SkyWare

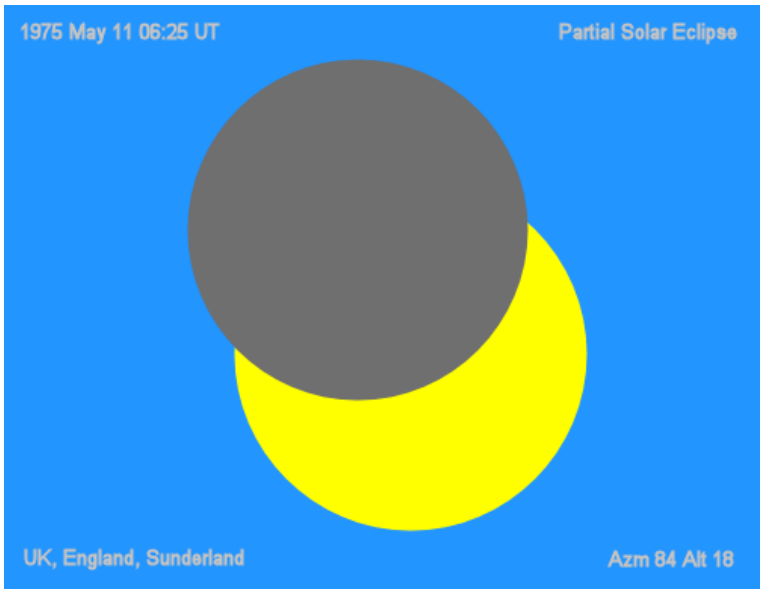
A mathematical software library for high-quality computations in positional astronomy, celestial mechanics, and the generation of ephemerides

(C99 version)

Created and developed from original code by

John Irwin

API Summary



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SkyWare API Modules

ASTEROID

Ephemerides of 343 asteroids from JPL's DE440 planetary integration:

- ICRS heliocentric state-vector and osculating orbital elements;
- Gravitational constants;
- Specification of orientation and shape parameters;
- Body-fixed coordinates;
- Orientation matrix and rate.

ASTEROID API SYMBOLS

SwAsteroidGroup (*enum-type*)
- SW_ASTEROID_GROUP_01
- SW_ASTEROID_GROUP_02
- SW_ASTEROID_GROUP_03
- SW_ASTEROID_GROUP_04
- SW_ASTEROID_GROUP_05
- SW_ASTEROID_GROUP_06
- SW_ASTEROID_GROUP_07
- SW_ASTEROID_GROUP_08
- SW_ASTEROID_GROUP_09
- SW_ASTEROID_GROUP_10
- SW_ASTEROID_GROUP_11
- SW_ASTEROID_NUM_GROUPS

SW_ASTEROID_NONE (*define*)

SwAsteroidObject (*enum-type*)
- SW_ASTEROID_CERES
- SW_ASTEROID_VESTA
- SW_ASTEROID_PALLAS
- SW_ASTEROID_HYGIEA
- SW_ASTEROID_DAVIDA
- SW_ASTEROID_INTERAMNIA
- SW_ASTEROID_EUROPA
- SW_ASTEROID_SYLVIA
- SW_ASTEROID_EUNOMIA
- SW_ASTEROID_JUNO
- SW_ASTEROID_PSYCHE
- SW_ASTEROID_CAMILLA
- SW_ASTEROID_THISBE
- SW_ASTEROID_IRIS
- SW_ASTEROID_EUPHROSYNE
- SW_ASTEROID_CYBELE
- SW_ASTEROID_DIDO
- SW_ASTEROID_AURORA
- SW_ASTEROID_DORIS
- SW_ASTEROID_BERTHA
- SW_ASTEROID_AMPHITRITE
- SW_ASTEROID_URSULA
- SW_ASTEROID_HERCULINA
- SW_ASTEROID_STEREOSKOPIA
- SW_ASTEROID_SIEGENA
- SW_ASTEROID_ALAUDA
- SW_ASTEROID_LAETITIA
- SW_ASTEROID_METIS
- SW_ASTEROID_HEBE
- SW_ASTEROID_BAMBERGA
- SW_ASTEROID_ELEKTRA
- SW_ASTEROID_THEMIS

- SW_ASTEROID_PATIENTIA
- SW_ASTEROID_FORTUNA
- SW_ASTEROID_PALMA
- SW_ASTEROID_DAPHNE
- SW_ASTEROID_IRENE
- SW_ASTEROID_DIOTIMA
- SW_ASTEROID_EGERIA
- SW_ASTEROID_HESPERIA
- SW_ASTEROID_PARTHENOPE
- SW_ASTEROID_PAPAGENA
- SW_ASTEROID_LACHESIS
- SW_ASTEROID_AGLAJA
- SW_ASTEROID_AEGLE
- SW_ASTEROID_HEDWIG
- SW_ASTEROID_ASPASIA
- SW_ASTEROID_JUEWA
- SW_ASTEROID_WINCHESTER
- SW_ASTEROID_KALLIOPE
- SW_ASTEROID_LOMIA
- SW_ASTEROID_SCHEILA
- SW_ASTEROID_NEMESIS
- SW_ASTEROID_IO
- SW_ASTEROID_HESTIA
- SW_ASTEROID_SIBYLLA
- SW_ASTEROID_GERMANIA
- SW_ASTEROID_EUGENIA
- SW_ASTEROID_PALES
- SW_ASTEROID_KREUSA
- SW_ASTEROID_DEMBOWSKA
- SW_ASTEROID_LUCINA
- SW_ASTEROID_EUKRATE
- SW_ASTEROID_FREIA

- SW_ASTEROID_PHILOMELA
- SW_ASTEROID_LAMBERTA
- SW_ASTEROID_ELEONORA
- SW_ASTEROID_BERBERICIA
- SW_ASTEROID_ELPIS
- SW_ASTEROID_MINERVA
- SW_ASTEROID_FLORA
- SW_ASTEROID_MASSALIA
- SW_ASTEROID_JULIA
- SW_ASTEROID_ARMENIA
- SW_ASTEROID_NEMAUSA
- SW_ASTEROID_PHILOSOPHIA
- SW_ASTEROID_POMPEJA
- SW_ASTEROID_EUCHARIS
- SW_ASTEROID_PRETORIA
- SW_ASTEROID_ATALANTE
- SW_ASTEROID_GUDRUN
- SW_ASTEROID_MELPOMENE
- SW_ASTEROID_BETTINA
- SW_ASTEROID_ARETHUSA
- SW_ASTEROID_ALETHEIA
- SW_ASTEROID_MYRRHA
- SW_ASTEROID_MEDEA
- SW_ASTEROID_KLYMENE
- SW_ASTEROID_MELETE
- SW_ASTEROID_GYPTIS
- SW_ASTEROID_KLEOPATRA
- SW_ASTEROID_PULCOVA
- SW_ASTEROID_VIBILIA
- SW_ASTEROID_ERMINIA
- SW_ASTEROID_ADOREA
- SW_ASTEROID_EMMA

