; This IDL program generates four plots from the data values in the

; file 'orbits.dat' file (generated by the Fortran 77 'orbits.f'

; program. The plots generated are: orbital speed vs orbital phase

; or extrasolar planet. Temperature of extrasolar planet vs. orbital

; phase, and planet to star flux ratios vs. planetary orbital phase

; at wavelengths of 0.5 micron, 1 micron, 3 microns, and 10 microns.

; Orbital parameters and the legend for the planet to star flux ratio

; vs orbital speed are also displayed in two separate IDL display

; windows. This IDL program also uses an IDL procedure program written

; by Liam E. Gumley called 'loadcolors.pro' (see the relevant comment

; lines in the body of the program below.

;

; This program also indicates whether the inputs entered meet the

; criteria for a planet which, possibly, lies in the "habitable

; zone" of its parent star. (For the purposes of this program, a

; planet lying in the habitable zone of its parent star has a

; temperature that fluctuates within and between 280K and 320K, where

; H2O can exist in liquid form.) If the program deems the planet to

; lie in the habitable zone of its host star, then the plot of

; planet temperature vs orbital phase will turn green and a message

; within the plot will notify the user that the planet may lie

; in the habitable zone according to these simplified criteria.

;

; In general, the conditions needed to support Earth-type life may

; exist for rocky planets (or sufficiently large moons of gas giant

; planets) that are orbiting a star in its "habitable zone"

; Such zones are bounded by the range of distances from a star for

; which liquid water can exist on a planetary surface, depending on such

; additional factors as the nature and density of its atmosphere and

; its surface gravity. In terms of orbital distance, the

; habitable zone for our own Solar System currently extends from at

; least 0.95 AU to 1.37 AU (where one AU equals Earth's average orbital

; distance around the Sun) (Reference: "Stars and Habitable Planets",

; http://www.solstation.com/habitable.htm)

;

;

; \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

; References used in writing this program:

;

; "Using IDL to Manipulate and Visualize Scientific Data",

; Brisson, Erik, Scientific Computing and Visualization Tutorials

; and presentations.

; http://scv.bu.edu/Tutorials/IDL/

;

; "Fanning Consulting -- Coyote's Guide to IDL Programming",

; David W. Fanning, 1996-2003

; http://www.dfanning.com/

;

; Gumley, Liam E., "Practical IDL Programming -- Creating Effective

; Data Analysis and Visualization Applications", Academic Press, 2002

;

; Gumley, Liam E. "Practical IDL Programming"

; http://www.gumley.com/

;

; "Stars and Habitable Planets", Sol Company, 1998-2002

; http://www.solstation.com/habitable.htm

;

; "Simple Graphs in IDL" and "Basics of IDL", Scientific/Numerical

; Computing at the Univeristy of Colorado in Boulder

; http://www.colorado.edu/ITS/docs/scientific/idl/graph/

;

; \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

PRO plots\_orbits

device,retain=2,pseudo=8,decomposed=0

;The following two lines compile and execute a procedure named

;'loadcolors.pro' from pages 249-250 of the book "Practical

; IDL Programming" by Liam E. Gumley ; Copyright 2002 by

; Academic Press. This procedure loads 16 plotting colors into

; the color table. The colors are loaded starting at index 0

; by default, or at the index specified by the 'bottom' keyword.

; The names of the colors can be returned by the 'names' keyword.

; The loadcolors.pro code (procedure) must be in the same

; directory as the 'orbits.f' and 'plots\_orbits.pro' programs

; are in order for the overall program/code to be successfully

; compiled and executed

loadcolors

; The 'orbits.f' Fortran 77 program is 'spawned' (i.e., it is

; compiled and executed) here within the IDL environment

spawn, 'g77 orbits.f'

spawn, './a.out'

; The 'orbits.dat' generated by 'orbits.f' is read here, and

; arrays are set up.

