

## General purpose IDL functions and procedures.

These are the programs contained within `/gryll/data1/buie/idl` – a collection of general purpose IDL functions and procedures. These routines cover diverse uses from file reading, astronomical data processing, and more.

Here is a list of all routines with their one line descriptions.

**2-D plotting**


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<code>cleandat</code>	Interactive program to eliminate and smooth over bad data points.
<code>focscan</code>	Summarize and plot focus log files from PCCD.
<code>occplot</code>	Plot small pieces of stellar occultation data.
<code>opler</code>	Overplot data points with accompanying x or y error bars.
<code>plotpcom</code>	Plot model fit residual files for Pluto-Charon map fitting
<code>rddat</code>	Display the X and Y value of the cursor in a plot
<code>zplot</code>	Plot differential refraction as a function of wavelength.

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**Asteroids**

<code>equTEMP</code>	Compute a simple thermal equilibrium temperature for an asteroidal surface
<code>neateMP</code>	Compute a simple effective black-body temperature for a near-Earth asteroid
<code>neoflux</code>	Compute the estimated thermal flux emitted from the surface of an asteroid
<code>neosignal</code>	DESCRIPTIO

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**Astrometry**

<code>addstar</code>	Add a reference star to the data base for fitting
<code>ast2ted</code>	Convert astrometry file to a Ted Bowell format astrometry file.
<code>astanal</code>	Analyze and provide summary plots and averages for one night of astrometry
<code>astchi1</code>	Astrometric goodness-of-fit for one image based on rotation and offset
<code>astcol</code>	Collect astrometry observations for multiple objects
<code>astcvT</code>	Convert between different astrometric coordinate systems.
<code>asteval</code>	Evaluate an astrometric polynomial function.
<code>astinfo</code>	Decode (or add) astrometric information from a FITS header
<code>astlinks</code>	Scan for linkages among a collection of asteroid astrometric measurements
<code>astlist</code>	Create a summary listing from a final astrometry file.
<code>astpdf</code>	Compute a discrete numerical probability sample for astrometry
<code>astpred</code>	Simple asteroid position predictor when no orbit is available.
<code>astprmt</code>	Promote version of an astrometry fit coefficient file to highest version.
<code>astrd2sn</code>	Astrometry conversion from $(\alpha, \delta)$ to $(\xi, \eta)$
<code>astrd2xy</code>	Astrometry conversion from $(\alpha, \delta)$ to image (x,y)
<code>astrepro</code>	Re-reduce existing astrometry originally measured with ASTROM
<code>astrom</code>	Astrometry from a digital image.
<code>astromerr</code>	Compute an estimate of the astrometric error given FWHM and SNR.
<code>astsn2rd</code>	Astrometry conversion from $(\xi, \eta)$ to $(\alpha, \delta)$
<code>astsn2xy</code>	Astrometry conversion from tangent plane $(\xi, \eta)$ to image (x,y)
<code>astsolve</code>	Solve for astrometric transformation from image to sky coordinates.
<code>astterms</code>	Evaluate the independent vectors to match an astrometric polynomial function.
<code>astwave</code>	Compute the effective wavelength of an observation for astrometry
<code>astxy2rd</code>	Astrometry conversion from image (x,y) to $(\alpha, \delta)$
<code>astxy2sn</code>	Astrometry conversion from image (x,y) to tangent plane $(\xi, \eta)$
<code>chiprot</code>	Find the best rotation and offset for one chip against monolith coordinates
<code>cloneast</code>	Clone astrometric solutions from one night to another
<code>desalt</code>	Flag fake objects in .obj files that were originally generated by insalt

(IDL)

dewarp	Transforms an image from (x,y) to ( $\xi,\eta$ ) accounting for rotation and warping.
dlooker	Visual identification and measurement of moving objects in digital images.
ephcheck	Compare a set of astrometry observations against an ephemeris.
frmdxdy	Given two lists of source on field, find the dx,dy offset between lists.
frmdxyr	Given two lists of source on field, find the dx,dy,dr offset between lists.
gaiafcats	Read a full Gaia DR2 catalog and convert to the fixed epoch format file
getnewid	Obtain an id that can be used for a new object based on database information
hsteditmask	Edit the bad pixel mask for a WFC3 image
hstextract	Define target position and extract sub-frame for processing
hstfinalpdf	Combine target and reference star PDFs for the final astrometry PDF
hstinitstar	Initialize data and fitting parameters for a star fit to HST WFC3 data
hstinitarg	Initialize data and fitting parameters for a target fit to HST WFC3 data
hstmeasure	Measure a science target position in an HST WFC3 image
hstmodstar	Calculate chi-square value for trailed star fit
hstmodarg	Calculate chi-square value for point source target fit
hstspdfp	Plot stellar PDF from a fit and save covariance to database
hststarerr	Determine fit errors for PSF fits to trailed stars
hststarfit	Fit a model to single source in HST WFC3 data.
hsttargerr	Determine fit errors for PSF fits to point source targets
hsttargfit	Fit a model of a single point source target to HST WFC3 data.
hsttpdfp	Plot target PDF from a fit and save covariance to database
hstwcpdf	Generate the final PDF from the joint constraints for all the good stars
hstwcsupdt	Update the WCS from a HST WFC3 image
kbompck	Pre-check and summary for MPC data submission for KBO/Centaur observations
linkobj2	Cross check source lists from one field and identify moving objects.
linkobj	Cross check three source lists from one field and identify moving objects.
looker	Visual identification and measurement of moving objects in digital images.
lplastchk	Scan for linkages among a collection of asteroid astrometric measurements
matchup	Read a batch of FITS files and create a list of common object exposures.
mergeobj	Merge a pair of object lists.
mkastinfo	Generate a simple astrometric description of an image
mosastrom	Astrometry solution for multi-detector image sets
moscheck	Scan Mosaic astrometry data and look for inconsistencies and problems
mosphot	Plot Mosaic astrometric solution for DES data and do photometric calibration.
mosplot	Plot Mosaic astrometric solution for DES data and do astrometry.
mpcdevt	Convert to and from Minor Planet Center packed designation format.
nobsupdt	Update the number of observations in the undesignated objects list.
objast	Generate astrometry from Looker (obj) files
objcheck	Validate and summarize object positions and astrometry
objid2mpc	Convert a geteph object id to a Minor Planet Center name
objprmt	Promote version of an object list file to highest version.
objrepor	Generate a report about the contents of the object files in a directory.
optaxis	Search for the optical axis in an astronomical image
paracorr	Take raw Gaia catalog data information and apply correction to a time
plast	Support routine for calling "PLAST" to get asteroids on an image.
plastext	Batch mode extraction of PLAST asteroid lists.
pmcorrdr3	Correct for the Gaia DR3 proper motion bias.
pntcol	Collate pointing data from astrometry results and image headers.
projerr	Re-project an error ellipse onto a new coordinate system
rdoblist	Read a object list from a file.

rdstarc	Read refnet based star catalog files.
rdtedast	Read a Ted Bowell format astrometry file
refcorr	Compute a differential refraction correction to an apparent position
refext	Batch mode extraction of REFNET star catalog fields in support of ASTROM
refgen	Generate a source/catalog cross-reference list
refnet	Support routine for calling "REFNET" to get stars from master catalogs.
srcast	Compute ra,dec for all objects in a source list (see findsrc).
wastrom	Widget for determining an interactive astrometric solution
wfc3_smear	Compute a smear kernel for a star while tracking a solar system object
wroblast	Write an object list to a file.
xdesig	Digest and record Minor Planet Center designation cross references.

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**Astronomy**

addstars	Manipulate the master star catalog (add/replace)
airmass	Compute airmass for one or more times.
altaz	Compute altitude and azimuth on sky given equatorial coordinates
altoha	Convert an object altitude to its hour angle.
appuldis	Find the circumstances of an appulse between a star and a solar system object
astmark	Annotate a graphic by marking an astronomical source in an image
astscbar	Draw a scale bar on an astronomical image.
caldatm	Find year, month, day, hour, minute, second from Julian Date.
col2teff	Find a black-body temperature for a star based on a photometric color
cvtsixty	General purpose routine for converting between sexagesimal and decimal.
decparse	Convert Declination string to radians.
decstr	Convert declination in radians to an ASCII string.
des_sum	Create a summary listing of KBOs in all directories of DES data
diamptoh	Compute asteroid absolute magnitude given diameter and V geometric albedo
dmstorad	Convert from degrees, minutes, and seconds to radians.
edtcoord	Display a celestial coordinate and permit editing the value.
eph4move	Generates ephemeris files for use by the MOVE computer.
ephem	Ephemeris generator for solar system objects.
etut	Compute ET-UT time offset for a given Julian Date
fieldobs	Real-time display of where objects are in the sky
finder	Interactive finder chart tool
findobj	Locate image changes with 3-plane color overlays
findobji	Locate image changes with 3-plane color overlays (array version)
fluxref	Provide standard fluxes for standard filters
futureob	Plot geometric circumstances for a solar system object for some years.
getlclmid	Compute the time of the next local midnight
getobloc	Fetch location of observatory given its code
getstars	Retrieve coordinates from the master star catalog
hangle	Compute the local hour angle of an object.
haparse	Convert Hour Angle (HA) string to radians.
hastr	Convert an Hour Angle to a string.
hatojd	Find the nearest Julian date for a given hour angle and date.
hdtoalb	Compute V geometric albedo of an asteroid given $H_V$ and diameter
hmstorad	Convert from hours, minutes, and seconds of Right Ascension to radians.
hptodiam	Compute diameter of an asteroid given $H_V$ and V-band geometric albedo
jd2year	Convert Julian date to decimal year.
jdparse	Read and parse a Julian Date from a calendar string