- SW_ASTEROID_HARMONIA
- SW_ASTEROID_ARGENTINA
- SW_ASTEROID_INO
- SW_ASTEROID_AQUITANIA
- SW_ASTEROID_BELLONA
- SW_ASTEROID_LAMPETIA
- SW_ASTEROID_SIWA
- SW_ASTEROID_VICTORIA
- SW_ASTEROID_HIPPO
- SW_ASTEROID_ASTRAEA
- SW_ASTEROID_IANTHE
- SW_ASTEROID_CHLORIS
- SW_ASTEROID_CIRCE
- SW_ASTEROID_ADEONA

SW_ASTEROID_OPHELIA
SW_ASTEROID_HERMIONE
SW_ASTEROID_COMACINA
SW_ASTEROID_NININA
SW_ASTEROID_AUSONIA
SW_ASTEROID_THIA
SW_ASTEROID_XANTHIPPE
SW_ASTEROID_ORNAMENTA
SW_ASTEROID_THALIA
SW_ASTEROID_GALLIA
SW_ASTEROID_MERAPI
SW_ASTEROID_NUWA
SW_ASTEROID_CHARYBDIS
SW_ASTEROID_EVA
SW_ASTEROID_ATHAMANTIS
SW_ASTEROID_LORELEY
SW_ASTEROID_ANTIOPE
SW_ASTEROID_MELIBOEA

SW_ASTEROID_PRINCETONIA
SW_ASTEROID_WRATISLAVIA
SW_ASTEROID_EUTERPE
SW_ASTEROID_ALEXANDRA
SW_ASTEROID_HISPANIA
SW_ASTEROID_ELFRIEDE
SW_ASTEROID_LIGURIA
SW_ASTEROID_ADRIA
SW_ASTEROID_KASSANDRA
SW_ASTEROID_PROTOGENEIA
SW_ASTEROID_JOHANNA
SW_ASTEROID_PROKNE
SW_ASTEROID_FIDES
SW_ASTEROID_CHICAGO
SW_ASTEROID_AURELIA
SW_ASTEROID_BERTHOLDA
SW_ASTEROID_MARIANNA
SW_ASTEROID_POLYXENA
SW_ASTEROID_PADUA
SW_ASTEROID_HYPATIA
SW_ASTEROID_LUMEN
SW_ASTEROID_POLYXO
SW_ASTEROID_ANI
SW_ASTEROID_ROBERTA
SW_ASTEROID_CARLOVA
SW_ASTEROID_DIANA
SW_ASTEROID_UNDINA
SW_ASTEROID_ASTEROPE
SW_ASTEROID_ADELHEID
SW_ASTEROID_LUTETIA
SW_ASTEROID_GERLINDE
SW_ASTEROID_BREDICHINA

SW_ASTEROID_MESSALINA
SW_ASTEROID_AEMILIA
SW_ASTEROID_MARION
SW_ASTEROID_GALATEA
SW_ASTEROID_HELIO
SW_ASTEROID_ARMIDA
SW_ASTEROID_ISIS
SW_ASTEROID_BEATRIX
SW_ASTEROID_ZELINDA
SW_ASTEROID_CONCORDIA
SW_ASTEROID_PROSERPINA
SW_ASTEROID_HOHENSTEINA
SW_ASTEROID_EDITH
SW_ASTEROID_HERSILIA
SW_ASTEROID_TANETE
SW_ASTEROID_DENISE
SW_ASTEROID_PENELOPE
SW_ASTEROID_ALINE
SW_ASTEROID_VATICANA
SW_ASTEROID_TOKIO

SW_ASTEROID_ARSINOE
SW_ASTEROID_PERAGA
SW_ASTEROID_TERCIDINA
SW_ASTEROID_IDUNA
SW_ASTEROID_BRIXIA
SW_ASTEROID_FAINA
SW_ASTEROID_ERATO
SW_ASTEROID_FERONIA
SW_ASTEROID_DYNAMENE
SW_ASTEROID_CHRISTA
SW_ASTEROID_EUNIKE
SW_ASTEROID_EOS

SW_ASTEROID_HERTHA
SW_ASTEROID_SEMELE
SW_ASTEROID_VERITAS
SW_ASTEROID_EMITA
SW_ASTEROID_AEGINA
SW_ASTEROID_ALKESTE
SW_ASTEROID_ARTEMIS
SW_ASTEROID_NEPHELE
SW_ASTEROID_FREDA
SW_ASTEROID_ANTIGONE
SW_ASTEROID_ERIGONE
SW_ASTEROID_THETIS
SW_ASTEROID_DESIDERATA
SW_ASTEROID_NIOBE
SW_ASTEROID_RUSTHAWELIA
SW_ASTEROID_LICTORIA
SW_ASTEROID_MELUSINA
SW_ASTEROID_HERA
SW_ASTEROID_ATE
SW_ASTEROID_ARIADNE
SW_ASTEROID_TERPSICHORE
SW_ASTEROID_BOLIVIANA
SW_ASTEROID_ELISABETHA
SW_ASTEROID_SAPIENTIA
SW_ASTEROID_TATJANA
SW_ASTEROID_JOSEPHINA
SW_ASTEROID_PANOPAEA
SW_ASTEROID_ARACHNE
SW_ASTEROID_SOPHROSYNE
SW_ASTEROID_LANZIA
SW_ASTEROID_FRINGILLA
SW_ASTEROID_MANDEVILLE

SW_ASTEROID_LETO
SW_ASTEROID_CANTABIA
SW_ASTEROID_IRMINTRAUD
SW_ASTEROID_BRUCHSALIA
SW_ASTEROID_CAVA
SW_ASTEROID_HAMBURGA
SW_ASTEROID_HAVNIA
SW_ASTEROID_LYDIA
SW_ASTEROID_LUSCINIA
SW_ASTEROID_GRATIA
SW_ASTEROID_HERMENTARIA
SW_ASTEROID_VUNDTIA
SW_ASTEROID_LUDMILLA
SW_ASTEROID_KLOTHO
SW_ASTEROID_LUISA
SW_ASTEROID_ILMATAR
SW_ASTEROID_RACHELE
SW_ASTEROID_LAURENTIA
SW_ASTEROID_APOLLONIA
SW_ASTEROID_MASHONA
SW_ASTEROID_ARA
SW_ASTEROID_CAMPANIA
SW_ASTEROID_KOLGA
SW_ASTEROID_VANADIS
SW_ASTEROID_OCTAVIA
SW_ASTEROID_VIRGINIA