OPENR,lun,'orbits.dat',/GET\_LUN

header=STRARR(16)

READF,lun,header

time=FLTARR(10000)

phase=FLTARR(10000)

xpos=FLTARR(10000)

ypos=FLTARR(10000)

radius=FLTARR(10000)

velocity=FLTARR(10000)

temp=FLTARR(10000)

fluxr10=FLTARR(10000)

fluxr3=FLTARR(10000)

fluxr1=FLTARR(10000)

fluxr05=FLTARR(10000)

t=0.0

p=0.0

x=0.0

y=0.0

r=0.0

v=0.0

te=0.0

fr10=0.0

fr3=0.0

fr1=0.0

fr05=0.0

count=0

WHILE (NOT EOF(lun)) DO BEGIN

READF, lun, t,p,x,y,r,v,te,fr10,fr3,fr1,fr05

time(count)=t

phase(count)=p

xpos(count)=x

ypos(count)=y

radius(count)=r

velocity(count)=v

temp(count)=te

fluxr10(count)=fr10

fluxr3(count)=fr3

fluxr1(count)=fr1

fluxr05(count)=fr05

count = count + 1

ENDWHILE

time = time(0:count-1)

phase=phase(0:count-1)

xpos=xpos(0:count-1)

ypos=ypos(0:count-1)

radius=radius(0:count-1)

velocity=velocity(0:count-1)

temp=temp(0:count-1)

fluxr10=fluxr10(0:count-1)

fluxr3=fluxr3(0:count-1)

fluxr1=fluxr1(0:count-1)

fluxr05=fluxr05(0:count-1)

close, lun

; The plot of Y position in AU vs. X position in AU is

; generated and displayed here.

window, 0, xsize=890,ysize=740

!p.multi=[0,2,2]

plot, xpos, ypos, linestyle=2, $

title='X (AU)  vs.  Y(AU)', $

xtitle='X in AU',  $

ytitle='Y in AU'

plot, phase, velocity, psym=4,/noclip, $

title='Plot of Orbital Speed  vs.  Orbital Phase', $

xtitle='Orbital Phase (elapsed time/orbital period)',xcharsize=1.0,  $

ytitle='Orbital speed in km/s'

; If the planetary temperature lies between 280 K and 320 K throughout

; the course of one orbital period, then it is deemed to lie in the

; "habitable zone" of its host star.

amax=max(temp)

amin=min(temp)

if (amin ge 280.) and (amax le 320.) then begin

plot, phase,temp, psym=6,color=4, $

title='Planet Temperature (K) vs Orbital Phase', $

xtitle='Orbital Phase (time elapsed / orbital period)', $

ytitle='Temperature (K) of Extra-Solar Planet'

xyouts, 0.08,0.25,'!6THIS PLANET LIES IN THE HABITABLE ZONE OF ITS PARENT STAR!X', /normal, charsize=1.0,color=4

xyouts, 0.08,0.21,'!6(Its temperature varies between 280K and 320K, where water!X', /normal, charsize=1.02,color=4

xyouts, 0.08,0.19,'!6can exist in liquid form, as it moves through its orbit)!X', /normal, charsize=1.02,color=4

goto, jump1

endif

; Plot of planet temperature vs. orbital phase is generated and

; displayed. The four different flux ratios for the four wavelenghts

; are distinguished by different colors and plotting symbols.

plot, phase,temp, psym=6, $

title='Planet Temperature (K) vs Orbital Phase', $

xtitle='Orbital Phase (time elapsed / orbital period)', $

ytitle='Temperature (K) of Extra-Solar Planet'

jump1: ymax=max(fluxr10)

foo=[fluxr10,fluxr3,fluxr1,fluxr05]

gd=where(foo gt 0.)