(IDL)

kbolist	Create a summary listing of KBOs in a single directory of DES data
kboplan	KBO observing planning table generation
lcltoeq	Convert from local horizon coordinates to equatorial coordinates
loadstar	Load the master star catalog file
lsidtim	Compute local sidereal time at a given longitude and time.
lst2jd	Compute UT given local sidereal time, longitude and approximate time.
lstlim	Compute the LST range for time of observation
mag2flx	Convert from magnitudes to flux units with errors.
mkhtmllog	Generate html viewer log for posting from .match file
naifname	Convert an ephemeris standard name to a common name (NAIF name scheme)
objappul	Generate a list of nightly appulses for a solar system object.
objstars	Get a list of stars from the USNO A2.0 catalog centered on a solar system object.
obsnight	Determine general details of a given night determined by Sun and Moon
obsplan	Generate a graphical summary of object location(s) for a given night.
obsprop	Observing proposal planning table generation
obswind	Compute possible observing window for a celestial object.
orb2obj	Extract object names from a slop orbit output file
orbvec	Computes orbit orientation vectors from angular orbital elements
patlatlon	Compute viewing and illumination geometry for Patroclus-Menoetius system
platlon	Compute viewing and illumination geometry for Pluto
pntfit2	Fit model to telescope pointing data.
pntfit3	Fit model to telescope pointing data.
pntfix3	Compute the pointing correction as used by MOVE at Anderson Mesa
ppolepa	Compute the position angle of Pluto's pole on the plane of the sky
radtodms	Convert an angle from radians to degrees, minutes, and seconds.
radtohrs	Convert from radians to hours, minutes, and seconds of right ascension.
raparse	Convert Right Ascension (RA) string to radians.
rastr	Convert RA in radians to hours, minutes, and seconds (ASCII string).
rdpoint	Read a raw ASCII format pointing data file as produced by MOVE.
refrac	Apply atmospheric refraction to a "true" zenith angle
remfit	Remove old pointing model from new data, create new pointing map data.
rhosc	Compute rhosinp, rhocosp from observatory lat, alt
savestar	Save the master star catalog file
shanelist	convert KBO target list to Lick Observatory Shane 3m telescope file
showelem	Print out current osculating orbital elements for a solar system object.
ssgeom	Compute Sun and Earth distance and phase angle for solar system object.
sspos	Interactive program for generating solar system body ephemerides.
starcatalog	Retrieve coordinates from the star catalogs.
starchart	Generate a star chart graphic
starset	Generate a list of nearby stars to help find a particular location
synstar2	Compute a synthetic (Lorentzian) star image.
tnoobs	Real-time planning and field selection tool for TNO survey observations.
tnorecov	Real-time planning and field selection tool for TNO survey observations.
wcsarrows	Draw sky-plane orientation arrows on an image based on WCS information
year2jd	Convert decimal year to Julian date (reverse of jd2year).

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### CCD data processing

acre	Automatic Cosmic Ray Extraction
addcrs	Add synthetic cosmic ray strikes to a CCD image.
addncal	Add calibration frames for entries in the nasacam calib data base

addpsf	Insert (add) one or more PSFs into an image
autocal	Automatic program for creating CCD calibration files.
avgclip	Average over a 3-D array, clipping unusual deviants.
backsub	Background subtraction from an image.
basphote	Circular aperture photometry extraction from images.
bildmask	Stack a set of bad pixel mask images into one master mask.
boxm	Find location of a maximum within a sub-array.
calibchg	Calibration structure maintenance utility.
calval	Validate overscan, cropping region, and calibration file settings.
ccdcal	Batch mode image calibration program (apply bias, dark and flats)
ccdgain	Extract and plot CCD gain transfer curve from flat field image data.
ccdproc	Apply standard CCD image correction steps to a raw image.
ccdsat	Find saturation properties of a CCD from one or more images
centrod	Compute center of mass of an object aperture.
cgetrng	How to integrate over a circle.
chknccal	Review and grade calibration images for nasacam.
clean	Remove a PSF from an image via the “clean” algorithm.
colbias	Determine and subtract column-wise overscan correction with cropping.
collapse	Take a detection image and collapse into a list of unique local maxima
darkadj	Adjust a superdark CCD calibration frame by a multiplicative constant.
editmask	Interactive image-based editing of a bad-pixel mask
findsrc	Automatic source detection and photometry from a digital image.
fitsbin	Software binning of an image in FITS file format.
fixsnap	Munge a SNAPSHOT format “FITS” header and make it legal FITS
fseeing	Collect and maintain seeing information for a group of images
fxtm	Fix bad time codes from Anderson Mesa CCD software.
getannul	Extract an annulus from a 2-D array.
gradebias	Automatic quality grading of a set of CCD bias images against a superbias
gradedark	Automatic quality grading of a set of CCD dark images against a superdark
gradeflat	Automatic quality grading of a set of CCD flat images against a superflat
gridwt	Compute circle overlap weights in a circle within an array.
hrcmodel	Generate synthetic PSF images for the HST ACS/HRC.
imqual	Generate a “grade” for image quality of input image.
imsalt	Implants fake point-source images into an image of the sky.
jitter	Generate a jitter convolution kernel for one WFPC2 observation.
jitterk	Convert pointing jitter data into a convolution kernel.
juploc	Find and extract Jupiter in images and create PDS FITS headers on output.
ldcalib	Load calibration frames and information as instructed by calib file.
limbcen	Find center of body from centroid of limb points (Designed for Jupiter).
maxloc	Find the column-wise, row-wise, or point location of the image maximum.
medarr_mwb	Combine arrays with a median average.
mkbias	Collect and combine CCD bias frames into a superbias frame
mkcalib	Interactive program for creating CCD calibration files.
mkdark	Collect and combine CCD dark frames into a superdark frame
mkflat	Collect and combine CCD flat frames into a superflat frame
mnicsky	Create a master sky image from a set of dithered NICMOS images.
mmaspli	Splice multi-amp CCD images back together.
moscal	Apply standard CCD image correction steps to a raw group-FITS image.
nicmodel	Generate synthetic PSF images for the HST NICMOS Camera
ois	Optimal image subtraction

(IDL)

p6model	Generate synthetic PSF images for the HST WFPC Planetary Camera, Chip 6.
pamgen	Compute a pixel-area map for an astronomical image
parsekey	Extract FITS header information by parsing supplied keys
pc2model	Generate synthetic PSF images for the HST WFPC2 Planetary Camera.
pfcamfix	Fix and reformat Lick 120" prime focus camera data.
photiso	Compute aperture photometry and grade sources for field contamination
pickim	Interactive program to select best image from cube for SL9 data.
pixwt	Circle-rectangle overlap area computation.
psffit2	Fit a numerical PSF to one or more sources in an image, fixed position.
psffit	Fit a numerical PSF to one or more sources in an image.
psfgen	Generate PSF files for a set of images
psfstack	Generate an average numerical psf by stacking observed images.
radp	Extract point-wise radial "profile" from image data.
rdsources	Read in a source list file created by findsrc or srcast
redfits	Apply standard CCD processing steps to a raw CCD image.
ringprof	Compute a surface brightness profile.
salt2des	Implant fake objects into DES data, second stage addition of objects.
salt2des	Implant fake objects into all relevant images on one night of DES data.
seeing	Given an astronomical image, determine the image quality (seeing).
showsrc	Show image with source lists and astrometric references overlain.
skyfit	Determine a 2-d polynomial fit to sky background in an image.
skyim	Calculate a smooth sky image from 2-d polynomial fit coefficients
sl9proc	Interactive program to process and crop image for SL9 data.
sortcube	Sort an image cube by brightness at each pixel
spotrm	Spot remover for images
srodcheck	Widget tool for verification of SRO data reduction results
stacker	Stack (co-add) image while registering images.
sumann	Integrate over an annulus.
synbias	Create a synthetic CCD bias frame with optional overscan.
syncalib	Create a synthetic suite of calibration image
syndark	Create a synthetic CCD dark frame with optional overscan
synflat	Create a synthetic flat frame with optional overscan
tmplinfo	Generate information about a template image based on an image header
warpstack	Stack a set of images on a given ROI warped to a master image
wfc3model	Generate synthetic PSF images for the HST WFC3 UVIS Camera.
wfpc2_distorted	Compute inverse of the wfpc2_metric function.
wrcalb	Save contents of a calibration structure to a file.

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### Celestial Mechanics

auxelem	Compute auxiliary orbital elements
eccrec	Compute coordinates given eccentricity anomaly
elem2xyz	Compute position given orbital elements (2-body Keplerian)
kepler1	Solve Kepler's Equation (small eccentricity)
moid	Compute the minimum orbit intersection distance between two orbits
newanom	Compute new mean anomaly from old given date.

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### Data Acquisition

obsdur	Calculate estimate of total duration of an exposure with PCCD.
slewdur	Estimate the time to slew the telescope from one location to another.

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### Database

dequote	Reconvert a string processed by QUOTE, or from the result of a MySQL query.
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hstloadhdr	Extract information from HST data headers and put in hstast.header database.
hstloadone	Read one header of a fit file and push select keywords to database
kboplot	Interactive plotting tool for the DES mySQL database contents.
mkdesast	Create data file to post into des.ast MySQL database from KBO search data
mkdesobj	Create data file to post into des.obj MySQL database from KBO search data
mkdesobs	Create data file to post into des_obs MySQL databse from KBO search data
mkdesxref	Create data file to post into des.xref MySQL database from KBO search data
mysqlcmd	Send a command to open database and collect the answer.
mysqldoc	Build a documentation file from internal mySQL documentation.
mysqldocedit	GUI editor for database documentation system
mysqldocscan	Scan a database and report discrepancies in the documentation table.
mysqlquery	Submit MySQL query and get response as vectors of data (like readcol).
mysqlsub	Recursive string substitution from mySQL doc table for building documentation
nasacamload	Load information from NASACAM data into mysql database
noterun	Widget to update notes field for runstat and other databases.
openmysql	Open a mySQL database for operations via a pipe.
pccd2load	Load information from PCCD (automated version) data into mysql database
pccdload	Load information from PCCD (automated version) data into mysql database
postfiltcl	Post-filter the vclass mySQL table removing uninteresting objects
quote	Convert a string into one safe for including in a mySQL query
reconcksum	Generate or refresh video data checksums
reconload	DESCRIPTIO
recontupd	Update start and ending times for RECON event video files in the database
roboccdload	Load information from Roboccd (automated version) data into mysql database
sc_bcheck	Search a star catalog for the number of stars near a given position
sc_nearest	Find the nearest N stars from a point in a star catalog.
sc_pstar	Search a star catalog for an isolated star near a given position.
sc_region	Extract a region of a star catalog about some location.

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## File I/O

exists	Check for file (or directory) existence.
fileline	Returns one line from a file at a chosen location.
finddata	Find valid file or directory names, using groups of path strings.
fitsedit	Interactive, widget-based editing of FITS header values.
gxpar	General purpose FITS file header keyword extraction.
hardcopy	Close printer or ps graphics device and spool output.
im2vid	Convert a sequence of images to a video file
loadkeys	Load FITS header keyword correspondence list from file.
logusage	Record a usage line to a log file
photprmt	Promote version of a photometry log file to highest version.
ppmsprmt	Promote version of photometry parmameter file to highest version.
rdainfo	Read final astrometry information file.
rdast	Read final astrometry data file.
rdastfc	Read an astrometry fit coefficient file.
rdat1i	Read and return a one dimensional 2-byte integer vector.
rdat1r	Read and return a one dimensional single precision floating point vector.
rdat2i	Read and return a two dimensional two byte integer vector.
rdat2r	Read and return a two dimensional single precision floating point vector.
rdat2u	Read and return a two dimensional two byte unsigned integer vector.
rdbyt	Read and return a two dimensional byte array from an animation file.