SW_ASTEROID_CARINA
SW_ASTEROID_EURYKLEIA
SW_ASTEROID_FELICITAS
SW_ASTEROID_HEKATE
SW_ASTEROID_EDNA
SW_ASTEROID_CORDUBA

SW_ASTEROID_AERIA
SW_ASTEROID_LEUKOTHEA
SW_ASTEROID_EVELYN
SW_ASTEROID_LEDA
SW_ASTEROID_GENOVEVA
SW_ASTEROID_NAUSIKAA
SW_ASTEROID_NYSA
SW_ASTEROID_PHAEO
SW_ASTEROID_PALATIA
SW_ASTEROID_FLAMMARIO
SW_ASTEROID_OLGA
SW_ASTEROID_INDUSTRIA
SW_ASTEROID_VINCENTINA
SW_ASTEROID_CHERUSKIA
SW_ASTEROID_POMONA
SW_ASTEROID_KALYPSO
SW_ASTEROID_ISABELLA
SW_ASTEROID_MARGHANNA
SW_ASTEROID_ISOLDA
SW_ASTEROID_TISIPHONE
SW_ASTEROID_KLIO
SW_ASTEROID_MNEMOSYNE
SW_ASTEROID_ANDROMACHE
SW_ASTEROID_DEVOSA
SW_ASTEROID_LILAEA
SW_ASTEROID_MIRIAM
SW_ASTEROID_CHALDAEA
SW_ASTEROID_NOTBURGA
SW_ASTEROID_THYRA
SW_ASTEROID_TAMARA
SW_ASTEROID_MASSINGA
SW_ASTEROID_LEONORA

SW_ASTEROID_MATHESIS
SW_ASTEROID_UNA
SW_ASTEROID_ANACOSTIA
SW_ASTEROID_HONORIA
SW_ASTEROID_HENRIETTA
SW_ASTEROID_MONTAGUE
SW_ASTEROID_DIONE
SW_ASTEROID_MEGAIRA
SW_ASTEROID_EURYDIKE
SW_ASTEROID_TAURIS
SW_ASTEROID_URANIA
SW_ASTEROID_AMHERSTIA
SW_ASTEROID_SAPPHO
SW_ASTEROID_MISA
SW_ASTEROID_ROSA
SW_ASTEROID_SULAMITIS
SW_ASTEROID_PICKERINGIA
SW_ASTEROID_FRIGGA
SW_ASTEROID_MARTHA
SW_ASTEROID_ALEKTO
SW_ASTEROID_LEHIGH
SW_ASTEROID_NEPHTHYS
SW_ASTEROID_EKARD
SW_ASTEROID_SVEA
SW_ASTEROID_DIKE
SW_ASTEROID_EURYNOME
SW_ASTEROID_BAUCIS
SW_ASTEROID_TEKMESSA
SW_ASTEROID_OCEANA
SW_ASTEROID_GENUA
SW_ASTEROID_PALISANA
SW_ASTEROID_TITANIA
SW_ASTEROID_ULLA
SW_ASTEROID_SEMIRAMIS
SW_ASTEROID_ALKMENE
SW_ASTEROID_EICHSFELDIA
SW_ASTEROID_AMPELLA
SW_ASTEROID_PRAXEDIS
SW_ASTEROID_PHOCAEA
SW_ASTEROID_IRMA
SW_ASTEROID_AMALTHEA
SW_ASTEROID_IPHIGENIA
SW_ASTEROID_BUDROSA
SW_ASTEROID_PARIANA
SW_ASTEROID_THEOBALDA
SW_ASTEROID_AETHRA
SW_ASTEROID_IRMGARD
SW_ASTEROID_ECHO
SW_ASTEROID_LACADIERA
SW_ASTEROID_PYTHIA
SW_ASTEROID_PEITHO
SW_ASTEROID_CHIMAERA
SW_ASTEROID_BILKIS
SW_ASTEROID_EROS

SwAsteroidOpenGroupFile
SwAsteroidCloseGroupFile

SwAsteroidSetShapeParameters
SwAsteroidSetOrientationParameters

SwAsteroidGetStateVector
SwAsteroidGetOrbitalElements
SwAsteroidGetGravitationalConstant
SwAsteroidGetEphemerisName
SwAsteroidGetEphemerisConstant
SwAsteroidGetClampStatus
SwAsteroidGetShapeParameters
SwAsteroidGetOrientationMatrix
SwAsteroidGetBodyFixedCoordinates
SwAsteroidGetObjectName
SwAsteroidHasShapeAndOrient

CIRS

Celestial Intermediate Reference System:

- GCRS coordinates of the CIP (X,Y,Z) and the CIO locator (s), and their rates, obtained from X, Y, and $s+XY/2$ series developments of the IAU-2000/2000A and IAU-2006/2000A precession-nutation models, together with an unofficial compressed version of the latter (2006B);
- CIRS matrix and rate (GCRS to CIRS frame transformation);
- CIP pole offsets (δX,δY) and rates update;
- Precise difference between the IAU-2006A and IAU-2000A X and Y coordinates, efficiently calculated from difference-series.

CIRS API SYMBOLS

SwCirsModel (*enum-type*)
SW_CIRS_IAU2000A
SW_CIRS_IAU2006A
SW_CIRS_IAU2006B
SW_CIRS_NUM_MODELS

SwCirsSetPoleOffsets
SwCirsGetPoleOffsets
SwCirsGetCoordinates
SwCirsGetMatrix
SwCirsGetModelADifference

DASTCOM

Utilities to access JPL's small-body catalog of orbital elements via a single binary data file:

- Orbital elements and covariance matrix;
- Non-gravitational parameters (NGP);
- Object and orbit identifiers;
- Object size (if any).

DASTCOM API SYMBOLS

SwDastcomCat (*enum-type*)
- SW_DASTCOM_CAT_AST
- SW_DASTCOM_CAT_CMT

SwDastcomOpenCatalog
SwDastcomCloseCatalog

SwDastcomLoadDataRecord
SwDastcomSaveDataRecord

SwDastcomSetDataRecordDirectory

SwDastcomGetObjectIdentifiers
SwDastcomGetOrbitIdentifiers
SwDastcomGetOrbitalElements
SwDastcomGetCovarianceMatrix
SwDastcomGetNonGravitationalParameters
SwDastcomGetObjectSize
SwDastcomGetRecordDataItem

DATE

Date and time utilities:

- Initialisation in various time-scales (UTC, UT1, TAI, TT, TDB, TCB, TCG, Teph, GPS);
- Conversion between calendar and Julian, and vice versa (applicable range ±5 million years);
- Conversion between calendar or Julian date and Julian or Besselian epochs, and vice versa;
- Creation of high-precision calendar and Julian date strings for printing.

