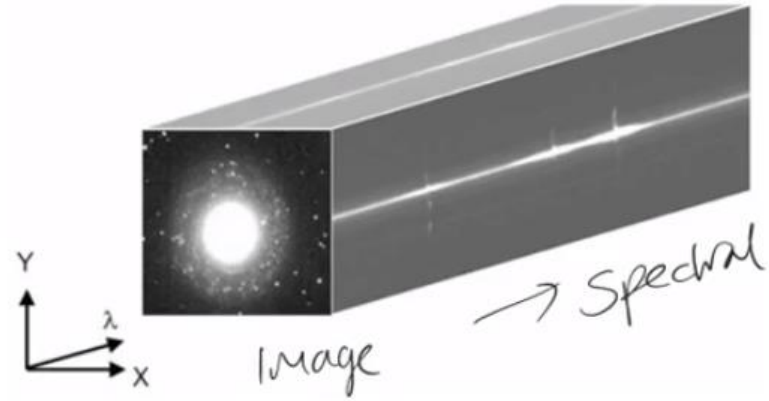
Data Units

- The data unit, if present, immediately follows the last 2880-byte block in the header unit. Note that the data unit is not required, so some HDUs only contain the header unit.
- The image pixels in a primary array or an image extension may have one of 5 supported data types:
- 8-bit (unsigned) integer bytes
- 16-bit (signed) integers
- 32-bit (signed) integers
- 32-bit single precision floating point real numbers
- 64-bit double precision floating point real numbers









FITS

→ cubs

MULTI-EXTENSION

Data unit is an array that holds values of pixels

fv: Summary of glg_bcat_all_bn180718763_v00.fit in C:/Users/user/Desktop/graduate/data/

File Edit Tools Help

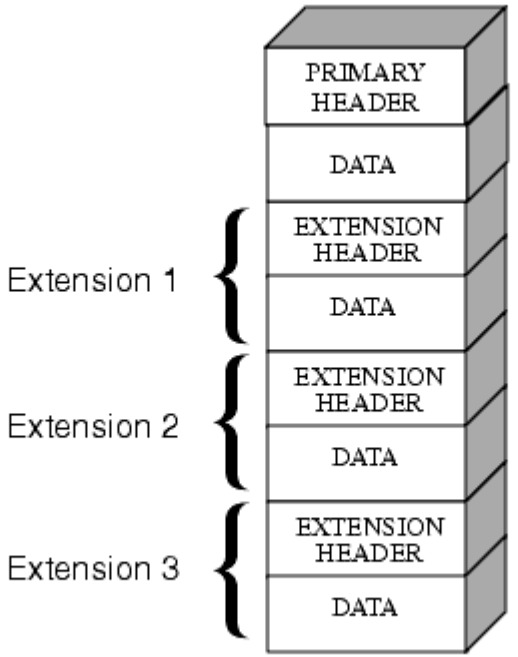
Index	Extension	Type	Dimension	View
0	NoName	Image	0	Header Image Table
1	DETECTOR DATA	Binary	13 cols X 5 rows	Header Hist Plot All Select
2	FIT PARAMS	Binary	15 cols X 3507 rows	Header Hist Plot All Select

fv: Header of glg_bcat_all_bn180718763_v00.fit[0] in C:/Users/user/Desktop/graduate/data/