(IDL)

rdctioph	Reads raw card image CTIO photometry data files.
rdflt	Read and return a two dimensional byte array from an animation file.
rdgrab	Read raw binary IRTF-grabber1 format data files.
rdimg	Read and return the two images in an old style MaxEnt map.
rdkeylis	Read a correspondence list file into arrays.
rdland2	Read the Combined Landolt Standard system photometry file.
rdland	Read the Landolt Standards data file.
rdlplast	Read a Bowell format asteroid cross reference file (lplast.xrft)
rdmatch	Read a standard name — non-standard name correspondence file.
rdobjdes	Read in a file in the format of newobj.dat for use
rdobscod	Read standard observatory code data file.
rdoccpht	Read a Occultation Photometer data file.
rdphalt	Reads photometry from an alternate format basphote log file.
rdphocat	Read a photometry standard catalog from a file.
rdphot2	Reads the original BASPHOTC photometry log file.
rdphot3	Reads photometry from a reduced photometry file (see WRPHOT)
rdphot	Reads photometry from a basphotc log file.
rdplast	Read “plast” output files (object lists for astrometry)
rdpricat	Read data from a private star catalog.
rdraw	Read and return a two dimensional byte array from a raw animation file.
rdrawast	Read raw astrometry data file.
rdref	Read a astrometry support (.ref) file.
rdstrarr	Read a file into a string array
rdtbl	Read the data from the table file from one night of OSIRIS observations
rdtfile	Reads the template file, tfile.dat, for a given night.
rdwfc3	Read a HST WFC3 image with an associated mask and select header information
rdxtrack	Read an occultation definition file
reducprmt	Promote version of a reductor info file to highest version.
reformlc	Reformat an old-style MallinCAM RECON lightcurve to the new occ format
starcprmt	Promote version of a star catalog file to highest version.
tvgrab	Grab plot window and save to a portable image file.
wrastfc	Write an astrometry fit coefficient file.
wrbophot	Write a simple photometry data file.
wrmatch	Write a standard name — non-standard name correspondence file.
wrphalt	Write a photometry log file.
wrphocat	Write a photometry standard catalog file.
wrphot	Write a standard raw photometry data file (Pluto format).
wrref	Write a astrometry support (.ref) file.
wrstarc	Write a binary version of a star catalog.
wrstrarr	Write a string array to a file
wrtbl	Update the table file of a night’s OSIRIS data

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**Function fitting**

atmofit	Fit 1 or 2 gaussians to an astronomical image that is seeing limited.
edgefit	Fit an edge between two signal levels
fourfit	Fit one or more fourier terms to discrete (periodic) data.
goodpoly	Robust fitting of a polynomial to data.
lcfits	Fit a lightcurve function (Fourier series plus phase coefficient).
lcfitsvd	Fit a lightcurve function (Fourier series plus phase coefficient).
mysvdfit	Perform a general least squares fit with optional error estimates.



plch_fun	Two 2-d gaussian images, support routine for PLCHFIT.
plchfit	Two gaussian fit to an image of the Pluto-Charon system.
rcgfit	Fit a radial gaussian function to the input data (no linear term).
rfgfit	Fit a radial gaussian to the input data (no linear term, width fixed).
rgfit	Fit a radial gaussian function and 2nd order polynomial to the input data.
robosvd	Robust SVD linear regression fit using mysvdfit
rqgfit	Fit a radial gaussian function to the input data (no linear term).
safesalb	Filter to enforce a valid range of single scattering albedo [0,1]
slope	Compute slope of a line using part of the data.
star_fun	Single 2-d gaussian image, support routine for STARFIT.
starfit	Single gaussian fit to a stellar image.

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**Image Processing**

spexpand	Sparse expansion of an array
upsample	Upsample an image given a dithered set of undersampled data

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**Image display**

cie2rgb	Convert from CIE Chromaticity coordinates to RGB color-space values
digit	Digitize from a displayed gif file.
dispmask	Combine an image and a mask so that you can see both using color
hardim	Create a postscript image and/or print from an image.
imagect	Convert a byte image to a rgb image using a standard color table
initvc	Compute unit vectors for a spherical surface map.
negative	Invert the current display lookup table.
render	Render a rectangular projection map to a sphere.
seerad	Display a radial profile at X and Y value of the cursor
skysclim	Compute stretch range for a hard stretch on the background in an image.
spec2cie	Convert from reflectance spectrum to CIE Chromaticity coordinates
subarr	Extract a sub-array from an image with bound checking
wedge	Compute and return a gray scale step wedge.

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**Mathematical**

angsep	Compute the angular distance between two spherical coordinates.
cumsum	Cumulative sum of a vector
deriver	Compute the step-wise derivative of a function of one variable.
fn_hg1	Evaluate the 1-parameter Henyey-Greenstein phase function.
fn_hg2	Evaluate the 2-parameter Henyey-Greenstein phase function.
fn_hg2a	Evaluate the 2-parameter Henyey-Greenstein phase function (alternate).
fn_hg3	Evaluate the 3-parameter Henyey-Greenstein phase function.
fourfunc	Compute a Fourier series function (called by fourfit)
gauss1d	Compute a two dimensional gaussian within an array.
gauss2d	Compute a two dimensional gaussian within an array.
hgp	Compute a single parameter Henyey-Greenstein phase function.
interp	One dimensional interpolation onto a new x grid (both irregular)
lcfun	Compute a lightcurve function (Fourier series plus phase coefficient).
lcfunf	Compute a lightcurve function independent variables.
mwb_round	round a floating point number.
prival	Reduce an angle to its principal value ( $0 \leq \Theta < 2\pi$ ).
ransphere	compute random points on a unit sphere
recsph	Convert from rectangular to spherical coordinates
rotpoint	Rotate x,y,z point(s) about arbitrary axis.

(IDL)

rotvec	Rotate 3-D vectors from one coordinate system to another
salb	Compute single particle scattering albedo.
skymat	Compute the sky plane rotation matrix from angular coordinates
smplprb	Sample a probability function to facilitate drawing random numbers from it.
sphrec	Convert from spherical to rectangular coordinates
sshift2d	Shift a 2-D array using a damped sinc function for the fractional part.
synstar	Compute a synthetic (gaussian) star image.

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### Miscellaneous

airindex	Compute the real part of the refractive index of air.
bidr2	Compute the bi-directional reflectance (newer Hapke formula).
bidr4	Compute the bi-directional reflectance (Hapke 2012+enhancements).
bidr	Compute the bi-directional reflectance (old Hapke formula).
bondalb	Compute the Bond albedo given the single-scattering albedo
colcob	Compute the offset from the center-of-light to center-of-body.
cpalette	Choose a color from a selection of palettes
craterfun	Compute depth as a function of distance from center for a crater
destat	to gather pertinent DES statistics and put them into an html file
dewp	Compute dew point temperature give temperature and relative humidity
difref	Compute amount of atmospheric refraction relative to 5000 Angstroms.
ellipse2hull	Given an ellipse, sample it to a discrete curve
getddir	Load configuration and resolve source data location
getsalb2	Solve for single scattering albedo given bi-directional reflectance
getsalb	Solve for single scattering albedo given bi-directional reflectance
getvalue	Retrieve a value from a configuration information structure
gpsproc	Process and average a single day GPS record.
hemr	Compute the hemispherical reflectance
hstjit	Read and interpret HST jitter information.
hstpsf	Find or create a HST PSF file using Tiny Tim.
idstring	Generate a (hopefully) unique string
interior	Compute if a point is interior to a polygon
listcor	Correlate two string lists
loadini	Load configuration information file
logerror	Simplified error logging program.
mapseq	Animate a sequence of PLUTOMEM maps.
mkcircle	Compute points that lie on a circle
mkxyarr	Create two arrays that contain the x,y positions of the elements in an array
nextfile	Return the next (sorted) filename, from a search path, based upon a pattern.
num_mag	Gives the relative number vs. magnitude of KBOs.
num_rate	Gives the relative number vs. apparent motion rate(arcsec/hr) of KBOs.
num_size	Gives the relative number vs. diameter of craters
plotglob	Plot a globe projection with latitude and longitude lines
pwd	Print current working directory.
qhygpsavg	Average one or more files of GPS log data from a QHY174GPS camera
qhyprop	Return QHY camera properties
readtil	Read and return the two images in a MaxEnt tile map file.
reconnotice	Generate a reminder email notice for a missing RECON signup or report
reconstmail	Scan RECON database and send a summary email about sign-up status.
sortpair	Sort a pair of vectors by the first and return a sorted copy
trimrank	Remove dimensions of 1 thus returning the lowest possible rank for input

tvmaps	Display a full set of Pluto/Charon model .til maps on the current display.
tvtil	Display a Pluto/Charon .til map as an image on the current display.
windstr	Convert a wind direction angle to a string name (or back).
<hr/>	
<b>NoCategory</b>	
chfun	Compute various approximations of the Chandrasekhar H scattering function
<hr/>	
<b>Numerical</b>	
avger	Temporal averaging of time-series data.
blurmap	Apply spherical blurring to a map
findmax	Find the interpolated local maximum in a 2-D array.
lowess	Lowess smoothing of data.
sincfltr	Pass 1-d data through a low-pass filter (damped sinc).
sint2d	Sinc interpolation of a 2-D array of data.
sint	Sinc interpolation of a 1-D vector of data.
sinterp4	Four-fold sinc interpolation of a vector of data.
slidefil	Sliding spatial filter on time series data.
sshift	Shift data using a damped sinc function for fractional part.
stats	Compute and print statistics plus plot histogram of data.
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<b>Occultations</b>	
drtimes	Compute disappearance and reappearance times for an occultation given a shape
eventprob	Compute the success probability for an occultation from discrete sites
image2hull	Convert a bit-mapped image of an object to a hull
initsite	Initialize a regular grid of occultation station into a file
kmlgen	Make KML files for occultation maps
mkhull	Create a smoothed outline based on an occultation limb profile
mkhull	Create a smoothed outline based on an occultation limb profile
mkocconfig	Build an initial config.ini for PSF reduction of occultation data
mkocceph	Compute an occultation ephemeris for Wasserman prediction tools
mkspace	Make spacing file for creating occultation tracks
occattr	Determine occultation attributes
occbingen	Generate a binned version of an occultation dataset
occbuildpsf	Build a stacked PSF for images in an occultation dataset
occinfo	Generate information about an occultation dataset
occinitcam	Initialize an occultation campaign in the occlc database.
occinittarg	Initialize the target star position for an occultation dataset
occlfig	Generate a set of publication quality lightcurves for an occultation campaign
occlloadinfo	Load image information from an occultation dataset into the database
occlloadstars	Load stars for each image in an occultation dataset into the database
occmag	Compute a scaled magnitude for occultation planning
occmap	Make support files for occultation maps
occmodel	Compute a synthetic occultation profile
occplotinfo	Plot information for the source extraction from an occultation dataset
occplotlc	Plot a single site lightcurve from an occultation dataset
occpopspos	Update star positions after WCS generated for occultation datasets
occpred	Make occultation prediction
occsearch	Search one or more object for occultations
occshowgrid	Show a grid of postage stamp images from an occultation dataset
occsnrtab	Create occultation SNR tables for various systems
occstarfit	Fit a numerical PSF to each star image in an occultation dataset