DATE API SYMBOLS

SwTimeScale (*enum-type*)
- SW_TIME_SCALE_UTC
- SW_TIME_SCALE_UT1
- SW_TIME_SCALE_TT
- SW_TIME_SCALE_TAI
- SW_TIME_SCALE_TDB
- SW_TIME_SCALE_TCG
- SW_TIME_SCALE_TCB
- SW_TIME_SCALE_TEB
- SW_TIME_SCALE_GPS
- SW_TIME_NUM_SCALES

SwEpoch (*enum-type*)
- SW_EPOCH_JULIAN
- SW_EPOCH_BESSELIAN

SwCalendarDate (*struct-type*)
SwJulianDate (*struct-type*)

SwDateInitialiseCalendar
SwDateInitialiseCalendar2
SwDateInitialiseEarliestCalendar
SwDateInitialiseLatestCalendar
SwDateIncrementCalendar
SwDateIncrementCalendar2
SwDateConvertCalendar2Epoch
SwDateConvertEpoch2Calendar
SwDateSetCalendarStringGrouping
SwDateGetCalendarString

SwDateInitialiseJulian
SwDateInitialiseJulian2
SwDateInitialiseEarliestJulian
SwDateInitialiseLatestJulian
SwDateIncrementJulian
SwDateIncrementJulian2
SwDateConvertJulian2Epoch
SwDateConvertEpoch2Julian
SwDateSetJulianStringGrouping
SwDateGetJulianString

SwDateConvertCalendar2Julian
SwDateConvertJulian2Calendar
SwDateGetMonthName

EARTHSAT

Ephemerides of Earth-orbiting artificial satellites:

- Object loading from USSPACECOM (NORAD) two-line elements;
- GCRS state-vector obtained either from the combined SGP4/SDP4 satellite propagation model or from two-body propagation;
- GCRS osculating orbital elements;
- Specification of orientation and shape parameters;
- Body-fixed coordinates;
- Orientation matrix and rate.

EARTHSAT API SYMBOLS

SwEarthSatObject (*int-type*)

SwEarthSatPropagationMode (*enum-type*)
- SW_EARTHSAT_SGP4_SDP4
- SW_EARTHSAT_J2_PRECESSING
- SW_EARTHSAT_TWO_BODY

SwEarthSatAllocateObjects
SwEarthSatFreeObjects
SwEarthSatLoadObject
SwEarthSatUnloadObject
SwEarthSatUnloadAllObjects

SwEarthSatSetPropagationMode
SwEarthSatSetShapeParameters
SwEarthSatSetOrientationParameters

SwEarthSatGetStateVector
SwEarthSatGetOrbitalElements
SwEarthSatGetEpoch
SwEarthSatGetClampStatus
SwEarthSatGetShapeParameters
SwEarthSatGetOrientationMatrix
SwEarthSatGetBodyFixedCoordinates
SwEarthSatGetObjectName
SwEarthSatHasShapeAndOrient

ECLIPSE

Top-level interface providing ephemerides of Earth-based solar and lunar eclipses:

- Solar eclipse search and determination of Besselian elements and general eclipse characteristics;

- Lunar eclipse search and determination of general eclipse characteristics;
- Local circumstances for an observer on, or near, the surface of the Earth;
- Determination of the longest umbral and penumbral durations (globally or restricted to the central line);
- Determination of shadow-axis contact points and the central line;
- Determination of shadow-cone contact points and the rising-and-setting curves;
- Determination of shadow-cone extreme points and the limiting curves;
- Determination of shadow-cone max-in-the-horizon curves;
- Determination of the shadow-cone outline curve;

ECLIPSE API SYMBOLS

SwEclipseShadowCone (*enum-type*)
- SW_ECLIPSE_UMBRA
- SW_ECLIPSE_PENUMBRA

SwEclipseGlobalSolarType (*enum-type*)
- SW_ECLIPSE_GS_NONE
- SW_ECLIPSE_GS_PARTIAL
- SW_ECLIPSE_GS_TOTAL_NON_CENTRAL
- SW_ECLIPSE_GS_ANNULAR_NON_CENTRAL
- SW_ECLIPSE_GS_TOTAL_CENTRAL
- SW_ECLIPSE_GS_ANNULAR_CENTRAL
- SW_ECLIPSE_GS_HYBRID_ATA
- SW_ECLIPSE_GS_HYBRID_TTA
- SW_ECLIPSE_GS_HYBRID_ATT
- SW_ECLIPSE_NUM_GS_TYPES

SwEclipseLocalSolarType (*enum-type*)
- SW_ECLIPSE_LS_NONE
- SW_ECLIPSE_LS_PARTIAL
- SW_ECLIPSE_LS_TOTAL
- SW_ECLIPSE_LS_ANNULAR

SwEclipseLocalSolarEvent (*enum-type*)
- SW_ECLIPSE_LS_1ST_CONTACT
- SW_ECLIPSE_LS_2ND_CONTACT
- SW_ECLIPSE_LS_GREATEST_ECLIPSE
- SW_ECLIPSE_LS_3RD_CONTACT
- SW_ECLIPSE_LS_4TH_CONTACT

SwEclipseGlobalSolarEvent (*enum-type*)
- SW_ECLIPSE_GS_C1
- SW_ECLIPSE_GS_C2
- SW_ECLIPSE_GS_P1
- SW_ECLIPSE_GS_P2
- SW_ECLIPSE_GS_P3
- SW_ECLIPSE_GS_P4
- SW_ECLIPSE_GS_U1
- SW_ECLIPSE_GS_U2
- SW_ECLIPSE_GS_U3
- SW_ECLIPSE_GS_U4
- SW_ECLIPSE_GS_PE1
- SW_ECLIPSE_GS_PE2
- SW_ECLIPSE_GS_PE3
- SW_ECLIPSE_GS_PE4
- SW_ECLIPSE_GS_UE1
- SW_ECLIPSE_GS_UE2
- SW_ECLIPSE_GS_UE3
- SW_ECLIPSE_GS_UE4

SwEclipseState (*enum-type*)
- SW_ECLIPSE_BEGINS
- SW_ECLIPSE_ENDS

SwEclipseGlobalLunarType (*enum-type*)
- SW_ECLIPSE_GL_NONE
- SW_ECLIPSE_GL_PENUMBRAL_PARTIAL
- SW_ECLIPSE_GL_PENUMBRAL_TOTAL
- SW_ECLIPSE_GL_UMBRAL_PARTIAL
- SW_ECLIPSE_GL_UMBRAL_TOTAL_NON_CENTRAL
- SW_ECLIPSE_GL_UMBRAL_TOTAL_CENTRAL
- SW_ECLIPSE_NUM_GL_TYPES

SwEclipseGlobalLunarEvent (*enum-type*)
- SW_ECLIPSE_GL_P1
- SW_ECLIPSE_GL_U1
- SW_ECLIPSE_GL_U2
- SW_ECLIPSE_GL_U3
- SW_ECLIPSE_GL_U4
- SW_ECLIPSE_GL_P4

SwEclipseBesselCoefficients (*struct-type*)
SwEclipseSolarData (*struct-type*)
SwEclipseLunarContact (*struct-type*)
SwEclipseLunarData (*struct-type*)
SwEclipseBesselElements (*struct-type*)
SwEclipseLocalSolarEvents (*struct-type*)
SwEclipseEventPoint (*struct-type*)
SwEclipseCentralLineData (*struct-type*)
SwEclipseOutlinePoint (*struct-type*)

SwEclipseSetPlaceType
SwEclipseFindNextSolar
SwEclipseFindNextLunar

SwEclipseTimeShiftBesselCoefficients
SwEclipseEvaluateBesselElements

SwEclipseGetPlaceType
SwEclipseGetEarthAtmosphereHeight
SwEclipseGetLocalCircumstances
SwEclipseGetLongestEclipse
SwEclipseGetLongestCentralEclipse
SwEclipseGetCentralLineLimits
SwEclipseGetCentralLineLength
SwEclipseGetShadowConeContactLimits
SwEclipseGetShadowConeExtremeLimits

SwEclipseSampleCentralLine
SwEclipseSampleRisingAndSettingCurve
SwEclipseSampleShadowConeLimitCurve
SwEclipseSampleMaxInTheHorizonCurve
SwEclipseSampleOutlineCurve

EMO

Earth and Moon orientation models and frames:

- Orientation matrix and rate;
- Pole and prime-meridian angles and rates.

