



# etruecolor

April 16, 2023

## Abstract

Generate three-color coded spatial image from scalar event table attribute

## 1 Instruments/Modes

Instrument	Mode
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## 2 Use

pipeline processing	yes
interactive analysis	yes

## 3 Description

**etruecolor** generates from a set of input event list(mos and pn) a spatial image in which the value of a specified scalar event attribute (e.g. energy) is three-color coded. The coloring process is driven by three fundamental color curves (red, green, blue) that are constructed from the contents of a pre-defined input color table (RGB.Scheme).

The energy bands (coded in the pre-defined color table) for the red, green and blue channels of the true color image have been chosen so that a power law spectrum with photon spectral index 1.7, absorbed by galactic gas with neutral hydrogen column density of  $10^{20} \text{ cm}^{-2}$ , results in approximately the same number of counts in each band.

Channel energy Range	
Red	300-700 eV
Green	700-1200 eV
blue	1200-7000 eV

Please note: The actual generation of the red, green, and blue component images is done through the task **evselect**. **etruecolor** therefore inherits some of **evselect**'s image extraction parameters which allows



to control the image generation process, e.g., binning, windowing, etc. **etruecolor** also assumes that all the input event files have the same astrometry origin.

The default value for the image scale creation is **4 arcsec/pixel**, that is equivalent to **aximagebinsize** equals to 80.

### 3.1 Filtering and vigneting correction

**etruecolor** task filters the input tables using the **min** and **max** parameter.

In order to flat field the images, **etruecolor** runs **evigweight** task. This task creates a **WEIGHT** column that it is used for vigneting correction.

### 3.2 Brightness limits and scaling

For a pipeline production of true color images it seems to be more adequate to use the same scaling and cuts in all images, instead of trying to optimize for every particular case. This approach may result in color saturation for very bright sources and/or missing the weakest sources. Also it permits a direct comparison between different images, independently on their effective exposure time.

Currently proposed limits correspond to 2.25 and 675 counts/ks/arcmin<sup>2</sup> and the scaling is logarithmic. This limits correspond to 0.01 and 3 counts/ks/pixel (assuming an image scale of 4 arcsec/pixel).

## 4 Parameters

This section documents the parameters recognized by this task (if any).

Parameter	Mand	Type	Default	Constraints
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<b>tablelist</b>	yes	table		name of existing table
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List of tables that contains the event data - need to at least contain the columns named with the **xcolumn**, **ycolumn**, **ecolumn** parameters.

<b>colortable</b>	no	string	RGB.Scheme	name of predefined color table
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The energy bands for the pre-defined color table are explained in the text.

<b>min</b>	no	real	300	
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Explicit minimum value of **ecolumn** column. This value is used for filtering.

<b>max</b>	no	real	7000	
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Explicit maximum value of **ecolumn** column. This value is used for filtering.



<b>ximagebinsize</b>	no	real	80	> 0
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passed to **evselect** as parameter **ximagebinsize**

<b>withfiltertransmission</b>	no	boolean	yes	yes/no
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factor the filter's transmission into vignetting weight

<b>withxranges</b>	no	boolean	false	true false
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passed to **evselect** as parameter **withxranges**

<b>ximagegin</b>	no	real	1	> 0
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passed to **evselect** as parameter **ximagegin**

<b>ximagemax</b>	no	real	600	> 0
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passed to **evselect** as parameter **ximagemax**

<b>yimagebinsize</b>	no	real	80	> 0
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passed to **evselect** as parameter **yimagebinsize**

<b>withyranges</b>	no	boolean	false	true false
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passed to **evselect** as parameter **withyranges**

<b>yimagegin</b>	no	real	1	> 0
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passed to **evselect** as parameter **yimagegin**

<b>yimagemax</b>	no	real	600	> 0
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passed to **evselect** as parameter **yimagemax**

<b>scalmin</b>	no	real	2.25	
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Min value for log scaling (counts/ks/arcmin<sup>2</sup>).

<b>scalmax</b>	no	real	675	
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Max value for log scaling (counts/ks/arcmin<sup>2</sup>)

<b>fileset</b>	no	string	default	name of output data set
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The name of the data set the color images as count rates. This file is a RGB cube ready to be displayed with Ds9. Leaving the default value, **etruecolor** task creates the following file name: Pppppp-pooeeEPX000RGBIMA0000.FIT, where ppppppooee is the extended observation Id.



<b>outputchoice</b>	no	string	ppmfile	dataset ppmfile
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If set to *dataset* image is written to a data set whose name is given via parameter **colorset**. Otherwise, image is written in PPM format to standard file named via **ppmfile**.

<b>colorset</b>	no	string	default	name of data set
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The name of the data set the color image shall be written to if **outputchoice**=*dataset*. Depending on the value of **ascube** the data will either be written to three separate arrays corresponding to the red, green, and blue components or three slices of a 3-D data cube in the primary array, respectively. The data set can be read and the contents displayed with Ds9. Leaving the default value, **etruecolor** task creates the following file name: PppppppooeeEPX000RGBCOL0000.FIT, where pppppppooee is the extended observation Id.

<b>ppmfile</b>	no	string	default	name of file
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If **outputchoice**=*ppmfile* the name of a PPM data file that the color image shall be written to. If **ppmfile**=*stdout* the data shall be written to standard output. Leaving the default value, **etruecolor** task creates the following file name: PppppppooeeEPX000RGBIMA0000.PPM, where pppppppooee is the extended observation Id.

<b>ascube</b>	no	boolean	false	false true
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Boolean parameter determining whether the red, green, and blue component images are to be written as three separate array extensions to the data set designated with **colorset** or as three slices of a single 3-dimensional data cube in the primary array.

## 5 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

### **MinMaxEqual** (*error*)

The minimum and maximum values of the scalar attribute data are equal. This must not happen because in this case the mapping onto the color table *level* range [0, 1] is undefined.

In addition all error and warning messages of the task **evselect** and package **dal** can occur.



## 6 Input Files

1. event file containing  $x$  and  $y$  position and scalar attribute of a set of events.
2. color set with a table that gives the intensities of red, green and blue as a function of a scalar value.

## 7 Output Files

1. PPM (portable pixmap) file or
2. data set containing either
  - three arrays with R/G/B components respectively
  - R/G/B images as slices in primary array

The data set format is readable by the image viewer Ds9 in version 2.3 or later. Generated PPM pixel maps can be visualized with the display program xv.

## 8 Algorithm

```
read RGB color curves
setup temporary table with columns red/green/blue
foreach event
  red = linearInterpolate(redcurve,energy)
  green = linearInterpolate(greencurve,energy)
  blue = linearInterpolate(bluecurve,energy)
foreach {red, green, blue}
  construct component image with evselect and divide by livetime
combine partial images
if (log)
  foreach pixel
    r,g,b = max ( log(r,g,b) - log(maxValue) + decades, 0)
normalize to 255
if (withcolorset)
  write image to data set
else
  write image in PPM format
```

## 9 Comments

## References