PREFACE

The routines described here comprise the SOFA astronomy library. Their general appearance and coding style conforms to conventions agreed by the SOFA Board, and their functions, names and algorithms have been ratified by the Board. Procedures for soliciting and agreeing additions to the library are still evolving.

PROGRAMMING LANGUAGES

The SOFA routines are available in two programming languages at present: Fortran 77 and ANSI C.

Except for a single obsolete Fortran routine, which has no C equivalent, there is a one-to-one relationship between the two language versions. The naming convention is such that a SOFA routine referred to generically as "EXAMPL" exists as a Fortran subprogram iau_EXAMPL and a C function iauExampl. The calls for the two versions are very similar, with the same arguments in the same order. In a few cases, the C equivalent of a Fortran SUBROUTINE subprogram uses a return value rather than an argument.

GENERAL PRINCIPLES

The principal function of the SOFA Astronomy Library is to provide definitive algorithms. A secondary function is to provide software suitable for convenient direct use by writers of astronomical applications.

The astronomy routines call on the SOFA vector/matrix library routines, which are separately listed.

The routines are designed to exploit the full floating-point accuracy of the machines on which they run, and not to rely on compiler optimizations. Within these constraints, the intention is that the code corresponds to the published formulation (if any).

Dates are always Julian Dates (except in calendar conversion routines) and are expressed as two double precision numbers which sum to the required value.

A distinction is made between routines that implement IAU-approved models and those that use those models to create other results. The former are referred to as "canonical models" in the preamble comments; the latter are described as "support routines".

Using the library requires knowledge of positional astronomy and time-scales. These topics are covered in "Explanatory Supplement to the Astronomical Almanac", 3rd Edition, Sean E. Urban & P. Kenneth Seidelmann (eds.), University Science Books, 2013. Recent developments are documented in the scientific journals, and references to the relevant papers are given in the SOFA code as required. The IERS Conventions are also an essential reference. The routines concerned with Earth attitude (precession-nutation etc.) are described in the SOFA document sofa_pn.pdf. Those concerned with transformations between different time scales are described in sofa_ts_f.pdf (Fortran) and sofa_ts_c.pdf (C). Those concerned with astrometric transformations are described in sofa_ast_f.pdf (Fortran) and sofa_ast_c (C).

ROUTINES

Calendars
CAL2JD  Gregorian calendar to Julian Day number
EPB  Julian Date to Besselian Epoch
EPB2JD  Besselian Epoch to Julian Date
EPJ  Julian Date to Julian Epoch
EPJ2JD  Julian Epoch to Julian Date
JD2CAL  Julian Date to Gregorian year, month, day, fraction
JDCALF  Julian Date to Gregorian date for formatted output

Astrometry
AB  apply stellar aberration
APCG  prepare for ICRS <-> GCRS, geocentric, special
APCG13  prepare for ICRS <-> GCRS, geocentric
APCI  prepare for ICRS <-> CIRS, terrestrial, special
APCI13  prepare for ICRS <-> CIRS, terrestrial
APCO  prepare for ICRS <-> observed, terrestrial, special
APCO13  prepare for ICRS <-> observed, terrestrial
APCS  prepare for ICRS <-> CIRS, space, special
APCS13  prepare for ICRS <-> CIRS, space
APER  insert ERA into context
APER13  update context for Earth rotation
API0  prepare for CIRS <-> observed, terrestrial, special
APIO13  prepare for CIRS <-> observed, terrestrial
ATCI13  catalog -> CIRS
ATCIQ  quick ICRS -> CIRS
ATCIQN  quick ICRS -> CIRS, multiple deflections
ATCIQZ  quick astrometric ICRS -> CIRS
ATCO13  ICRS -> observed
ATCICL  CIRS -> ICRS
ATICO  quick CIRS -> ICRS
ATICO13  quick CIRS -> ICRS, multiple deflections
APIO13  prepare for CIRS <-> CIRS, terrestrial
ATOI13  observed -> CIRS
ATOC13  observed -> astrometric CIRS
ATOCI13  observed -> observed
ATQ1O  quick observed -> CIRS
LD  light deflection by a single solar-system body
LDN  light deflection by multiple solar-system bodies
LDSUN  light deflection by the Sun
PMPX  apply proper motion and parallax
PMSAFE  apply proper motion, with zero-parallax precautions
PVTOB  observatory position and velocity
PVSTAR  space motion pv-vector to star catalog data
REFCO  refraction constants
STARPM  apply proper motion
STARPV  star catalog data to space motion pv-vector