EMO API SYMBOLS

SwEmoEarthFrame (*enum-type*)
- SW_EMO_EARTH_FRAME_MOD
- SW_EMO_EARTH_FRAME_TOD
- SW_EMO_EARTH_FRAME_CIRS
- SW_EMO_EARTH_FRAME_TIRS
- SW_EMO_EARTH_FRAME_ITRS
- SW_EMO_NUM_EARTH_FRAMES

SwEmoEarthOrientationModel (*enum-type*)
- SW_EMO_EOM_IAU2000A
- SW_EMO_EOM_IAU2006A
- SW_EMO_EOM_IAU2006B
- SW_EMO_EOM_IAU1976_80_94

SW_EMO_EOM_VON2011
SW_EMO_NUM_EOMS

SwEmoEarthOrientationOrigin (*enum-type*)
SW_EMO_EOO_EQX
SW_EMO_EOO_CIO

SwEmoEarthOrientationRate (*enum-type*)
SW_EMO_EOR_FULL
SW_EMO_EOR_ROTATION_ONLY

SwEmoMoonFrame (*enum-type*)
SW_EMO_MOON_FRAME_PA
SW_EMO_MOON_FRAME_ME
SW_EMO_NUM_MOON_FRAMES

SwEmoSetEarthOrientation

SwEmoGetEarthOrientation
SwEmoGetEarthPrecessionModel
SwEmoGetEarthNutationModel
SwEmoGetEarthSiderealModel
SwEmoGetEarthCIRSModel
SwEmoGetEarthOrientationMatrix
SwEmoGetEarthOrientationParameters
SwEmoGetEarthOrientationName
SwEmoGetEarthFrameName

SwEmoGetMoonOrientationMatrix
SwEmoGetMoonOrientationParameters
SwEmoGetMoonFrameName

EOP

IERS Earth orientation parameters:

- Conversion of IERS finals or CSSI ASCII data files to a binary access file containing EOP data and estimated rates;
- UT1–TAI and excess length-of-day (XLOD), with optional ocean tide variations;
- Polar motion components (x_p,y_p) and rates, with optional high-frequency nutation and ocean tide variations;
- TIO locator (s') and rate;
- Celestial pole offsets ($\delta\Delta\psi_{1980}$,$\delta\Delta\varepsilon_{1980}$) and rates;
- Celestial pole offsets (δX_{2000},δY_{2000}) and rates;
- Celestial pole offsets (δX_{2006},δY_{2006}) and rates (derived from IAU-2000 values);
- Conversion of (δX,δY) and rates to equivalent ($\delta\Delta\psi$,$\delta\Delta\varepsilon$) and rates, and vice versa;
- Transformation of (δX_{2000},δY_{2000}) and rates to ($\delta\Delta\psi_{1980}$,$\delta\Delta\varepsilon_{1980}$) and rates, and vice versa.

EOP API SYMBOLS

SwEopBulletin (*enum-type*)
SW_EOP_BULLETIN_A
SW_EOP_BULLETIN_B

SwEopConvertCSSI
SwEopConvertIERSFinals
SwEopConvertIERSNewC04

SwEopOpenFile
SwEopCloseFile

SwEopGetDataSource
SwEopGetTimeSpan
SwEopGetUT1mTAI
SwEopGetPolarMotion
SwEopGetTIOLocator
SwEopGetCelestialPoleOffsetsIAU1980
SwEopGetCelestialPoleOffsetsIAU2000
SwEopGetCelestialPoleOffsetsIAU2006

SwEopConvertDXDY
SwEopConvertDDpsiDDeps

SwEopTransformDXDY
SwEopTransformDDpsiDDeps

EPH–FILE

Utilities for creating and accessing SkyWare binary ephemeris files based on the Chebyshev polynomial format:

EPH–FILE API SYMBOLS

SwEphFileHeader (*struct-type*)
SwEphFileConstant (*struct-type*)
SwEphFileTargetAccessData (*struct-type*)

SwEphFileDataSource (*enum-type*)
SW_EPH_FILE_SRC_JPL_PLANET
SW_EPH_FILE_SRC_JPL_SATELLITE
SW_EPH_FILE_SRC_JPL_ASTEROID
SW_EPH_FILE_SRC_JPL_COMET
SW_EPH_FILE_SRC_IMCCE_PLANET
SW_EPH_FILE_SRC_IMCCE_SATELLITE
SW_EPH_FILE_SRC_IMCCE_ASTEROID
SW_EPH_FILE_SRC_IMCCE_COMET
SW_EPH_FILE_SRC_USNO_ASTEROID
SW_EPH_FILE_SRC_OTHER

SwEphFileChebyshevType (*enum-type*)
SW_EPH_FILE_CBY_1
SW_EPH_FILE_CBY_2

SW_EPH_FILE_ID (*define*)
SW_EPH_FILE_MAX_NAME_LEN (*define*)
SW_EPH_FILE_MAX_NUM_TARGETS (*define*)
SW_EPH_FILE_MAX_NUM_CONSTANTS (*define*)

SwEphFileOpenFile
SwEphFileCloseFile

SwEphFileGetStateVector
SwEphFileGetEphemerisName
SwEphFileGetTimeSpan
SwEphFileGetEphemerisConstant
SwEphFileGetClampStatus

SwEphFileHasTargetData

SwEphFilePrintHeader
SwEphFilePrintCoefficientArray

SwEphFileEvaluateChebyshevSeries1
SwEphFileEvaluateChebyshevSeries2
SwEphFileEvaluateChebyshevSeries12
SwEphFileFitChebyshevType1
SwEphFileFitChebyshevType2

SwEphFileExtractTargets
SwEphFileSwitchEndian

EQM

Top-level interface implementing components of the equations-of-motion for use in the propagation of minor bodies:

- Newtonian, point-mass, perturbations from the Sun;
- Newtonian, point-mass, perturbations from the planets, Earth, Moon, and Pluto;
- Newtonian, point-mass, perturbations from the most massive asteroids;
- Perturbations from non-gravitational forces (NGP);
- Perturbations from the J2-field of the Sun;
- Perturbations from a spherical harmonic Earth gravity model (EGM);
- Perturbations from a *simple* GR correction to the gravitational fields of the Sun and planets;
- Perturbations from an *extended* GR correction to the gravitational fields of the Sun and planets (EIH-based);
- All-body GR perturbations based on the full EIH/PPN equations-of-motion;
- Basic 1st- and 2nd-order derivative functions.