(IDL)

occsumtab	Create table of occultation attributes
occtargfit	PSF fitting of the occultation target star
occtimbin	Bin QHY174 occultation images in time
occtime	Extract simple occultation timing from an occultation lightcurve
occtracks	Make support files for occultation tracks
occtsig	Estimate occultation event timing uncertainty
ocwcsgen	WCS solutions for occultation datasets
occxtrack	Compute cross-track and other geometric information for an occultation
rdevents	Read an occultation event file
rdoccroi	Read an occultation region of interest definition file and return a structure
rdccsnr	Read an occultation SNR definition file and return a structure
rdsites	Read an occultation event file
recondscan	Scan for RECON data for a given event
reconscore	Calculate occultation circumstances for the RECON telescope stations
recontarg	Add or update a specific RECON targeted occultation campaign
scindex	Build an index into the data produced from one night and site of QHY data
synthocc	Generate simulated occultation data

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**Photometry**

colorsol	Find the standard color of an unknown star.
contamchk	Check solar system object for contamination from field star.
coord	Given a list of names and JD, return coordinates (RA and Dec).
crmatch	Create a standard name — non-standard name correspondence file.
datamon	Summary plot of raw data contained in photometry log file
dbphot	Add or update observation entries in the photometry data base.
disphase	Apply distance and phase angle correction to observed magnitudes.
flx2mag	Convert from flux units to magnitudes with errors.
fourpdm	Period search by Fourier fit dispersion minimization ( $\chi^2$ based).
gareabv	Determine B,V transformation from Gaia in a region
getcolor	Given a list of names and JD, return B-V and V-R colors.
gettran	Find and return transformation solution for a given night and instrument
gtrans	Transform from Gaia (G,GB,GR) magnitudes to another standard bandpass
inst2std	Apply photometric transformation from instrumental to standard mags.
iof2mag	Compute the flux (mJy) of unit surface area ( $1 \text{ km}^2$ ) with unit reflectivity
iota2lc	Read an IOTA cvs lightcurve file and convert to a simple text table
lterv2	Photometric lightcurve reductions with known transformation.
lterv2c	2-color lightcurve reductions with known transformation.
lterv	Photometric lightcurve reductions against a single comparison star.
moschipcal	Determine the photometric calibration of a single Mosaic CCD
msrcor	Spatial correlation of source positions found in multiple lists
occproc	Aperture photometry of occultation data
onchip	Extract and optionally plot differential on-chip photometry.
parseop	Parse an operation line from photometry reduction, reduc.inf, file
pdm2	Period search by phase dispersion minimization ( $\chi^2$ based)
pdm2dis	Phase disconnect shift search by phase dispersion minimization ( $\theta$ based).
pdm2shif	Zero-point shift search by phase dispersion minimization ( $\theta$ based).
pdm	Period search by phase dispersion minimization ( $\theta$ based).
pdmshif	Zero-point shift search by phase dispersion minimization ( $\theta$ based).
perser	Automated asteroid period search tool.
phasebin	Compute a phase binned average lightcurve

phot2db	Process a file of external photometry and add to phot database.
photcal	Photometric calibration using two lists of partially overlapping sources.
photphot	Photometry from photographic image data.
photred	Reduction of non-variable point source absolute photometry.
plotphot	Plot extinction fits from Tholen's ltrv program.
plpedit	Interactive editing of photometry data files.
plreduc	Computes the standard magnitude of Pluto for each image per observing night.
puttran	Add or replace transformation solution for a given
raw1cat	Determine standard magnitudes of isolated sources for the raw1 catalog.
raw2cat	Determine standard magnitudes of crowded sources for the raw2 catalog.
rdreduc	Reader for a reductor info file (reduc.inf)
reduc	Photometry reduction widget for using reductor.
reductor	Automated photometry reduction tool.
rephot	Reprocess photometry data set by re-extracting from images.
siftstar	Generate filtered lists of stars from a single image tagged by crowding
snrpred	Compute an estimated signal-to-noise ratio for a point source
stage1cat	Generates the Stage1 catalog for a given Raw1 catalog
stage2cat	Generates the Stage2 catalog for a given Raw2 catalog
stageselect	Selects catalog stars for a given RA/Dec range.
starproc	Collect and process final (standard) star photometry
stdcheck	Determine if object is in a given standard catalog.
transf	Determine transformation coefficients from instrumental to standard mags.
wrreduc	Write a reductor info file (reduc.inf)
<hr/> <b>Plotting</b>	
axextend	Adjust an axis plot range
rescale	Scale data for plotting from one range to another.
<hr/> <b>Publications</b>	
authorproc	Create author lists for LaTeX manuscripts
<hr/> <b>Set Manipulation</b>	
fulljoin	Create the full join, or Cartesian product of two sets.
intrsect	Find the intersection or its inverse between two arrays.
<hr/> <b>Spectroscopy</b>	
avgspec	Robust average of a set of 1-D spectra from FITS files.
cavgspec	Robust average of a set of 1-D spectra.
clnspec	Interactive cleaning of bad pixels in an OSIRIS XD spectrum.
clscan	Scan a group of raw OSIRIS XD frames and find rough spectral location.
flagspec	Interactive marking of bad pixels in an OSIRIS XD spectrum.
getpair	Read two OSIRIS XD data files and return the difference strip image.
getspec	Extract a point source spectrum from OSIRIS XD data.
getstrip	Extract a 2-d rectangular strip image from a OSIRIS XD image.
inslit	Compute flux passing through a slit assuming a gaussian image.
lclxtrem	Find local minima or maxima in a 1-d vector.
ldcalir	Load calibration information for OSIRIS XD data from a calib file.
nic1scan	Scan for best spectrum location of a weak-signal NICMOS spectrum.
nic1src	Improved 1 source extraction from single NICMOS Grism image data.
nic2src	Detangle two sources from single NICMOS Grism image data.
nicinit	Extract initial spectrum and profile from NICMOS Grism image data.
nicplot	Create a summary plot of the contents of a NICMOS Grism data structure.

(IDL)

nicprof	Update NICMOS observation structure based on a new centerline.
objratio	Ratio object spectra to one or more comp star spectra.
optspec	Optimal extraction of a point source spectrum from OSIRIS XD data.
osiclean	Automatic cleaning of bad and low signal data from OSIRIS XD spectrum
osidvfit	Find the linear fit coefficients for a spectrum for each order
osislope	Correct an IR OSIRIS spectrum for the slope problem.
osismean	Compute mean of a set of OSIRIS XD spectra.
plotsn	Analyze a vector and retrieve the signal-to-noise ratio.
plotspec	Plot OSIRIS XD spectral data with wavelength scale.
rdnicobs	Read a NICMOS observation set description file.
sigratio	Compute the relative signal level between a set of spectra (1-d vectors).
ss.et	Simple spectral extraction tool
ss.extin	Simple Spectra - determine differential extinction
ss.group	Simple Spectr
tblparse	Determine properties and problems from the table file with OSIRIS data
wrcalir	Write calibration information for OSIRIS XD data to a calib file.
xdavg	Interactive tool for combining and correcting OSIRIS XD spectra.
xdspec	End-to-end reduction tool for OSIRIS XD spectral data.

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### Statistics

mcmcsamp	Markov-chain Monte-Carlo sampling tool
meanerr2	Calculate the mean and estimated error for a set of weighted data points
meanerr	Calculate the mean and estimated errors for a set of data points
moment4	Compute various statistical moments of the data.
pdf2covar	Convert a probability density function to a covariance matrix
robomean	Robust statistical moments of the data.

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### Utility

addslash	Append a trailing / to string (if needed).
badpar	Validate an input parameter against valid entries.
buildarr	Build up a master array by concatenation
cputime	Return the accumulated user and system times since an arbitrary time.
delelem	Delete one or more array elements from an array
display	IDL procedure for initializing the X window display for plotting.
exporter	GUI to facilitate exporting a subset of a night's data.
jdstr	Convert Julian date into an ASCII string.
landscap	Procedure for initializing the PS device for plotting.
mailmsg	Send an email message
matchobj	Find matches for non-standard names in a correspondence list.
maxmin	Return vector [max,min] of input array or vector.
mimiretc	Exposure time and throughput calculator for <i>Mimir</i>
mkrundate	Create a run date string given a Julian Date.
mon2num	Convert the name of a month to its integer equivalent.
nobname	Replace all blanks in a string with an underscore character.
nofile	Validate the existence of a file
numtoflist	Convert array of integer numbers to roboccd style filenames and back.
portrait	IDL procedure for initializing the PS device for portrait mode plotting.
rangepar	Parse a string with numbers and ranges to get an expanded list of numbers.
relpath	Prepend a path to the file name if file starts with +
repchar	Replace a target string with a new string in string or string array.
repwrite	Update file by replacing or adding line of information

setcolor	Set a 24-bit color value for plotting on 24-bit direct graphics or Postscript
setpage	Set size and location of plot on page to center the output.
setusym	Set the user defined symbol to one of many shapes.
setwin	Set current draw window, create if needed.
showcall	Print a copy of the command line
strb36	Convert an integer into a Base 36 formatted string.
strb62	Convert an integer into a Base 62 formatted string.
tobacksl	Convert forward slash (/) to backslash (\) in string.
uniqueid	Create a unique identifying string

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**Video data processing**

getdigits	Decode a single image with an IOTA-VTI time code
timeinfo	Collect IOTA-VTI time codes from one or more video frames
vidinfo	Extract and return information about a video file

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**Widgets**

calibed	Widget for editing CCD calibration information.
ccdphot	General purpose display and processing of CCD image (FITS) files.
cw_osipl	Display the various spectra generated by xdavg
eggtimer	Widget countdown timer
garth	Visual inspector of moving target triplet detections.
itool	General purpose image display (front-end for itool__define).
itool	To display an image and provide tools for its visualization.
itool_pplod	Load itool photometry parameters from a file.
itool_ppsav	Save itool photometry parameters to a file.
itool_template	Plots profiles of an extracted array of data.
itool_tpannounc	Custom text and graphical-dialog tool, specific to template corruption.
itoolimage__define	Define the 'itoolimage' object class.
itoolwacpmgr	To perform interactive sky selection for faint-comet photometry.
itoolwaimparms	To display and edit itool image parameters.
itoolwaphparms	To display and edit itool photometry parameters.
itoolwapixed	To edit individual pixels in an itool image.
itoolwaprofile	To plot profiles of an extracted array of data.
itoolwatpmgr	To define, edit, and manage itool photometry templates.
logmanip	Widget for editing and manipulating photometry log files.
markdata	Widget for marking/unmarking bad data.
picker	Widget for selecting a text item from a list.
qinput	Prompt user for input using a popup widget.
viewtext	View a string, or string array, of text in a scrollable text widget.
xoracle	Display "oracle" animation image sequences.
xrunplot	Display a complete graphical summary of "plutomem" output logs.