Time scales
D2DTF  format 2-part JD for output
DAT  Delta(AT) (=TAI-UTC) for a given UTC date
DTDB  TDB-TT
DTF2D  encode time and date fields into 2-part JD
TAITT  TAI to TT
TAU1T  TAI to UT1
TAUT1  TAI to UTC
TCBTD  TCB to TDB
TCGTT  TCG to TT
TDBTDB  TDB to TDB
TDBTT  TDB to TT
TTTAI  TT to TAI
TTTCT  TT to TCG
TTTDB  TT to TDB
TTUUT  TT to UT1
U1T1AI  UT1 to TAI
U1T1T  UT1 to TT
U1UT1  UT1 to UTC
UTCTAI  UTC to TAI
UTCUT1  UTC to UT1

Earth rotation angle and sidereal time
EE00  equation of the equinoxes, IAU 2000
EE00A  equation of the equinoxes, IAU 2000A
EE00B  equation of the equinoxes, IAU 2000B
EE06A  equation of the equinoxes, IAU 2006/2000A
EEC00  equation of the equinoxes complementary terms, IAU 2000
EQEQ94 equation of the equinoxes, IAU 1994
ERA00  Earth rotation angle, IAU 2000
GMT00  Greenwich mean sidereal time, IAU 2000
GMT06  Greenwich mean sidereal time, IAU 2006
GMT82  Greenwich mean sidereal time, IAU 1982
GST00A  Greenwich apparent sidereal time, IAU 2000A
GST00B  Greenwich apparent sidereal time, IAU 2000B
GST06  Greenwich apparent ST, IAU 2006, given NPB matrix
GST06A  Greenwich apparent sidereal time, IAU 2006/2000A
GST94  Greenwich apparent sidereal time, IAU 1994

Ephemerides (limited precision)
EPV00  Earth position and velocity
PLAN94  major-planet position and velocity

Precession, nutation, polar motion
BI00  frame bias components, IAU 2000
BP00  frame bias and precession matrices, IAU 2000
BP06  frame bias and precession matrices, IAU 2006
BPNCXY extract CIP X,Y coordinates from NPB matrix
C2100A celestial-to-intermediate matrix, IAU 2000A
C2100B celestial-to-intermediate matrix, IAU 2000B
C2106A celestial-to-intermediate matrix, IAU 2006/2000A
C21BN celestial-to-intermediate matrix, given NPB matrix, IAU 2000
C21XY celestial-to-intermediate matrix, given X,Y, IAU 2000
C21YXS celestial-to-intermediate matrix, given X,Y and s
C2T00A celestial-to-terrestrial matrix, IAU 2000A
C2T00B celestial-to-terrestrial matrix, IAU 2000B
C2T06A celestial-to-terrestrial matrix, IAU 2006/2000A
C2TC1O form CIO-based celestial-to-terrestrial matrix
C2TPE celestial-to-terrestrial matrix given nutation, IAU 2000
C2XY celestial-to-terrestrial matrix given CIP, IAU 2000
EO06A equation of the origins, IAU 2006/2000A
EOE6S equation of the origins, given NPB matrix and s
FW2M  Fukushima-Williams angles to r-matrix
FW2XY  Fukushima-Williams angles to X,Y
LTP  long-term precession matrix
LTBP  long-term precession matrix, including ICRS frame bias
LTPB  long-term precession of the ecliptic
LTPQU  long-term precession of the equator
NUM00A nutation matrix, IAU 2000A
NUM00B nutation matrix, IAU 2000B
NUM06A nutation matrix, IAU 2006/2000A
NUMAT  form nutation matrix
NUT00A nutation, IAU 2000A
NUT00B nutation, IAU 2000B
NUT06A nutation, IAU 2006/2000A
NUT80  nutation, IAU 1980
NUTM80 nutation matrix, IAU 1980
OBL06 mean obliquity, IAU 2006
OBL80 mean obliquity, IAU 1980
PB06  zeta, z, theta precession angles, IAU 2006, including bias
PFW06  bias-precession Fukushima-Williams angles, IAU 2006
PMA00  precession matrix (including frame bias), IAU 2000
PMA06  PB matrix, IAU 2006
PMA76  precession matrix, IAU 1976
PN00  bias/precession/nutation results, IAU 2000
PN00A bias/precession/nutation, IAU 2000A
PN00B bias/precession/nutation, IAU 2000B
PN06  bias/precession/nutation results, IAU 2006
PN06A bias/precession/nutation results, IAU 2006/2000A
PNM00A classical NPB matrix, IAU 2000A
PNM00B classical NPB matrix, IAU 2000B
PNM06A classical NPB matrix, IAU 2006/2000A
PNM80  precession/nutation matrix, IAU 1976/1980
P06E  precession angles, IAU 2006, equinox based
polar motion matrix
IAU 2000 precession adjustments
accumulated precession angles, IAU 1976
given X,Y, IAU 2000A
the CIO locator s, IAU 2000A
the CIO locator s, IAU 2000B
given X,Y, IAU 2006
the CIO locator s, IAU 2006/2000A
the TIO locator s’, IERS 2003
CIP, IAU 2006/2000A, from series
CIP and s, IAU 2000A
CIP and s, IAU 2000B
CIP and s, IAU 2006/2000A