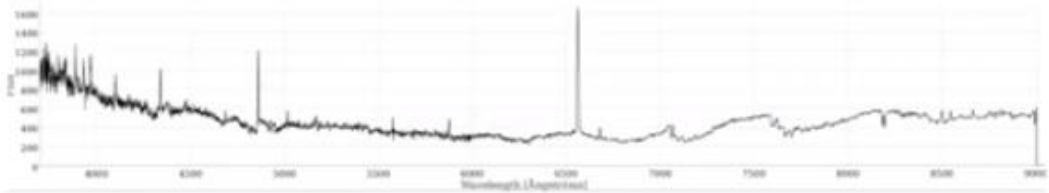
File Edit Tools Help

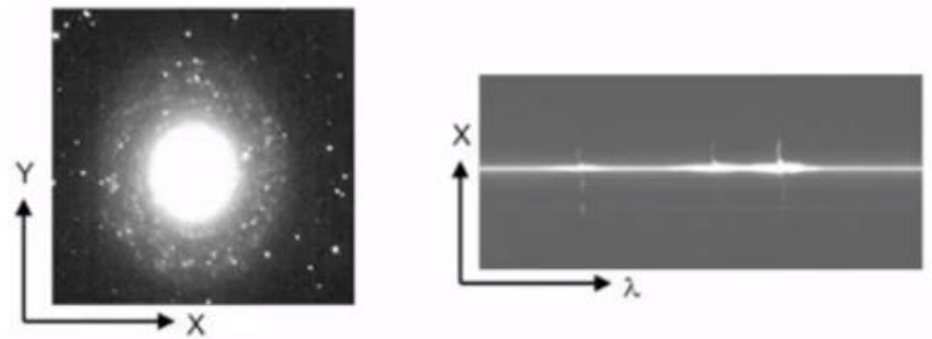
Search for: Find Case sensitive? No

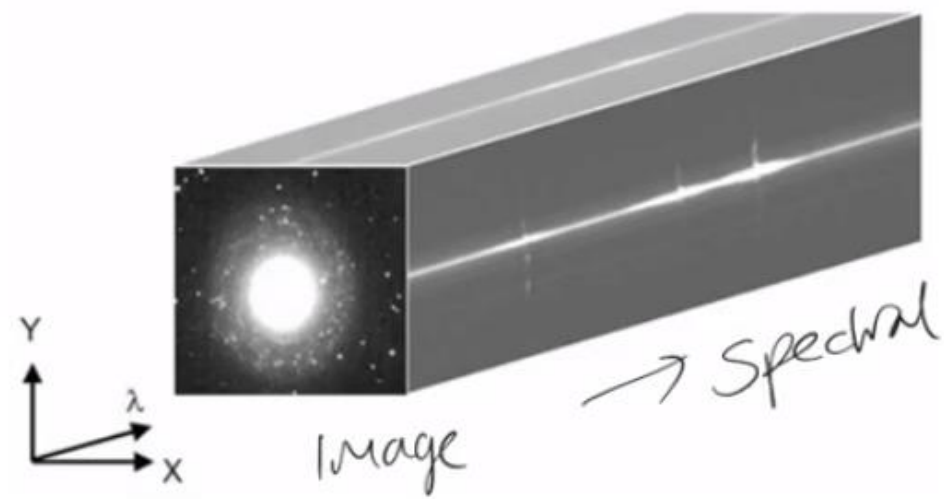
```
SIMPLE  =                    T /Written by IDL:  Wed Jul 18 19:52:43 2018
BITPIX  =                    8 /
NAXIS   =                    0 /
EXTEND  =                    T /File contains extensions
DATE    = '2018-07-19T00:52:44' /
FILETYPE= 'SPECTRAL FITS'      /Unique FITS file type name
CREATOR = 'rmfit 4.4.2BA'      /Software/version creating file
ORIGIN  = 'GIOC    '           /Name of organization
TELESCOP= 'GLAST   '           /Name of mission
INSTRUME= 'GBM     '           /Name of instrument
OBSERVER= 'Meegan  '           /Name of instrument PI
MJDREFI =              51910.0 /MJD date of reference epoch, int part
MJDREFF = 7.428703703703703E-04 /MJD date of reference epoch, frac part
TIMESYS = 'TT      '           /Time system
TIMEUNIT= 's       '           /Time unit used in TSTART, TSTOP and TRIGTIME
DATE-OBS= '2018-07-18T18:17:28' /Date of start of observation
DATE-END= '2018-07-18T18:21:58' /Date of start of observation
TSTART  =    553630648.4063380 /Observation start time, relative to MJDREF
TSTOP   =    553630918.6836979 /Observation end time, relative to MJDREF
TRIGTIME=    553630709.4635760 /Trigger time, relative to MJDREF
FLU     =          1.48998E-05 /[erg/cm^2]  10- 1000 keV fluence
FLU_ERR =          4.95578E-08 /[erg/cm^2] Uncertainty on fluence
FLUB    =          6.27233E-06 /[erg/cm^2] 50-300 keV fluence
FLUB_ERR=          2.69605E-08 /[erg/cm^2] Uncertainty on fluence
```



On the left is the image showing all that is contained in the Primary Header of the FITS file.







FITS

→ cubs

MULTI-EXTENSION

3. IMPLEMENTATION IN PYTHON