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**All routines**

acre	Automatic Cosmic Ray Extraction
addcrs	Add synthetic cosmic ray strikes to a CCD image.
addnccal	Add calibration frames for entries in the nasacam calib data base
addpsf	Insert (add) one or more PSFs into an image
addslash	Append a trailing / to string (if needed).
addstar	Add a reference star to the data base for fitting
addstars	Manipulate the master star catalog (add/replace)
airindex	Compute the real part of the refractive index of air.
airmass	Compute airmass for one or more times.
altaz	Compute altitude and azimuth on sky given equatorial coordinates
altoha	Convert an object altitude to its hour angle.
angsep	Compute the angular distance between two spherical coordinates.
appuldis	Find the circumstances of an appulse between a star and a solar system object
ast2ted	Convert astrometry file to a Ted Bowell format astrometry file.
astanal	Analyze and provide summary plots and averages for one night of astrometry
astchi1	Astrometric goodness-of-fit for one image based on rotation and offset
astcol	Collect astrometry observations for multiple objects
astcvt	Convert between different astrometric coordinate systems.
asteval	Evaluate an astrometric polynomial function.
astinfo	Decode (or add) astrometric information from a FITS header
astlinks	Scan for linkages among a collection of asteroid astrometric measurements
astlist	Create a summary listing from a final astrometry file.
astmark	Annotate a graphic by marking an astronomical source in an image
astpdf	Compute a discrete numerical probability sample for astrometry
astpred	Simple asteroid position predictor when no orbit is available.
astprmt	Promote version of an astrometry fit coefficient file to highest version.
astrd2sn	Astrometry conversion from $(\alpha, \delta)$ to $(\xi, \eta)$
astrd2xy	Astrometry conversion from $(\alpha, \delta)$ to image (x,y)
astrepro	Re-reduce existing astrometry originally measured with ASTROM
astrom	Astrometry from a digital image.
astromerr	Compute an estimate of the astrometric error given FWHM and SNR.
astsclbar	Draw a scale bar on an astronomical image.
astsn2rd	Astrometry conversion from $(\xi, \eta)$ to $(\alpha, \delta)$
astsn2xy	Astrometry conversion from tangent plane $(\xi, \eta)$ to image (x,y)
astsolve	Solve for astrometric transformation from image to sky coordinates.
astterms	Evaluate the independent vectors to match an astrometric polynomial function.
astwave	Compute the effective wavelength of an observation for astrometry
astxy2rd	Astrometry conversion from image (x,y) to $(\alpha, \delta)$
astxy2sn	Astrometry conversion from image (x,y) to tangent plane $(\xi, \eta)$
atmofit	Fit 1 or 2 gaussians to an astronomical image that is seeing limited.
authorproc	Create author lists for LaTeX manuscripts
autocal	Automatic program for creating CCD calibration files.
auxelem	Compute auxiliary orbital elements
avgclip	Average over a 3-D array, clipping unusual deviants.
avger	Temporal averaging of time-series data.
avgspec	Robust average of a set of 1-D spectra from FITS files.
axextend	Adjust an axis plot range
backsub	Background subtraction from an image.
badpar	Validate an input parameter against valid entries.



basphote	Circular aperture photometry extraction from images.
bidr2	Compute the bi-directional reflectance (newer Hapke formula).
bidr4	Compute the bi-directional reflectance (Hapke 2012+enhancements).
bidr	Compute the bi-directional reflectance (old Hapke formula).
bildmask	Stack a set of bad pixel mask images into one master mask.
blurmap	Apply spherical blurring to a map
bondalb	Compute the Bond albedo given the single-scattering albedo
boxm	Find location of a maximum within a sub-array.
buildarr	Build up a master array by concatenation
caldatm	Find year, month, day, hour, minute, second from Julian Date.
calibchg	Calibration structure maintenance utility.
calibed	Widget for editing CCD calibration information.
calval	Validate overscan, cropping region, and calibration file settings.
cavgspec	Robust average of a set of 1-D spectra.
ccdcal	Batch mode image calibration program (apply bias, dark and flats)
ccdgain	Extract and plot CCD gain transfer curve from flat field image data.
ccdphot	General purpose display and processing of CCD image (FITS) files.
ccdproc	Apply standard CCD image correction steps to a raw image.
ccdsat	Find saturation properties of a CCD from one or more images
centrod	Compute center of mass of an object aperture.
cgetrng	How to integrate over a circle.
chfun	Compute various approximations of the Chandrasekhar H scattering function
chiprot	Find the best rotation and offset for one chip against monolith coordinates
chknccal	Review and grade calibration images for nasacam.
cie2rgb	Convert from CIE Chromaticity coordinates to RGB color-space values
clean	Remove a PSF from an image via the “clean” algorithm.
cleandat	Interactive program to eliminate and smooth over bad data points.
clnspec	Interactive cleaning of bad pixels in an OSIRIS XD spectrum.
cloneast	Clone astrometric solutions from one night to another
clscan	Scan a group of raw OSIRIS XD frames and find rough spectral location.
col2teff	Find a black-body temperature for a star based on a photometric color
colbias	Determine and subtract column-wise overscan correction with cropping.
colcob	Compute the offset from the center-of-light to center-of-body.
collapse	Take a detection image and collapse into a list of unique local maxima
colorsol	Find the standard color of an unknown star.
contamchk	Check solar system object for contamination from field star.
coord	Given a list of names and JD, return coordinates (RA and Dec).
cpalette	Choose a color from a selection of palettes
cptime	Return the accumulated user and system times since an arbitrary time.
craterfun	Compute depth as a function of distance from center for a crater
crmatch	Create a standard name — non-standard name correspondence file.
cumsum	Cumulative sum of a vector
cvtsixty	General purpose routine for converting between sexagesimal and decimal.
cw_osipl	Display the various spectra generated by xdavg
darkadj	Adjust a superdark CCD calibration frame by a multiplicative constant.
datamon	Summary plot of raw data contained in photometry log file
dbphot	Add or update observation entries in the photometry data base.
decparse	Convert Declination string to radians.
decstr	Convert declination in radians to an ASCII string.
delelem	Delete one or more array elements from an array

(IDL)

dequote	Reconvert a string processed by QUOTE, or from the result of a MySQL query.
deriver	Compute the step-wise derivative of a function of one variable.
des_sum	Create a summary listing of KBOs in all directories of DES data
desalt	Flag fake objects in .obj files that were originally generated by insalt
destat	to gather pertinent DES statistics and put them into an html file
dewarp	Transforms an image from (x,y) to ( $\xi,\eta$ ) accounting for rotation and warping.
dewp	Compute dew point temperature give temperature and relative humidity
diamptoh	Compute asteroid absolute magnitude given diameter and V geometric albedo
difref	Compute amount of atmospheric refraction relative to 5000 Angstroms.
digit	Digitize from a displayed gif file.
disphase	Apply distance and phase angle correction to observed magnitudes.
display	IDL procedure for initializing the X window display for plotting.
dispmask	Combine an image and a mask so that you can see both using color
dlooker	Visual identification and measurement of moving objects in digital images.
dmstorad	Convert from degrees, minutes, and seconds to radians.
drtimes	Compute disappearance and reappearance times for an occultation given a shape
eccrec	Compute coordinates given eccentricity anomaly
edgefit	Fit an edge between two signal levels
editmask	Interactive image-based editing of a bad-pixel mask
edtcoord	Display a celestial coordinate and permit editing the value.
eggtimer	Widget countdown timer
elem2xyz	Compute position given orbital elements (2-body Keplerian)
ellipse2hull	Given an ellipse, sample it to a discrete curve
eph4move	Generates ephemeris files for use by the MOVE computer.
ephcheck	Compare a set of astrometry observations against an ephemeris.
ephem	Ephemeris generator for solar system objects.
equtemp	Compute a simple thermal equilibrium temperature for an asteroidal surface
etut	Compute ET-UT time offset for a given Julian Date
eventprob	Compute the success probability for an occultation from discrete sites
exists	Check for file (or directory) existence.
exporter	GUI to facilitate exporting a subset of a night's data.
fieldobs	Real-time display of where objects are in the sky
fileline	Returns one line from a file at a chosen location.
finddata	Find valid file or directory names, using groups of path strings.
finder	Interactive finder chart tool
findmax	Find the interpolated local maximum in a 2-D array.
findobj	Locate image changes with 3-plane color overlays
findobji	Locate image changes with 3-plane color overlays (array version)
findsrc	Automatic source detection and photometry from a digital image.
fitsbin	Software binning of an image in FITS file format.
fitsedit	Interactive, widget-based editing of FITS header values.
fixsnap	Munge a SNAPSHOT format "FITS" header and make it legal FITS
flagspec	Interactive marking of bad pixels in an OSIRIS XD spectrum.
fluxref	Provide standard fluxes for standard filters
flx2mag	Convert from flux units to magnitudes with errors.
fn_hg1	Evaluate the 1-parameter Henyey-Greenstein phase function.
fn_hg2	Evaluate the 2-parameter Henyey-Greenstein phase function.
fn_hg2a	Evaluate the 2-parameter Henyey-Greenstein phase function (alternate).
fn_hg3	Evaluate the 3-parameter Henyey-Greenstein phase function.
focscan	Summarize and plot focus log files from PCCD.