Fundamental arguments for nutation etc.

mean elongation of the Moon from the Sun
mean longitude of Earth
mean argument of the latitude of the Moon
mean longitude of Jupiter
mean anomaly of the Moon
mean anomaly of the Sun
mean longitude of Mars
mean longitude of Mercury
mean longitude of Neptune
mean longitude of the Moon’s ascending node
general accumulated precession in longitude
mean longitude of Saturn
mean longitude of Uranus
mean longitude of Venus

Star catalog conversions

convert B1950.0 FK4 star catalog data to J2000.0 FK5
convert a B1950.0 FK4 star position to J2000.0 FK5, assuming zero
proper motion in the FK5 system
convert J2000.0 FK5 star catalog data to B1950.0 FK4
transform FK5 star data into the Hipparcos system
convert a J2000.0 FK5 star position to B1950.0 FK4, assuming zero
proper motion in FK5 system and zero parallax
FK5 to Hipparcos rotation and spin
FK5 to Hipparcos assuming zero Hipparcos proper motion
transform Hipparcos star data into the FK5 system
Hipparcos to FK5 assuming zero Hipparcos proper motion

Ecliptic coordinates

ecliptic to ICRS, IAU 2006
rotation matrix, ICRS to ecliptic, IAU 2006
ICRS to ecliptic, IAU 2006
ecliptic to ICRS, long term
rotation matrix, ICRS to ecliptic, long-term
ICRS to ecliptic, long term

Galactic coordinates

transform IAU 1958 galactic coordinates to ICRS
transform ICRS coordinates to IAU 1958 Galactic

Geodetic/geocentric

a,f for a nominated Earth reference ellipsoid
geodetic to geodetic for a nominated ellipsoid
geodetic to geodetic given ellipsoid a,f
geodetic to geodetic for a nominated ellipsoid
geodetic to geodetic given ellipsoid a,f

Gnomonic projection

solve for tangent point, spherical
solve for tangent point, vector
deproject tangent plane to celestial, spherical
deproject tangent plane to celestial, vector
TPXES     project celestial to tangent plane, spherical
TPXEV     project celestial to tangent plane, vector

Horizon/equatorial

AE2HD     (azimuth, altitude) to (hour angle, declination)
HD2AE     (hour angle, declination) to (azimuth, altitude)
HD2PA     parallactic angle