ymin=min(foo[gd])

plot, phase,fluxr10,yrange=[ymin,ymax],/ylog, linestyle=2,/noerase,  $

title='Planet to Star Flux Ratios vs Orbital Phase',   $

xtitle='Orbital Phase (time elapsed / orbital period)',   $

ytitle='Planet to Star Flux Ratios vs Orbital Phase'

oplot, phase,fluxr3, linestyle=3, color=5

oplot, phase,fluxr1,linestyle=4, color=6

oplot, phase,fluxr05,linestyle=5, color=9

; Black and white .jpeg images (.jpg) of the plots are now written to the

; current working directory. These images can be displayed with Linux

; graphics programs such as "Electric Eyes" or using the IDL "tv"

; command. To display the .jpg file instead of just saving it to the

; hard disk, activate (i.e., remove the semicolons from) the four

; commented lines below. (Note that all four of the plots generated

; appear in one large display window as standard output and as a saved

; black and white .jpg image).

image=tvrd()

info=size(image)

nx = info[1]

ny = info[2]

true\_image=bytarr(3, nx, ny)

tvlct, r, g, b, /get

true\_image[0, \*, \*] = r[image]

true\_image[1, \*, \*] = g[image]

true\_image[2, \*, \*] = b[image]

write\_jpeg, 'plots\_orbits.jpg', true\_image,true=1

; device,retain=2,pseudo=8,decomposed=0

;READ\_JPEG, 'plots\_orbits.jpg', a, TRUE=1

;window,4,xsize=900,ysize=735

;TV, a, TRUE=1

device,retain=2,pseudo=8,decomposed=0

; Setting up graphics for the display of the orbital parameters.

window, 1, xsize=470, ysize=350

xyouts,0.0,0.95,'!6Orbital Parameters:!X', /normal, charsize=1.5,color=2, $

alignment=0.0

xyouts,0.0,0.90,header(0), /normal, alignment=0.0, charsize=1.3, color=2

xyouts,0.0,0.86, header(2), /normal, alignment=0.0, charsize=1.3, color=2

xyouts,0.0,0.82, header(3), /normal, alignment=0.0, charsize=1.3, color=2

xyouts,0.0,0.78, header(4), /normal, alignment=0.0, charsize=1.3, color=2

xyouts,0.0,0.74, header(5), /normal, alignment=0.0, charsize=1.3, color=2

xyouts,0.0,0.70, header(6), /normal, alignment=0.0, charsize=1.3, color=2

xyouts,0.0,0.66, header(11), /normal, alignment=0.0, charsize=1.3, color=2

xyouts,0.0,0.62, header(12), /normal, alignment=0.0, charsize=1.3, color=2

xyouts,0.0,0.55,'!6Star and Planet Properties:!X', /normal, charsize=1.5, $

color=15, alignment=0.0

xyouts,0.0,0.50, header(7), /normal, alignment=0.0, charsize=1.3,color=15

xyouts,0.0,0.46, header(8), /normal, alignment=0.0, charsize=1.3,color=15

xyouts,0.0,0.42, header(9), /normal, alignment=0.0, charsize=1.3,color=15

xyouts,0.0,0.38, header(10), /normal, alignment=0.0, charsize=1.3,color=15

; A black and white .jpeg image (.jpg) of the parameters display is

; now written to the current working directory. These images can be

; displayed with Linux graphics programs such as "Electric Eyes" or

; using the IDL "tv" command. To display the .jpg file instead of just

; saving it to the hard disk, activate (i.e., remove the semicolons

; from) the four lines of code below that have been commented out.)

image=tvrd()

info=size(image)

nx = info[1]

ny = info[2]

true\_image=bytarr(3, nx, ny)

tvlct, r, g, b, /get

true\_image[0, \*, \*] = r[image]

true\_image[1, \*, \*] = g[image]

true\_image[2, \*, \*] = b[image]

write\_jpeg, 'parameters.jpg', true\_image,true=1

; device,retain=2,pseudo=8,decomposed=0

;READ\_JPEG, 'parameters.jpg', c, TRUE=1

;window,5

;TV, c, TRUE=1

device,retain=2,pseudo=8,decomposed=0

;Setting up graphics for the next display of the legend of the plot of

; planet-to-star flux ratios vs. orbital phase for different

; wavelenghts (in the infrared part of the spectrum)

window,2,ysize=260

xyouts,0.0,0.95,'!6Legend for the Plot of Planet to Star Flux Ratios vs Orbital Phase!X', $