fourfit	Fit one or more fourier terms to discrete (periodic) data.
fourfunc	Compute a Fourier series function (called by fourfit)
fourpdm	Period search by Fourier fit dispersion minimization ( $\chi^2$ based).
frmdxdy	Given two lists of source on field, find the dx,dy offset between lists.
frmdxyr	Given two lists of source on field, find the dx,dy,dr offset between lists.
fseeing	Collect and maintain seeing information for a group of images
fulljoin	Create the full join, or Cartesian product of two sets.
futureob	Plot geometric circumstances for a solar system object for some years.
fxtm	Fix bad time codes from Anderson Mesa CCD software.
gaiafcats	Read a full Gaia DR2 catalog and convert to the fixed epoch format file
gareabv	Determine B,V transformation from Gaia in a region
garth	Visual inspector of moving target triplet detections.
gauss1d	Compute a two dimensional gaussian within an array.
gauss2d	Compute a two dimensional gaussian within an array.
getannul	Extract an annulus from a 2-D array.
getcolor	Given a list of names and JD, return B-V and V-R colors.
getddir	Load configuration and resolve source data location
getdigits	Decode a single image with an IOTA-VTI time code
getlclmid	Compute the time of the next local midnight
getnewid	Obtain an id that can be used for a new object based on database information
getobloc	Fetch location of observatory given its code
getpair	Read two OSIRIS XD data files and return the difference strip image.
getsalb2	Solve for single scattering albedo given bi-directional reflectance
getsalb	Solve for single scattering albedo given bi-directional reflectance
getspec	Extract a point source spectrum from OSIRIS XD data.
getstars	Retrieve coordinates from the master star catalog
getstrip	Extract a 2-d rectangular strip image from a OSIRIS XD image.
gettran	Find and return transformation solution for a given night and instrument
getvalue	Retrieve a value from a configuration information structure
goodpoly	Robust fitting of a polynomial to data.
gpsproc	Process and average a single day GPS record.
gradebias	Automatic quality grading of a set of CCD bias images against a superbias
gradedark	Automatic quality grading of a set of CCD dark images against a superdark
gradeplat	Automatic quality grading of a set of CCD flat images against a superflat
gridwt	Compute circle overlap weights in a circle within an array.
gtrans	Transform from Gaia (G,GB,GR) magnitudes to another standard bandpass
gxpar	General purpose FITS file header keyword extraction.
hangle	Compute the local hour angle of an object.
haparse	Convert Hour Angle (HA) string to radians.
hardcopy	Close printer or ps graphics device and spool output.
hardim	Create a postscript image and/or print from an image.
hastr	Convert an Hour Angle to a string.
hatojd	Find the nearest Julian date for a given hour angle and date.
hdtoalb	Compute V geometric albedo of an asteroid given $H_V$ and diameter
hemr	Compute the hemispherical reflectance
hgp	Compute a single parameter Henyey-Greenstein phase function.
hmstorad	Convert from hours, minutes, and seconds of Right Ascension to radians.
hptodiam	Compute diameter of an asteroid given $H_V$ and V-band geometric albedo
hrcmodel	Generate synthetic PSF images for the HST ACS/HRC.
hsteditmask	Edit the bad pixel mask for a WFC3 image

(IDL)

hstextract	Define target position and extract sub-frame for processing
hstfinalpdf	Combine target and reference star PDFs for the final astrometry PDF
hstinitstar	Initialize data and fitting parameters for a star fit to HST WFC3 data
hstinittarg	Initialize data and fitting parameters for a target fit to HST WFC3 data
hstjit	Read and interpret HST jitter information.
hstloadhdr	Extract information from HST data headers and put in hstast.header database.
hstloadone	Read one header of a fit file and push select keywords to database
hstmeasure	Measure a science target position in an HST WFC3 image
hstmodstar	Calculate chi-square value for trailed star fit
hstmodtarg	Calculate chi-square value for point source target fit
hstpsf	Find or create a HST PSF file using Tiny Tim.
hstspdfp	Plot stellar PDF from a fit and save covariance to database
hststarerr	Determine fit errors for PSF fits to trailed stars
hststarfit	Fit a model to single source in HST WFC3 data.
hsttargerr	Determine fit errors for PSF fits to point source targets
hsttargfit	Fit a model of a single point source target to HST WF3 data.
hsttpdfp	Plot target PDF from a fit and save covariance to database
hstwcspdf	Generate the final PDF from the joint constraints for all the good stars
hstwcsupd	Update the WCS from a HST WFC3 image
idstring	Generate a (hopefully) unique string
im2vid	Convert a sequence of images to a video file
image2hull	Convert a bit-mapped image of an object to a hull
imagect	Convert a byte image to a rgb image using a standard color table
imqual	Generate a “grade” for image quality of input image.
imsalt	Implants fake point-source images into an image of the sky.
initsite	Initialize a regular grid of occultation station into a file
initvc	Compute unit vectors for a spherical surface map.
inslit	Compute flux passing through a slit assuming a gaussian image.
inst2std	Apply photometric transformation from instrumental to standard mags.
interior	Compute if a point is interior to a polygon
interp	One dimensional interpolation onto a new x grid (both irregular)
intrsect	Find the intersection or its inverse between two arrays.
iof2mag	Compute the flux (mJy) of unit surface area (1 km <sup>2</sup> ) with unit reflectivity
iota2lc	Read an IOTA cvs lightcurve file and convert to a simple text table
itool	General purpose image display (front-end for itool__define).
itool	To display an image and provide tools for its visualization.
itool_pplod	Load itool photometry parameters from a file.
itool_ppsav	Save itool photometry parameters to a file.
itool_template	Plots profiles of an extracted array of data.
itool_tpannounc	Custom text and graphical-dialog tool, specific to template corruption.
itoolimage__define	Define the 'itoolimage' object class.
itoolwacpmgr	To perform interactive sky selection for faint-comet photometry.
itoolwaimparms	To display and edit itool image parameters.
itoolwaphparms	To display and edit itool photometry parameters.
itoolwapixed	To edit individual pixels in an itool image.
itoolwaprofile	To plot profiles of an extracted array of data.
itoolwatpmgr	To define, edit, and manage itool photometry templates.
jd2year	Convert Julian date to decimal year.
jdparse	Read and parse a Julian Date from a calendar string
jdstr	Convert Julian date into an ASCII string.

jitter	Generate a jitter convolution kernel for one WFPC2 observation.
jitterk	Convert pointing jitter data into a convolution kernel.
juploc	Find and extract Jupiter in images and create PDS FITS headers on output.
kbolist	Create a summary listing of KBOs in a single directory of DES data
kbompck	Pre-check and summary for MPC data submission for KBO/Centaur observations
kboplan	KBO observing planning table generation
kboplot	Interactive plotting tool for the DES MySQL database contents.
kepler1	Solve Kepler's Equation (small eccentricity)
kmlgen	Make KML files for occultation maps
landscap	Procedure for initializing the PS device for plotting.
lcfits	Fit a lightcurve function (Fourier series plus phase coefficient).
lcfitsvd	Fit a lightcurve function (Fourier series plus phase coefficient).
lcfun	Compute a lightcurve function (Fourier series plus phase coefficient).
lcfunf	Compute a lightcurve function independent variables.
lcltoeq	Convert from local horizon coordinates to equatorial coordinates
lclxtrem	Find local minima or maxima in a 1-d vector.
ldcalib	Load calibration frames and information as instructed by calib file.
ldcalir	Load calibration information for OSIRIS XD data from a calib file.
limbcen	Find center of body from centroid of limb points (Designed for Jupiter).
linkobj2	Cross check source lists from one field and identify moving objects.
linkobj	Cross check three source lists from one field and identify moving objects.
listcor	Correlate two string lists
loadini	Load configuration information file
loadkeys	Load FITS header keyword correspondence list from file.
loadstar	Load the master star catalog file
logerror	Simplified error logging program.
logmanip	Widget for editing and manipulating photometry log files.
logusage	Record a usage line to a log file
looker	Visual identification and measurement of moving objects in digital images.
lowess	Lowess smoothing of data.
lplastchk	Scan for linkages among a collection of asteroid astrometric measurements
lsidtim	Compute local sidereal time at a given longitude and time.
lst2jd	Compute UT given local sidereal time, longitude and approximate time.
lstlim	Compute the LST range for time of observation
lterv2	Photometric lightcurve reductions with known transformation.
lterv2c	2-color lightcurve reductions with known transformation.
lterv	Photometric lightcurve reductions against a single comparison star.
mag2flx	Convert from magnitudes to flux units with errors.
mailmsg	Send an email message
mapseq	Animate a sequence of PLUTOMEM maps.
markdata	Widget for marking/unmarking bad data.
matchobj	Find matches for non-standard names in a correspondence list.
matchup	Read a batch of FITS files and create a list of common object exposures.
maxloc	Find the column-wise, row-wise, or point location of the image maximum.
maxmin	Return vector [max,min] of input array or vector.
mcmcsamp	Markov-chain Monte-Carlo sampling tool
meanerr2	Calculate the mean and estimated error for a set of weighted data points
meanerr	Calculate the mean and estimated errors for a set of data points
medarr_mwb	Combine arrays with a median average.
mergeobj	Merge a pair of object lists.

(IDL)

mimiretc	Exposure time and throughput calculator for <i>Mimir</i>
mkastinfo	Generate a simple astrometric description of an image
mkbias	Collect and combine CCD bias frames into a superbias frame
mkcalib	Interactive program for creating CCD calibration files.
mkcircle	Compute points that lie on a circle
mkdark	Collect and combine CCD dark frames into a superdark frame
mkdesast	Create data file to post into des.ast MySQL database from KBO search data
mkdesobj	Create data file to post into des.obj MySQL database from KBO search data
mkdesobs	Create data file to post into des_obs MySQL database from KBO search data
mkdesxref	Create data file to post into des.xref MySQL database from KBO search data
mkflat	Collect and combine CCD flat frames into a superflat frame
mkhtmllog	Generate html viewer log for posting from .match file
mkhull	Create a smoothed outline based on an occultation limb profile
mkhull	Create a smoothed outline based on an occultation limb profile
mknicisky	Create a master sky image from a set of dithered NICMOS images.
mkocconfig	Build an initial config.ini for PSF reduction of occultation data
mkocceph	Compute an occultation ephemeris for Wasserman prediction tools
mkrundate	Create a run date string given a Julian Date.
mkspac	Make spacing file for creating occultation tracks
mkxyarr	Create two arrays that contain the x,y positions of the elements in an array
mmaspli	Splice multi-amp CCD images back together.
moid	Compute the minimum orbit intersection distance between two orbits
moment4	Compute various statistical moments of the data.
mon2num	Convert the name of a month to its integer equivalent.
mosastrom	Astrometry solution for multi-detector image sets
moscal	Apply standard CCD image correction steps to a raw group-FITS image.
moscheck	Scan Mosaic astrometry data and look for inconsistencies and problems
moschipcal	Determine the photometric calibration of a single Mosaic CCD
mosphot	Plot Mosaic astrometric solution for DES data and do photometric calibration.
mosplot	Plot Mosaic astrometric solution for DES data and do astrometry.
mpcdcv	Convert to and from Minor Planet Center packed designation format.
msrcor	Spatial correlation of source positions found in multiple lists
mwb_round	round a floating point number.
mysqlcmd	Send a command to open database and collect the answer.
mysqldoc	Build a documentation file from internal MySQL documentation.
mysqldocedit	GUI editor for database documentation system
mysqldocscan	Scan a database and report discrepancies in the documentation table.
mysqlquery	Submit MySQL query and get response as vectors of data (like readcol).
mysqlsub	Recursive string substitution from MySQL doc table for building documentation
mysvdfit	Perform a general least squares fit with optional error estimates.
naifname	Convert an ephemeris standard name to a common name (NAIF name scheme)
nasacamload	Load information from NASACAM data into mysql database
neatemp	Compute a simple effective black-body temperature for a near-Earth asteroid
negative	Invert the current display lookup table.
neoflux	Compute the estimated thermal flux emitted from the surface of an asteroid
neosignal	DESCRIPTIO
newanom	Compute new mean anomaly from old given date.
nextfile	Return the next (sorted) filename, from a search path, based upon a pattern.
niclscan	Scan for best spectrum location of a weak-signal NICMOS spectrum.
niclsrc	Improved 1 source extraction from single NICMOS Grism image data.