Obsolete

C2TCEO    former name of C2TCIO

CALLS: FORTRAN VERSION

CALL iau_AB     ( PNAT, V, S, BM1, PPR )
CALL iau_AE2HD   ( AZ, EL, PHI, HA, DEC )
CALL iau_APCG    ( DATE1, DATE2, EB, EH, ASTROM )
CALL iau_APCG13  ( DATE1, DATE2, ASTROM )
CALL iau_APCI    ( DATE1, DATE2, EB, EH, X, Y, S, ASTROM )
CALL iau_APCI13  ( DATE1, DATE2, ASTROM, EO )
CALL iau_APCO    ( DATE1, DATE2, EB, EH, X, Y, S, THETA, ELONG, PHI, HM, XP, YP, REFA, REFB, ASTROM )
CALL iau_APCO13  ( UTC1, UTC2, DUT1, ELONG, PH1, HM, XP, YP, PHPA, TC, RH, WL, ASTROM, EO, J )
CALL iau_APCS    ( DATE1, DATE2, PV, EB, EH, ASTROM )
CALL iau_APCS13  ( DATE1, DATE2, PV, ASTROM )
CALL iau_APER    ( THETA, ASTROM )
CALL iau_APER13  ( UT11, UT12, ASTROM )
CALL iau_APIO    ( SP, THETA, ELONG, PHI, HM, XP, YP, REFA, REFB, ASTROM )
CALL iau_APIO13  ( UTC1, UTC2, DUT1, ELONG, PHI, HM, XP, YP, PHPA, TC, RH, WL, AOB, ZOB, HOB, DOB, ROB, EO, J )
CALL iau_ATCI13  ( RC, DC, PR, PD, PX, RV, DATE1, DATE2, RI, DI, EO )
CALL iau_ATCI13Q ( RC, DC, PR, PD, PX, RV, ASTROM, RI, DI )
CALL iau_ATCIQ   ( RC, DC, PR, PD, PX, RV, ASTROM, RI, DI )
CALL iau_ATCIQ13 ( RC, DC, ASTROM, RI, DI )
CALL iau_ATCO13  ( UTC, DUT1, ELONG, PH1, HM, XP, YP, PHPA, TC, RH, WL, AOB, ZOB, HOB, DOB, ROB, EO, J )
CALL iau_ATOCI13 ( RC, DC, ASTROM, RI, DI )
CALL iau_ATOC13  ( TYPE, OB1, OB2, UTC1, UTC2, DUT1, ELONG, PHI, HM, XP, YP, PHPA, TC, RH, WL, RC, DC, J )
CALL iau_ATOI13  ( TYPE, OB1, OB2, UTC1, UTC2, DUT1, ELONG, PHI, HM, XP, YP, PHPA, TC, RH, WL, RI, DI, J )
CALL iau_ATOIQ   ( TYPE, OB1, OB2, UTC1, UTC2, DUT1, ELONG, PHI, HM, XP, YP, PHPA, TC, RH, WL, RI, DI, J )
CALL iau_BI00    ( DPSIBI, DEPSIBI, DRA )
CALL iau_BP00    ( DATE1, DATE2, RB, RP, RBP )
CALL iau_BP06    ( DATE1, DATE2, RB, RP, RBP )
CALL iau_BPN2XY  ( RBPN, X, Y )
CALL iau_C2I00A  ( DATE1, DATE2, RC2I )
CALL iau_C2I00B  ( DATE1, DATE2, RC2I )
CALL iau_C2I05A  ( DATE1, DATE2, RC2I )
CALL iau_C2I06A  ( DATE1, DATE2, RC2I )
CALL iau_C2IBPN  ( DATE1, DATE2, RBPN, RC2I )
CALL iau_C2IXY  ( DATE1, DATE2, X, Y, RC2I )
CALL iau_C2IXYS ( X, Y, S, RC2I )
CALL iau_C2T00A  ( TTA, TTB, UTA, UTB, XP, YP, RC2T )
CALL iau_C2T00B  ( TTA, TTB, UTA, UTB, XP, YP, RC2T )
CALL iau_C2T05A  ( TTA, TTB, UTA, UTB, XP, YP, RC2T )
CALL iau_C2TCEO  ( RC2I, ERA, RPM, RC2T )
CALL iau_C2TCIO  ( RC2I, ERA, RPM, RC2T )
CALL iau_C2TEQX  ( RBPN, GST, RPM, RC2T )
CALL iau_C2TPE   ( TTA, TTB, UTA, UTB, DPSI, DEPS, XP, YP, RC2T )
CALL iau_C2TXY  ( TTA, TTB, UTA, UTB, X, Y, XP, YP, RC2T )
CALL iau_TPXES ( A, B, A0, B0, XI, ETA, J )
CALL iau_TPXEV ( V, V0, XI, ETA, J )
CALL iau_TTTAI ( TT1, TT2, TAI1, TAI2, J )
CALL iau_TTTAOG ( TT1, TT2, TCG1, TCG2, J )
CALL iau_TTDB ( TT1, TT2, DTR, TDB1, TDB2, J )
CALL iau_TTUT1 ( TT1, TT2, DT, UT11, UT12, J )
CALL iau_UTITAI ( UT11, UT12, TAI1, TAI2, J )
CALL iau_UTIT2 ( UT11, UT12, D, TT1, TT2, J )
CALL iau_UTUTC ( UT11, UT12, UTC1, UTC2, J )
CALL iau_UTUT1 ( UT11, UT12, DT, UT1, UT2, J )
CALL iau_UTCUT1 ( UTC1, UTC2, UTC1, UTC2, DUT, UTC1, UTC2, J )