/normal, charsize=1.5,color=14

xyouts,0.0,0.87,'----------  Planet to Star Flux Ratio at wavelength = 10 microns (dashed ; white)', $

/normal, alignment=0.0, charsize=1.3

xyouts,0.0,0.81,'-.-.-.-.-.-.-.  Planet to Star Flux Ratio at wavelength = 3 microns (dash/dot ; red)',$

/normal, alignment=0.0, charsize=1.3, color=5

xyouts,0.0,0.75, '-...-...-...-...  Planet to Star Flux Ratio at wavelength = 1 micron  (dash/dot/dot/dot ; blue)',$

/normal, alignment=0.0, charsize=1.3, color=6

xyouts,0.0,0.69, '\_ \_ \_ \_ \_ \_ \_ \_ Planet to Star Flux Ratio at wavelength = 0.5 micron (long dashes ; gold)',$

/normal, alignment=0.0, charsize=1.3, color=9

; A black and white .jpeg image (.jpg) of the flux ratios legend

; display is now written to the current working directory. These

; images can be displayed with Linux graphics programs such as

; "Electric Eyes" or using the IDL "tv" command. To display the

; .jpg file instead of just saving it to the hard disk, activate

; (i.e., remove the semicolons from) the four commented lines below.

image=tvrd()

info=size(image)

nx = info[1]

ny = info[2]

true\_image=bytarr(3, nx, ny)

tvlct, r, g, b, /get

true\_image[0, \*, \*] = r[image]

true\_image[1, \*, \*] = g[image]

true\_image[2, \*, \*] = b[image]

wri

te\_jpeg, 'fluxratios.jpg', true\_image,true=1

READ\_JPEG, 'fluxratios.jpg', b, TRUE=1

;window,6

;TV, b, TRUE=1

device,retain=2,pseudo=8,decomposed=0

; Creates postscript versions of these plots in a file called

; 'orbits\_plots.ps' in the current directory

mydevice=!D.NAME

SET\_PLOT, 'PS'

DEVICE, FILENAME = 'plots\_orbits.ps', /LANDSCAPE

!p.multi=[0,2,2]

plot, xpos, ypos, linestyle=2, $

title='X (AU)  vs.  Y(AU)', $

xtitle='X in AU',  $

ytitle='Y in AU'

plot, phase, velocity, psym=4, $

title='Plot of Orbital Speed  vs.  Orbital Phase', $

xtitle='Orbital Phase (elapsed time/orbital period)',xcharsize=1.0,  $

ytitle='Orbital speed in km/s'

plot, phase,temp, psym=6, $

title='Planet Temperature (K) vs Orbital Phase', $

xtitle='Orbital Phase (time elapsed / orbital period)', $

ytitle='Temperature (K) of Extra-Solar Planet'

foo=[fluxr10,fluxr3,fluxr1,fluxr05]

gd=where(foo gt 0.)

ymin=min(foo[gd])

plot, phase,fluxr10,yrange=[ymin,ymax],/ylog, linestyle=2,/noerase,  $

title='Planet to Star Flux Ratios vs Orbital Phase',   $

xtitle='Orbital Phase (time elapsed / orbital period)',   $

ytitle='Planet to Star Flux Ratios vs Orbital Phase'

oplot, phase,fluxr3, linestyle=3, color=5

oplot, phase,fluxr1,linestyle=4, color=6

oplot, phase,fluxr05,linestyle=5, color=9

DEVICE, /CLOSE

SET\_PLOT, mydevice

spawn, 'more orbits.dat'

; $gv plots\_orbits.ps &

; Note that the postscript plots can be displayed and viewed by

; typing in '$gv orbits\_plot.ps &' at the IDL command prompt

END