nic2src	Detangle two sources from single NICMOS Grism image data.
nicinit	Extract initial spectrum and profile from NICMOS Grism image data.
nicmodel	Generate synthetic PSF images for the HST NICMOS Camera
nicplot	Create a summary plot of the contents of a NICMOS Grism data structure.
nicprof	Update NICMOS observation structure based on a new centerline.
nobname	Replace all blanks in a string with an underscore character.
nobsupdt	Update the number of observations in the undesignated objects list.
nofile	Validate the existence of a file
noterun	Widget to update notes field for runstat and other databases.
num_mag	Gives the relative number vs. magnitude of KBOs.
num_rate	Gives the relative number vs. apparent motion rate(arcsec/hr) of KBOs.
num_size	Gives the relative number vs. diameter of craters
numtoflist	Convert array of integer numbers to roboccd style filenames and back.
objappul	Generate a list of nightly appulses for a solar system object.
objast	Generate astrometry from Looker (obj) files
objcheck	Validate and summarize object positions and astrometry
objid2mpc	Convert a geteph object id to a Minor Planet Center name
objprmt	Promote version of an object list file to highest version.
objratio	Ratio object spectra to one or more comp star spectra.
objrepor	Generate a report about the contents of the object files in a directory.
objstars	Get a list of stars from the USNO A2.0 catalog centered on a solar system object.
obsdur	Calculate estimate of total duration of an exposure with PCCD.
obsnight	Determine general details of a given night determined by Sun and Moon
obsplan	Generate a graphical summary of object location(s) for a given night.
obsprop	Observing proposal planning table generation
obswind	Compute possible observing window for a celestial object.
occattr	Determine occultation attributes
occbingen	Generate a binned version of an occultation dataset
occbuildpsf	Build a stacked PSF for images in an occultation dataset
occinfo	Generate information about an occultation dataset
occinitcam	Initialize an occultation campaign in the occlc database.
occinittarg	Initialize the target star position for an occultation dataset
occlcfg	Generate a set of publication quality lightcurves for an occultation campaign
occlloadinfo	Load image information from an occultation dataset into the database
occlloadstars	Load stars for each image in an occultation dataset into the database
occmag	Compute a scaled magnitude for occultation planning
occmmap	Make support files for occultation maps
occmodel	Compute a synthetic occultation profile
occplot	Plot small pieces of stellar occultation data.
occplotinfo	Plot information for the source extraction from an occultation dataset
occplotlc	Plot a single site lightcurve from an occultation dataset
occpopspos	Update star positions after WCS generated for occultation datasets
occpred	Make occultation prediction
occproc	Aperture photometry of occultation data
occprof	Plot an occultation profile based on a set of chords
occsearch	Search one or more object for occultations
occshowgrid	Show a grid of postage stamp images from an occultation dataset
occsnrtab	Create occultation SNR tables for various systems
occstarfit	Fit a numerical PSF to each star image in an occultation dataset
occstrip	Generate a postage stamp strip of images for an occultation

(IDL)

occsumtab	Create table of occultation attributes
occtargfit	PSF fitting of the occultation target star
occtimbin	Bin QHY174 occultation images in time
occtime	Extract simple occultation timing from an occultation lightcurve
occtracks	Make support files for occultation tracks
occtsig	Estimate occultation event timing uncertainty
occwcsgen	WCS solutions for occultation datasets
occxtrack	Compute cross-track and other geometric information for an occultation
ois	Optimal image subtraction
onchip	Extract and optionally plot differential on-chip photometry.
openmysql	Open a mySQL database for operations via a pipe.
oplerr	Overplot data points with accompanying x or y error bars.
optaxis	Search for the optical axis in an astronomical image
optspec	Optimal extraction of a point source spectrum from OSIRIS XD data.
orb2obj	Extract object names from a slop orbit output file
orbvec	Computes orbit orientation vectors from angular orbital elements
osiclean	Automatic cleaning of bad and low signal data from OSIRIS XD spectrum
osidvfit	Find the linear fit coefficients for a spectrum for each order
osislope	Correct an IR OSIRIS spectrum for the slope problem.
osismean	Compute mean of a set of OSIRIS XD spectra.
p6model	Generate synthetic PSF images for the HST WFPC Planetary Camera, Chip 6.
pamgen	Compute a pixel-area map for an astronomical image
paracorr	Take raw Gaia catalog data information and apply correction to a time
parsekey	Extract FITS header information by parsing supplied keys
parseop	Parse an operation line from photometry reduction, reduc.inf, file
patlatlon	Compute viewing and illumination geometry for Patroclus-Menoetius system
pc2model	Generate synthetic PSF images for the HST WFPC2 Planetary Camera.
pccd2load	Load information from PCCD (automated version) data into mysql database
pccdload	Load information from PCCD (automated version) data into mysql database
pdf2covar	Convert a probability density function to a covariance matrix
pdm2	Period search by phase dispersion minimization ( $\chi^2$ based)
pdm2dis	Phase disconnect shift search by phase dispersion minimization ( $\theta$ based).
pdm2shif	Zero-point shift search by phase dispersion minimization ( $\theta$ based).
pdm	Period search by phase dispersion minimization ( $\theta$ based).
pdmshif	Zero-point shift search by phase dispersion minimization ( $\theta$ based).
perser	Automated asteroid period search tool.
pfcamfix	Fix and reformat Lick 120" prime focus camera data.
phasebin	Compute a phase binned average lightcurve
phot2db	Process a file of external photometry and add to phot database.
photcal	Photometric calibration using two lists of partially overlapping sources.
photiso	Compute aperture photometry and grade sources for field contamination
photphot	Photometry from photographic image data.
photprmt	Promote version of a photometry log file to highest version.
photred	Reduction of non-variable point source absolute photometry.
picker	Widget for selecting a text item from a list.
pickim	Interactive program to select best image from cube for SL9 data.
pixwt	Circle-rectangle overlap area computation.
plast	Support routine for calling "PLAST" to get asteroids on an image.
plastext	Batch mode extraction of PLAST asteroid lists.
platlon	Compute viewing and illumination geometry for Pluto



plch_fun	Two 2-d gaussian images, support routine for PLCHFIT.
plchfit	Two gaussian fit to an image of the Pluto-Charon system.
plotglob	Plot a globe projection with latitude and longitude lines
plotpcomc	Plot model fit residual files for Pluto-Charon map fitting
plotphot	Plot extinction fits from Tholen's ltrcv program.
plotsn	Analyze a vector and retrieve the signal-to-noise ratio.
plotspec	Plot OSIRIS XD spectral data with wavelength scale.
plpedit	Interactive editing of photometry data files.
plreduc	Computes the standard magnitude of Pluto for each image per observing night.
pmcorrdr3	Correct for the Gaia DR3 proper motion bias.
pntcol	Collate pointing data from astrometry results and image headers.
pntfit2	Fit model to telescope pointing data.
pntfit3	Fit model to telescope pointing data.
pntfix3	Compute the pointing correction as used by MOVE at Anderson Mesa
portrait	IDL procedure for initializing the PS device for portrait mode plotting.
postfiltcl	Post-filter the vclass mySQL table removing uninteresting objects
ppmsprmt	Promote version of photometry parmameter file to highest version.
ppolepa	Compute the position angle of Pluto's pole on the plane of the sky
prival	Reduce an angle to its principal value ( $0 \leq \Theta < 2\pi$ ).
projerr	Re-project an error ellipse onto a new coordinate system
psffit2	Fit a numerical PSF to one or more sources in an image, fixed position.
psffit	Fit a numerical PSF to one or more sources in an image.
psfgen	Generate PSF files for a set of images
psfstack	Generate an average numerical psf by stacking observed images.
puttran	Add or replace transformation solution for a given
pwd	Print current working directory.
qannounc	Scrollable text display widget with true and false response buttons.
qhygpsavg	Average one or more files of GPS log data from a QHY174GPS camera
qhyprop	Return QHY camera properties
qinput	Prompt user for input using a popup widget.
quote	Convert a string into one safe for including in a mySQL query
radp	Extract point-wise radial "profile" from image data.
radtodms	Convert an angle from radians to degrees, minutes, and seconds.
radtohms	Convert from radians to hours, minutes, and seconds of right ascension.
rangepar	Parse a string with numbers and ranges to get an expanded list of numbers.
ransphere	compute random points on a unit sphere
raparse	Convert Right Ascension (RA) string to radians.
rastr	Convert RA in radians to hours, minutes, and seconds (ASCII string).
raw1cat	Determine standard magnitudes of isolated sources for the raw1 catalog.
raw2cat	Determine standard magnitudes of crowded sources for the raw2 catalog.
rcgfit	Fit a radial gaussian function to the input data (no linear term).
rdainfo	Read final astrometry information file.
rdast	Read final astrometry data file.
rdastfc	Read an astrometry fit coefficient file.
rdat1i	Read and return a one dimensional 2-byte integer vector.
rdat1r	Read and return a one dimensional single precision floating point vector.
rdat2i	Read and return a two dimensional two byte integer vector.
rdat2r	Read and return a two dimensional single precision floating point vector.
rdat2u	Read and return a two dimensional two byte unsigned integer vector.
rdbyt	Read and return a two dimensional byte array from an animation file.