EQM API SYMBOLS

SwEqmEGM (*enum-type*)
- SW_EQM_EGM_DE440
- SW_EQM_EGM_INPOP21A
- SW_EQM_EGM_EGM96
- SW_EQM_EGM_GGM05S

SW_EQM_EGM_MAX_N (*define*)

SwEqmSetActiveEGM

SwEqmSun
SwEqmPlanets
SwEqmAsteroids
SwEqmNonGravitational
SwEqmSolarJ2
SwEqmEarthGravityModel
SwEqmSimplePlanetGR
SwEqmExtendedPlanetGR
SwEqmAllPlanetGR

SwEqmBarycentric1stOrderDerivative
SwEqmBarycentric2ndOrderDerivative

ERROR

Utilities to aid source code debugging:

- Specification of error handler function;
- Sending a message to the error handler.

ERROR API SYMBOLS

SW_ERROR (*define*)

SwErrorHandler (*func-type*)

SwErrorSetMessageHandler
SwErrorMessage

GEOMETRY

Utilities for operating on triaxial ellipsoids, planar ellipses, infinite planes, and rays:

- Initialisation;
- Transformation;
- Ellipsoid limb-plane;
- Ellipsoid limb-ellipse;
- Ellipsoid near-point;
- Ellipsoid/ray near-point;
- Intersection state of ray with ellipsoid and plane.

GEOMETRY API SYMBOLS

SwEllipsoid (*array-type*)
SwEllipse (*struct-type*)
SwPlane (*struct-type*)
SwRay (*struct-type*)

SwGeometryInitialiseEllipse
SwGeometryInitialisePlane
SwGeometryInitialisePlane2
SwGeometryInitialiseRay

SwGeometryGetEllipsoidLimbEllipse
SwGeometryGetEllipsoidLimbPlane
SwGeometryGetEllipsoidNearPoint
SwGeometryGetEllipsoidRayNearPoint
SwGeometryGetEllipsoidRayIntersectPoint
SwGeometryGetPlaneRayIntersectPoint
SwGeometryGetPlaneReferencePoint

SwGeometrySampleEllipse

SwGeometryTransfromEllipse
SwGeometryTransfromEllipse2
SwGeometryTransformRay
SwGeometryTransformRay2

INTEGRATE

First- and second-order differential equation solvers, specialised for state-vector propagation:

- Runge-Kutta integrator (RK4, fixed step-size);
- Fehlberg Runge-Kutta integrators (RKF45, RKF78);
- Dormand Runge-Kutta integrator (RKD87);
- Feagin Runge-Kutta integrator (RKF1210);
- Fehlberg Runge-Kutta-Nystrom integrator for non-conservative forces (RKNFG78);
- Dormand Runge-Kutta-Nystrom integrators for conservative forces (RKND76, RKND1210);
- Gauss-Radau integrator for conservative and non-conservative forces (GR15).

INTEGRATE API SYMBOLS

SwIntegrate1stOrderDerivative (*func-type*)
SwIntegrate1stOrderIntegrator (*func-type*)
SwIntegrate2ndOrderDerivative (*func-type*)
SwIntegrate2ndOrderIntegrator (*func-type*)

SwIntegrateOutputHandler (*func-type*)

SwIntegrateSetMonitoring
SwIntegrateSetOutputHandler
SwIntegrateRK4
SwIntegrateRKF45
SwIntegrateRKF78
SwIntegrateRKD87
SwIntegrateRKF1210
SwIntegrateRKNFG78
SwIntegrateRKND76
SwIntegrateRKND1210

SwIntegrateGR15SetMonitoring
SwIntegrateGR15SetOutputHandler
SwIntegrateGR15SetAdaptiveMode
SwIntegrateGR15

MATRIX

Matrix mathematics:

- Matrix addition, subtraction, scaling, linear combination, multiply, identity-matrix, null-matrix;
- Rotation, spin, reflection, and scaling matrices;
- Axis and angle to-and-from rotation matrix;
- Euler angles to-and-from rotation matrix;
- Matrix inversion and transpose;
- Frame transformation of a matrix;
- Creation of matrix strings for printing.

MATRIX API SYMBOLS

SwMatrix (*struct-type*)

SW_MATRIX_MAX_SIZE (*define*)

SwAxis (*enum-type*)
- SW_AXIS_X
- SW_AXIS_Y
- SW_AXIS_Z

SwMatrixAdd
SwMatrixAdd2
SwMatrixSubtract
SwMatrixSubtract2
SwMatrixScale
SwMatrixScale2
SwMatrixMultiply
SwMatrixMultiply2
SwMatrixLinearCombination2
SwMatrixLength

SwMatrixNull
SwMatrixIdentity
SwMatrixIsIdentity

SwMatrixOuterVectorProduct
SwMatrixCrossProductMatrix
SwMatrixExtractColumns
SwMatrixInsertColumns
SwMatrixInvert
SwMatrixInvertOrthogonal

SwMatrixTransform
SwMatrixTransform2
SwMatrixTranspose
SwMatrixTranspose2

SwMatrixRotationMatrix
SwMatrixRotationMatrixFromAxisAndAngle
SwMatrixRotationMatrixToAxisAndAngle
SwMatrixRotationMatrixFromEulerAngles313
SwMatrixRotationMatrixToEulerAngles313

SwMatrixReflectionMatrix
SwMatrixScalingMatrix

SwMatrixSetStringGrouping
SwMatrixGetString

MINOR–BODY

Ephemerides of asteroids and comets:

- Object loading from user-supplied state-vector and osculating orbital elements, or elements obtained from JPL databases;
- Specification of object state integrators and equations-of-motion;
- Specification of non-gravitational parameters;
- ICRS barycentric state-vector, obtained by integration of the equations-of-motion if requested, otherwise by two-body propagation;
- Integration of the 1st-order variational equations for the partial derviatives of the equations-of-motion;
- ICRS heliocentric osculating orbital elements;
- Specification of orientation and shape parameters;
- Body-fixed coordinates;
- Orientation matrix and rate.

MINOR-BODY API SYMBOLS

SwMinorBodyObject (*int-type*)
SwMinorBodyNGP (*struct-type*)
SwMinorBodySSP (*struct-type*)
SwMinorBodyIntegratorData (*struct-type*)

SwMinorBodyElementsFrame (*enum-type*)
- SW_MINOR_BODY_ELM_FRAME_ICRS
- SW_MINOR_BODY_ELM_FRAME_ECL_IAU
- SW_MINOR_BODY_ELM_FRAME_ECL_JPL
- SW_MINOR_BODY_ELM_FRAME_ECL_GAIA
- SW_MINOR_BODY_ELM_FRAME_ECL_NIMA
- SW_MINOR_BODY_NUM_ ELM_FRAMES

SwMinorBodyPerturbation (*enum-type*)
- SW_MINOR_BODY_PTB_SUN
- SW_MINOR_BODY_PTB_PLN
- SW_MINOR_BODY_PTB_AST
- SW_MINOR_BODY_PTB_NGP
- SW_MINOR_BODY_PTB_SJ2
- SW_MINOR_BODY_PTB_EGM
- SW_MINOR_BODY_PTB_SIM_SGR
- SW_MINOR_BODY_PTB_EXT_SGR
- SW_MINOR_BODY_PTB_ALL_PGR