CALLS: C VERSION

iauAb ( pnat, v, s, bml, ppr );
iauAe2hd ( az, el, phi, &ha, &dec );
iauApco ( datel, date2, eb, eh, &astrom );
iauApco13 ( datel, date2, &astrom );
iauApco13 ( datel, date2, eb, eh, x, y, s, &astrom );
iauApco13 ( datel, date2, eb, eh, x, y, s, theta, elong, phi, hm, xp, yp, sp, refa, refe, &astrom );
i = iauApco13 ( utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, &astrom, &eo );
iauApco13 ( datel, date2, pv, eb, eh, &astrom );
iauApco13 ( datel, date2, pv, &astrom );
iauAper ( theta, &astrom );
iauAper13 ( utc1, utc2, &astrom );
iauApio ( sp, theta, elong, phi, hm, xp, yp, refa, refe, &astrom );
i = iauApio13 ( utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, &astrom );
iauAtco13 ( rc, dc, pr, pd, px, rc2i, date1, date2, &rc, &dc, &eo );
iauAtco13 ( ri, di, date1, date2, &rc, &dc, &eo );
iauAtco13 ( ri, di, date1, date2, &rc, &dc, &eo );
iauAtco13 ( ri, di, date1, date2, &rc, &dc, &eo );
i = iauAtco13 ( rc, dc, pr, pd, px, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, &astrom, &eo );
iauAtco13 ( ri, di, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, aob, zob, hob, dob, rob, eo );
iauAtco13 ( ri, di, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, aob, zob, hob, dob, rob, eo );
iauAtco13 ( ri, di, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, aob, zob, hob, dob, rob, eo );
iauAtco13 ( ri, di, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, aob, zob, hob, dob, rob, eo );
iauAtco13 ( ri, di, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, &astrom, &ao, &zob, &hob, &dob, &rob );
i = iauAtco13 ( type, ob1, ob2, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, &astrom, &ao, &zob, &hob, &dob, &rob );
i = iauAtco13 ( type, ob1, ob2, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, &astrom, &ao, &zob, &hob, &dob, &rob );
i = iauAtco13 ( type, ob1, ob2, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, &astrom, &ao, &zob, &hob, &dob, &rob );
i = iauAtco13 ( type, ob1, ob2, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, &astrom, &ao, &zob, &hob, &dob, &rob );
iauAtco13 ( type, ob1, ob2, utc1, utc2, dut1, elong, phi, hm, xp, yp, phpa, tc, rh, w1, &astrom, &ao, &zob, &hob, &dob, &rob );
IAUC2tpe (tta, ttb, uta, utb, deps, xp, yp, rc2t);
IAUC2txy (tta, ttb, uta, utb, x, y, xp, yp, rc2t);
i = iauCal2jd (iy, im, id, &djm0, &djm);
i = iauD2dtf (scale, ndp, d1, d2, &iy, &im, &id, ihmsf);
i = iauDat (iy, im, id, &djm0, &djm);
d = iauDtn (date1, date2, ut, elong, u, v);
i = iauDtf2d (scale, iy, im, id, ihr, imn, sec, &d1, &d2);
iauEceq06 (date1, date2, d1, db, &dr, &dd);
iauEcm06 (date1, date2, rm);