(IDL)

rdctioph	Reads raw card image CTIO photometry data files.
rddat	Display the X and Y value of the cursor in a plot
rdevents	Read an occultation event file
rdfft	Read and return a two dimensional byte array from an animation file.
rdgrab	Read raw binary IRTF-grabber1 format data files.
rdimg	Read and return the two images in an old style MaxEnt map.
rdkeylis	Read a correspondence list file into arrays.
rdland2	Read the Combined Landolt Standard system photometry file.
rdland	Read the Landolt Standards data file.
rdlplast	Read a Bowell format asteroid cross reference file (lplast.xrft)
rdmatch	Read a standard name — non-standard name correspondence file.
rdnicobs	Read a NICMOS observation set description file.
rdobjdes	Read in a file in the format of newobj.dat for use
rdoblist	Read a object list from a file.
rdobscod	Read standard observatory code data file.
rdoccpht	Read a Occultation Photometer data file.
rdoccroi	Read an occultation region of interest definition file and return a structure
rdocsnr	Read an occultation SNR definition file and return a structure
rdphalt	Reads photometry from an alternate format basphote log file.
rdphocat	Read a photometry standard catalog from a file.
rdphot2	Reads the original BASPHOTC photometry log file.
rdphot3	Reads photometry from a reduced photometry file (see WRPHOT)
rdphot	Reads photometry from a basphotc log file.
rdplast	Read “plast” output files (object lists for astrometry)
rdpoint	Read a raw ASCII format pointing data file as produced by MOVE.
rdpricat	Read data from a private star catalog.
rdraw	Read and return a two dimensional byte array from a raw animation file.
rdrawast	Read raw astrometry data file.
rdreduc	Reader for a reductor info file (reduc.inf)
rdref	Read a astrometry support (.ref) file.
rdsites	Read an occultation event file
rdsource	Read in a source list file created by findsrc or srcast
rdstarc	Read refnet based star catalog files.
rdstrarr	Read a file into a string array
rdtbl	Read the data from the table file from one night of OSIRIS observations
rdtedast	Read a Ted Bowell format astrometry file
rdtfile	Reads the template file, tfile.dat, for a given night.
rdwfc3	Read a HST WFC3 image with an associated mask and select header information
rdxtrack	Read an occultation definition file
readtil	Read and return the two images in a MaxEnt tile map file.
reconcksum	Generate or refresh video data checksums
recondscan	Scan for RECON data for a given event
reconload	DESCRIPTIO
reconnotice	Generate a reminder email notice for a missing RECON signup or report
reconscore	Calculate occultation circumstances for the RECON telescope stations
reconstmail	Scan RECON database and send a summary email about sign-up status.
recontarg	Add or update a specific RECON targeted occultation campaign
recontupd	Update start and ending times for RECON event video files in the database
recsph	Convert from rectangular to spherical coordinates
redfits	Apply standard CCD processing steps to a raw CCD image.

reduc	Photometry reduction widget for using reductor.
reducprmt	Promote version of a reductor info file to highest version.
reductor	Automated photometry reduction tool.
refcorr	Compute a differential refraction correction to an apparent position
refext	Batch mode extraction of REFNET star catalog fields in support of ASTROM
refgen	Generate a source/catalog cross-reference list
refnet	Support routine for calling "REFNET" to get stars from master catalogs.
reformlc	Reformat an old-style MallinCAM RECON lightcurve to the new occ format
refrac	Apply atmospheric refraction to a "true" zenith angle
relpath	Prepend a path to the file name if file starts with +
remfit	Remove old pointing model from new data, create new pointing map data.
render	Render a rectangular projection map to a sphere.
repchar	Replace a target string with a new string in string or string array.
rephot	Reprocess photometry data set by re-extracting from images.
repwrite	Update file by replacing or adding line of information
rescale	Scale data for plotting from one range to another.
rfgfit	Fit a radial gaussian to the input data (no linear term, width fixed).
rgfit	Fit a radial gaussian function and 2nd order polynomial to the input data.
rhosc	Compute rhosinp,rhocosp from observatory lat,alt
ringprof	Compute a surface brightness profile.
roboccdload	Load information from Roboccd (automated version) data into mysql database
robomean	Robust statistical moments of the data.
robosvd	Robust SVD linear regression fit using mysvdfit
rotpoint	Rotate x,y,z point(s) about arbitrary axis.
rotvec	Rotate 3-D vectors from one coordinate system to another
rqgfit	Fit a radial gaussian function to the input data (no linear term).
safesalb	Filter to enforce a valid range of single scattering albedo [0,1]
salb	Compute single particle scattering albedo.
saltdes2	Implant fake objects into DES data, second stage addition of objects.
saltdes	Implant fake objects into all relevant images on one night of DES data.
savestar	Save the master star catalog file
sc_bcheck	Search a star catalog for the number of stars near a given position
sc_nearest	Find the nearest N stars from a point in a star catalog.
sc_pstar	Search a star catalog for an isolated star near a given position.
sc_region	Extract a region of a star catalog about some location.
scindex	Build an index into the data produced from one night and site of QHY data
seeing	Given an astronomical image, determine the image quality (seeing).
seerad	Display a radial profile at X and Y value of the cursor
setcolor	Set a 24-bit color value for plotting on 24-bit direct graphics or Postscript
setpage	Set size and location of plot on page to center the output.
setusym	Set the user defined symbol to one of many shapes.
setwin	Set current draw window, create if needed.
shanelist	convert KBO target list to Lick Observatory Shane 3m telescope file
showcall	Print a copy of the command line
showelem	Print out current osculating orbital elements for a solar system object.
showsrc	Show image with source lists and astrometric references overlain.
siftstar	Generate filtered lists of stars from a single image tagged by crowding
sigratio	Compute the relative signal level between a set of spectra (1-d vectors).
sincfltr	Pass 1-d data through a low-pass filter (damped sinc).
sint2d	Sinc interpolation of a 2-D array of data.

(IDL)

sint	Sinc interpolation of a 1-D vector of data.
sinterp4	Four-fold sinc interpolation of a vector of data.
skyfit	Determine a 2-d polynomial fit to sky background in an image.
skyim	Calculate a smooth sky image from 2-d polynomial fit coefficients
skymat	Compute the sky plane rotation matrix from angular coordinates
skysclim	Compute stretch range for a hard stretch on the background in an image.
sl9proc	Interactive program to process and crop image for SL9 data.
slewdur	Estimate the time to slew the telescope from one location to another.
slidefil	Sliding spatial filter on time series data.
slope	Compute slope of a line using part of the data.
smplprb	Sample a probability function to facilitate drawing random numbers from it.
snrpred	Compute an estimated signal-to-noise ratio for a point source
sortcube	Sort an image cube by brightness at each pixel
sortpair	Sort a pair of vectors by the first and return a sorted copy
spec2cie	Convert from reflectance spectrum to CIE Chromaticity coordinates
spexpand	Sparse expansion of an array
sphrec	Convert from spherical to rectangular coordinates
spotrm	Spot remover for images
srcast	Compute ra,dec for all objects in a source list (see findsrc).
srodcheck	Widget tool for verification of SRO data reduction results
ss_et	Simple spectral extraction tool
ss_extin	Simple Spectra - determine differential extinction
ss_group	Simple Spectr
ssgeom	Compute Sun and Earth distance and phase angle for solar system object.
sshift2d	Shift a 2-D array using a damped sinc function for the fractional part.
sshift	Shift data using a damped sinc function for fractional part.
sspos	Interactive program for generating solar system body ephemerides.
stacker	Stack (co-add) image while registering images.
stage1cat	Generates the Stage1 catalog for a given Raw1 catalog
stage2cat	Generates the Stage2 catalog for a given Raw2 catalog
stageselect	Selects catalog stars for a given RA/Dec range.
star_fun	Single 2-d gaussian image, support routine for STARFIT.
starcats	Retrieve coordinates from the star catalogs.
starchart	Generate a star chart graphic
starcprmt	Promote version of a star catalog file to highest version.
starfit	Single gaussian fit to a stellar image.
starproc	Collect and process final (standard) star photometry
starset	Generate a list of nearby stars to help find a particular location
stats	Compute and print statistics plus plot histogram of data.
stdcheck	Determine if object is in a given standard catalog.
strb36	Convert an integer into a Base 36 formatted string.
strb62	Convert an integer into a Base 62 formatted string.
subarr	Extract a sub-array from an image with bound checking
sumann	Integrate over an annulus.
synbias	Create a synthetic CCD bias frame with optional overscan.
syncalib	Create a synthetic suite of calibration image
syndark	Create a synthetic CCD dark frame with optional overscan
synflat	Create a synthetic flat frame with optional overscan
synstar2	Compute a synthetic (Lorentizian) star image.
synstar	Compute a synthetic (gaussian) star image.

synthocc	Generate simulated occultation data
tblparse	Determine properties and problems from the table file with OSIRIS data
timeinfo	Collect IOTA-VTI time codes from one or more video frames
tmplinfo	Generate information about a template image based on an image header
tnoobs	Real-time planning and field selection tool for TNO survey observations.
tnorecov	Real-time planning and field selection tool for TNO survey observations.
tobacksl	Convert forward slash (/) to backslash (\) in string.
transf	Determine transformation coefficients from instrumental to standard mags.
trimrank	Remove dimensions of 1 thus returning the lowest possible rank for input
tvgrab	Grab plot window and save to a portable image file.
tvmaps	Display a full set of Pluto/Charon model .til maps on the current display.
tvtil	Display a Pluto/Charon .til map as an image on the current display.
uniqueid	Create a unique identifying string
upsample	Upsample an image given a dithered set of undersampled data
vidinfo	Extract and return information about a video file
viewtext	View a string, or string array, of text in a scrollable text widget.
warpstack	Stack a set of images on a given ROI warped to a master image
wastrom	Widget for determining an interactive astrometric solution
wcsarrows	Draw sky-plane orientation arrows on an image based on WCS information
wedge	Compute and return a gray scale step wedge.
wfc3_smeas	Compute a smear kernel for a star while tracking a solar system object
wfc3model	Generate synthetic PSF images for the HST WFC3 UVIS Camera.
wfpc2_distorted	Compute inverse of the wfpc2_metric function.
windstr	Convert a wind direction angle to a string name (or back).
wrastfc	Write an astrometry fit coefficient file.
wrbophot	Write a simple photometry data file.
wrcalb	Save contents of a calibration structure to a file.
wrcalir	Write calibration information for OSIRIS XD data to a calib file.
wrmatch	Write a standard name — non-standard name correspondence file.
wroblast	Write an object list to a file.
wrphalt	Write a photometry log file.
wrphocat	Write a photometry standard catalog file.
wrphot	Write a standard raw photometry data file (Pluto format).
wrreduc	Write a reductor info file (reduc.inf)
wrref	Write a astrometry support (.ref) file.
wrstarc	Write a binary version of a star catalog.
wrstrarr	Write a string array to a file
wrtbl	Update the table file of a night's OSIRIS data
xdavg	Interactive tool for combining and correcting OSIRIS XD spectra.
xdesig	Digest and record Minor Planet Center designation cross references.
xdspec	End-to-end reduction tool for OSIRIS XD spectral data.
xoracle	Display “oracle” animation image sequences.
xrunplot	Display a complete graphical summary of “plutomem” output logs.
year2jd	Convert decimal year to Julian date (reverse of jd2year).
zplot	Plot differential refraction as a function of wavelength.

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