SwMinorBodyAllocateObjects
SwMinorBodyFreeObjects
SwMinorBodyLoadObjectFromJPLCatalog
SwMinorBodyLoadObjectFromStateVector
SwMinorBodyLoadObjectFromOrbitalElements
SwMinorBodyUnloadObject
SwMinorBodyUnloadAllObjects

SwMinorBodySet1stOrderIntegrator
SwMinorBodySet2ndOrderIntegrator
SwMinorBodySetEpochStateUpdateInterval
SwMinorBodySetAsteroidPerturbers
SwMinorBodySetEGMDegreeAndOrder
SwMinorBodySetShapeParameters
SwMinorBodySetOrientationParameters
SwMinorBodySetSpinStateParameters

SwMinorBodyTogglePerturbation

SwMinorBodyGetStateVector
SwMinorBodyGetOrbitalElements
SwMinorBodyGetGravitationalConstant
SwMinorBodyGetNonGravitationalParameters
SwMinorBodyGetCovarianceMatrix
SwMinorBodyGetShapeParameters

SwMinorBodyGetOrientationMatrix
SwMinorBodyGetBodyFixedCoordinates
SwMinorBodyGetObjectName
SwMinorBodyGetObjectDataSource

SwMinorBodyHasShapeAndOrient

NUTATION

Earth nutation models:

- Nutation angles and rates obtained from IAU-1980, IAU-2000A and IAU-2000B models;
- Nutation angles and rates obtained from IAU-2000 models compatible with IAU-2006 precession (designated here as IAU-2006A and IAU-2006B);
- Fundamental arguments and rates;
- Nutation matrix and rate (mean-of-date to true-of-date frame transformation);
- Pole offsets ($\delta\Delta\psi$,$\delta\Delta\varepsilon$) and rates update.

NUTATION API SYMBOLS

SwNutationModel (*enum-type*)
SW_NUTATION_IAU1980
SW_NUTATION_IAU2000A
SW_NUTATION_IAU2000B
SW_NUTATION_IAU2006A
SW_NUTATION_IAU2006B
SW_NUTATION_NUM_MODELS

SwNutationSetPoleOffsets

SwNutationGetPoleOffsets
SwNutationGetAngles
SwNutationGetFundamentalArguments
SwNutationGetMatrix

OBJECT

Top-level module providing streamlined access to the various sources of ephemerides and other object data:

- ICRS barycentric state-vector and osculating orbital elements;
- Body-fixed coordinates;
- Orientation matrix and rate;
- Shape parameters;
- Gravitational constants;
- Object and ephemeris names.

OBJECT API SYMBOLS

SwEphemerisObject (*int-type*)

SwEphemerisObjectGetStateVector
SwEphemerisObjectGetOrbitalElements
SwEphemerisObjectGetClampStatus
SwEphemerisObjectGetGravitationalConstant
SwEphemerisObjectGetEphemerisName
SwEphemerisObjectGetOrientationMatrix
SwEphemerisObjectGetShapeParameters
SwEphemerisObjectGetBodyFixedCoordinates
SwEphemerisObjectGetName

SwEphemerisObjectHasShapeAndOrient

PLACE

Relativistic ICRS state-vector transformations to each of the following places for any observer in the Solar System:

- Geometric;
- Astrometric – geometric place adjusted for light time;
- Virtual – astrometric place adjusted for solar gravitational deflection;
- Proper – virtual place adjusted for stellar aberration;
- Apparent – virtual place adjusted for planetary aberration.

PLACE API SYMBOLS

SwPlace (*enum-type*)
SW_PLACE_GEOMETRIC
SW_PLACE_ASTROMETRIC
SW_PLACE_VIRTUAL
SW_PLACE_PROPER
SW_PLACE_APPARENT
SW_PLACE_NUM_PLACES

SwPlaceOffset (*enum-type*)
SW_PLACE_OFFSET_NONE
SW_PLACE_OFFSET_GEO
SW_PLACE_OFFSET_AST
SW_PLACE_OFFSET_VIR
SW_PLACE_OFFSET_PRO_APP

SwPlaceSetPositionOffset

SwPlaceGetStateVector
SwPlaceGetAberrationAxisAndAngle
SwPlaceGetName
SwPlaceGetOffsetName

PLANET

Ephemerides of the Sun, Earth, Moon, and planet barycentres, and the Lagrangian points of the Sun-EMB and Earth-Moon systems, obtained from JPL DE or IMCCE INPOP integrations:

- ICRS Solar-System barycentric state-vector;
- ICRS Solar-System barycentric and heliocentric osculating orbital elements;
- Lunar libration angles;
- Time-ephemeris parameter (TT–TDB or TCG–TCB), if present;
- Lagrange point state-vector for the Sun-EMB and Earth-Moon systems;
- Gravitational constants;
- Orientation and shape parameters;
- Body-fixed coordinates;
- Orientation matrix and rate.

PLANET API SYMBOLS

SwPlanetObject (*enum-type*)
SW_PLANET_MERCURY
SW_PLANET_VENUS
SW_PLANET_EARTH_BC
SW_PLANET_MARS_BC
SW_PLANET_JUPITER_BC
SW_PLANET _SATURN_BC
SW_PLANET _URANUS_BC
SW_PLANET _NEPTUNE_BC
SW_PLANET _PLUTO_BC

SW_PLANET_SUN
SW_PLANET_EARTH
SW_PLANET_MOON

SW_PLANET_EMB_L1
SW_PLANET_EMB_L2
SW_PLANET_EMB_L3
SW_PLANET_EMB_L4
SW_PLANET_EMB_L5

SW_PLANET_MOON_L1
SW_PLANET_MOON_L2
SW_PLANET_MOON_L3
SW_PLANET_MOON_L4
SW_PLANET_MOON_L5

SwPlanetLightSpeedUnits (*enum-type*)
SW_PLANET_LS_KMS
SW_PLANET_LS_AUD

SwPlanetOpenFile
SwPlanetCloseFile

SwPlanetSetShapeParameters

SwPlanetGetStateVector
SwPlanetGetOrbitalElements
SwPlanetGetLunarLibrationAngles
SwPlanetGetTimeEphemerisParameter
SwPlanetGetEarthMoonMassRatio
SwPlanetGetLightSpeed
SwPlanetGetUnitDistance
SwPlanetGetGravitationalConstant
SwPlanetGetEphemerisConstant
SwPlanetGetClampStatus
SwPlanetGetLunarLibrationClampStatus
SwPlanetGetTimeEphemerisClampStatus
SwPlanetGetEphemerisName
SwPlanetGetEphemerisTimeSpan
SwPlanetGetShapeParameters
SwPlanetGetOrientationMatrix
SwPlanetGetOrientationParameters
SwPlanetGetBodyFixedCoordinates
SwPlanetGetObjectName

SwPlanetHasObjectData
SwPlanetHasLunarLibrationData
SwPlanetHasTimeEphemerisData
SwPlanetHasShapeAndOrient

PRECESSION

Earth precession models:

- Precession angles and rates obtained from IAU-1976, SIMON-1994, IAU-2000, SMART-2003, IAU-2006, and VONDRAK-2011 models;
- Mean obliquity and rate;
- Precession matrix and rate (J2000 to mean-of-date frame transformation);
- Frame-bias matrix (GCRS to J2000 frame transformation).