d = iauEe00 (date1, date2, epsa, dpsi);
d = iauEe00a (date1, date2);
d = iauEe00b (date1, date2);
d = iauEe06 (date1, date2);
d = iauEect00 (date1, date2);
i = iauEform (n, &a, &f);
d = iauEo06 (date1, date2);
d = iauEors (rnpb, s);
d = iauEpb (dj1, dj2);
iauEpb2jd (epb, &djm0, &djm);
d = iauEpj (dj1, dj2);
iauEpj2jd (epj, &djm0, &djm);
i = iauEv00 (dj1, dj2, pvh, pvb);
iauEvc06 (date1, date2, dr, dd, &d1, &db);
d = iauEveq94 (date1, date2);
d = iauEra00 (dj1, dj2);
d = iauFad03 (t);
d = iauFae03 (t);
d = iauFaf03 (t);
d = iauFaj03 (t);
d = iauFal03 (t);
d = iauFama03 (t);
d = iauFame03 (t);
d = iauFane03 (t);
d = iauFamo03 (t);
d = iauFapa03 (t);
d = iauFasa03 (t);
d = iauFaur03 (t);
d = iauFave03 (t);
aufk45z (r1950, d1950, bepoch, &r2000, &d2000);
aufk52h (r5, d5, dr5, dd5, px5, rv5, &rh, &dh, &drh, &dhh, &pxh, &rvh);
aufk54z (r2000, d2000, bepoch, &r1950, &d1950, &dr1950, &dd1950);
aufk5hip (r5h, s5h);
aufk5hz (r5, d5, date1, date2, &rh, &dh);
aufw2m (gamma, phi, psi, eps, r);
aufw2xy (gamma, phi, psi, eps, &x, &y);
aug2icrs (dl, db, &dr, &dd);
i = iauGc2gd (n, xyz, &elong, &phi, &height);
i = iauGc2gde (a, f, xyz, &elong, &phi, &height);
i = iauGd2gc (n, elong, phi, height, xyz);
i = iauGd2gce (a, f, elong, phi, height, xyz);
d = iauGmat00 (uts, utb, tta, ttt);
d = iauGmat06 (uts, utb, tta, ttt, rnpb);
d = iauGmat06a (uts, utb, tta, ttt);
d = iauGmat0 (uts, utb, tta, ttt);
d = iauH2fk5 (rh, dh, drr, d2h, pxh, pvh, &r5, &d5, &drr, &d2h, &pxh, &pvh);
auhd2ae (ha, dec, phi, &az, &el);
d = iauHf2pa (ha, dec, phi);
auhf5z (rh, dh, datel, date2, &r5, &d5, &dr5, &dd5);
auicrs2g (dr, dd, &d1, &d2);
i = iauJd2cal (dj1, dj2, &iy, &im, &id, &fd);
i = iauJdcal1 (ndp, dj1, dj2, iymdf);
iauxLd (bm, p, q, e, em, dlim, pl);
iauxLdn (n, b, ob, sc, sn);
iauxLdsun (p, e, em, pl);
iauxLteceq (epj, dl, db, &dr, &dd);
iauxLtecm (epj, rm);
iauxLteqec (epj, dr, dd, &dl, &db);
iauxLtp (epj, rp);
iauxLtpb (epj, rpb);
iauxLtepcl (epj, vec);
iauxLtepequ (epj, veq);
iauxNum00a (date1, date2, rmatn);
iauxNum00b (date1, date2, rmatn);
iauxNum06a (date1, date2, rmatn);
iauxNumat (epsa, dpsi, deps, rmatn);
iauxNut00a (date1, date2, &dpsi, &deps);
iauxNut00b (date1, date2, &dpsi, &deps);
iauxNut06a (date1, date2, &dpsi, &deps);
iauxNut80 (date1, date2, &dpsi, &deps);
iauxNutm80 (date1, date2, rmatn);
d = iauOb106 (date1, date2);
d = iauOb180 (date1, date2);
iauxPb06 (date1, date2, &bzeta, &bz, &btheta);
iauxPfw06 (date1, date2, &gamb, &phib, &psi1b, &epsa);
i = iauPlan94 (date1, date2, np, pv);
iauxPmat00 (date1, date2, rbp);
iauxPmat06 (date1, date2, rbp);
iauxPmat76 (date1, date2, rmatp);
iauxPmpx (rc, dc, pr, pd, px, rv, pmt, pob, pco);
i = iauPmsafe (ral, decl, pmr1, pm1, px1, rv1, 
    epl1, eplb, ep2a, ep2b, 
    &ra2, &dec2, &pmr2, &pm2, &px2, &rv2);
iauxPn00 (date1, date2, dpsi, deps, 
    &epsa, rb, rp, rbp, rn, rbpn);
iauxPn00a (date1, date2, 
    &dpsi, &deps, &epsa, rb, rp, rbp, rn, rbpn);
iauxPn00b (date1, date2, 
    &dpsi, &deps, &epsa, rb, rp, rbp, rn, rbpn);
iauxPn06 (date1, date2, dpsi, deps, 
    &epsa, rb, rp, rbp, rn, rbpn);
iauxPn06a (date1, date2, 
    &dpsi, &deps, &epsa, rb, rp, rbp, rn, rbpn);
iauxPn00b (date1, date2, 
    &dpsi, &deps, &epsa, rb, rp, rbp, rn, rbpn);
iauxPn06a (date1, date2, 
    &dpsi, &deps, &epsa, rb, rp, rbp, rn, rbpn);
iauxPnm00a (date1, date2, rmatp);
iauxPnm06a (date1, date2, rmatp);
iauxP06e (date1, date2, 
    &eps0, &epsa, &oma, &bpa, &bqa, &apia, &apia, 
    &epsa, &chia, &za, &zetaa, &ethetaa, &pa, 
    &gam, &phi, &psi);
iauxPom00 (xp, yp, sp, rpm);
iauxP00 (date1, date2, &dpsi1p, &depsp);
iauxPrec76 (date01, date02, &zeta, &z, &etheta);
i = iauPvstar (pv, &ra, &dec, &pmr, &pmd, &px, &rv);
iauxPvtob (elong, phi, hm, xp, yp, sp, theta, pv);
iauxRefco (phpa, tc, rh, w, refa, refb);
d = iauS00 (date1, date2, x, y);
d = iauS00a (date1, date2);
d = iauS00b (date1, date2);
d = iauS06 (date1, date2, x, y);
d = iauS06a (date1, date2);
d = iauSp00 (date1, date2);
i = iauStarpm (ra, decl, pmr1, pm1, px1, rv1, 
    epl1, eplb, epl2a, epl2b, 
    &ra2, &dec2, &pmr2, &pm2, &px2, &rv2);
iauxStarpm (ra, decl, pmr, pmx, px, rv, pv);
i = iauTaitt (tail, tai2, &tt1, &tt2);
i = iauTaitul (tail, tai2, dca, &ut1, &ut2);
i = iauTaitutc (tail, tai2, &ut1c, &ut2c);
i = iauTcbtdb (tcb1, tcb2, &tdbl, &tdb2);
i = iauTcgtt (tcgl, tcg2, &tt1, &tt2);
i = iauTdbtcb (tdbl, tdb2, &tcb1, &tcb2);
i = iauTdbtt ( tdb1, tdb2, dtr, &tt1, &tt2 );
i = iauTpors ( xi, eta, a, b, &a01, &b01, &a02, &b02 );
i = iauTporv ( xi, eta, v, v01, v02 );
i = iauTpsts ( xi, eta, a0, b0, &a, &b );
i = iauTpstv ( xi, eta, v0, v );
i = iauTpxes ( a, b, a0, b0, &xi, &eta );
i = iauTpxev ( v, v0, &xi, &eta );
i = iauTtta1 ( ttl, tt2, &tai1, &tai2 );
i = iauTttcg ( ttl, tt2, &tcg1, &tcg2 );
i = iauTttcdb ( ttl, tt2, dtr, &tdb1, &tdb2 );
i = iauTttt1 ( ttl, tt2, dt, &ut11, &ut12 );
i = iauUtlt1 ( utl1, utl2, &tai1, &tai2 );
i = iauUtlttt ( utl1, utl2, dt, &tt1, &tt2 );
i = iauUttutc ( utl1, utl2, dut, &utc1, &utc2 );
i = iauUttctai ( utc1, utc2, dta, &tai1, &tai2 );
i = iauUttcut1 ( utc1, utc2, dut, &ut11, &ut12 );
  iauXy06 ( date1, date2, &x, &y );
i = iauXys00a ( date1, date2, &x, &y, &m );
i = iauXys00b ( date1, date2, &x, &y, &m );
i = iauXys06a ( date1, date2, &x, &y, &m );