PRECESSION API SYMBOLS

SwPrecessionModel (*enum-type*)
SW_PRECESSION_IAU1976
SW_PRECESSION_SIM1994
SW_PRECESSION_IAU2000
SW_PRECESSION_SMART2003
SW_PRECESSION_IAU2006
SW_PRECESSION_VON2011
SW_PRECESSION_NUM_MODELS

SwPrecessionGetAngles1
SwPrecessionGetAngles2
SwPrecessionGetAngles3

SwPrecessionGetMeanObliquity
SwPrecessionGetMatrix
SwPrecessionGetFrameBiasMatrix

SATELLITE

Ephemerides of the natural satellites at Mars, Jupiter, Saturn, Uranus, Neptune and Pluto, obtained from JPL integrations and orbit fitting:

- ICRS planet-system barycentric state-vector;
- ICRS planetocentric osculating orbital elements;
- Gravitational constants;
- Orientation and shape parameters;
- Body-fixed coordinates;
- Orientation matrix and rate.

SATELLITE API SYMBOLS

SwSatelliteSystem (*enum-type*)
SW_SATELLITE_SYSTEM_MARS_1
SW_SATELLITE_SYSTEM_JUPITER_1
SW_SATELLITE_SYSTEM_JUPITER_2
SW_SATELLITE_SYSTEM_JUPITER_3
SW_SATELLITE_SYSTEM_SATURN_1
SW_SATELLITE_SYSTEM_SATURN_2
SW_SATELLITE_SYSTEM_SATURN_3
SW_SATELLITE_SYSTEM_SATURN_4
SW_SATELLITE_SYSTEM_URANUS_1
SW_SATELLITE_SYSTEM_URANUS_2
SW_SATELLITE_SYSTEM_URANUS_3
SW_SATELLITE_SYSTEM_NEPTUNE_1
SW_SATELLITE_SYSTEM_NEPTUNE_2
SW_SATELLITE_SYSTEM_PLUTO_1
SW_SATELLITE_NUM_SYSTEMS

SwSatelliteObject (*enum-type*)
SW_SATELLITE_PHOBOS
SW_SATELLITE_DEIMOS
SW_SATELLITE_MARS

SW_SATELLITE_IO
SW_SATELLITE_EUROPA
SW_SATELLITE_GANYMEDE
SW_SATELLITE_CALLISTO
SW_SATELLITE_AMALTHEA
SW_SATELLITE_THEBE
SW_SATELLITE_ADRASTEA
SW_SATELLITE_METIS
SW_SATELLITE_JUPITER

SW_SATELLITE_HIMALIA
SW_SATELLITE_ELARA
SW_SATELLITE_PASIPHAE
SW_SATELLITE_SINOPE
SW_SATELLITE_LYSITHEA
SW_SATELLITE_CARME
SW_SATELLITE_ANANKE
SW_SATELLITE_LEDA
SW_SATELLITE_CALLIRRHOE
SW_SATELLITE_THEMISTO
SW_SATELLITE_MAGACLITE
SW_SATELLITE_TAYGETE
SW_SATELLITE_CHALDENE
SW_SATELLITE_HARPALYKE
SW_SATELLITE_KALYKE

SW_SATELLITE_IOCASTE
SW_SATELLITE_ERINOME
SW_SATELLITE_ISONOE
SW_SATELLITE_PRAXIDIKE
SW_SATELLITE_AUTONOE
SW_SATELLITE_THYONE
SW_SATELLITE_HERMIPPE
SW_SATELLITE_AITNE
SW_SATELLITE_EURYDOME
SW_SATELLITE_EUANTHE
SW_SATELLITE_EUPORIE
SW_SATELLITE_ORTHOSIE
SW_SATELLITE_SPONDE
SW_SATELLITE_KALE
SW_SATELLITE_PASITHEE
SW_SATELLITE_HEGEMONE
SW_SATELLITE_MNEME

SW_SATELLITE_AOEDE
SW_SATELLITE_THELXINOE
SW_SATELLITE_ARCHE
SW_SATELLITE_KALLICHORE
SW_SATELLITE_HELIKE
SW_SATELLITE_CARPO
SW_SATELLITE_EUKELADE
SW_SATELLITE_CYLLENE
SW_SATELLITE_KORE
SW_SATELLITE_HERSE
SW_SATELLITE_DIA
SW_SATELLITE_EIRENE
SW_SATELLITE_PHILOPHROSYNE
SW_SATELLITE_EUPHEME
SW_SATELLITE_PANDIA
SW_SATELLITE_ERSA

SW_SATELLITE_MIMAS
SW_SATELLITE_ENCELADUS
SW_SATELLITE_TETHYS
SW_SATELLITE_DIONE
SW_SATELLITE_RHEA
SW_SATELLITE_TITAN
SW_SATELLITE_HYPERION
SW_SATELLITE_IAPETUS
SW_SATELLITE_PHOEBE
SW_SATELLITE_SATURN

SW_SATELLITE_JANUS
SW_SATELLITE_EPIMETHEUS
SW_SATELLITE_HELENE
SW_SATELLITE_TELESTO
SW_SATELLITE_CALYPSO
SW_SATELLITE_ATLAS
SW_SATELLITE_PROMETHEUS
SW_SATELLITE_PANDORA
SW_SATELLITE_METHONE
SW_SATELLITE_PALLENE
SW_SATELLITE_POLYDEUCES
SW_SATELLITE_ANTHE
SW_SATELLITE_AEGAEON
SW_SATELLITE_PAN
SW_SATELLITE_DAPHNIS

SW_SATELLITE_YMIR
SW_SATELLITE_PAALIAQ
SW_SATELLITE_TARVOS
SW_SATELLITE_IJIRAQ
SW_SATELLITE_SUTTUNGR
SW_SATELLITE_KIVIUQ
SW_SATELLITE_MUNDILFARI
SW_SATELLITE_ALBIORIX
SW_SATELLITE_SKATHI
SW_SATELLITE_ERRIAPUS
SW_SATELLITE_SIARNAQ
SW_SATELLITE_THRYMR
SW_SATELLITE_NARVI
SW_SATELLITE_AEGIR
SW_SATELLITE_BEBHIONN
SW_SATELLITE_BERGELMIR
SW_SATELLITE_BESTLA
SW_SATELLITE_FARBAUTI
SW_SATELLITE_FENRIR
SW_SATELLITE_FORNJOT
SW_SATELLITE_HATI
SW_SATELLITE_HYRROKKIN
SW_SATELLITE_KARI
SW_SATELLITE_LOGE
SW_SATELLITE_SKOLL
SW_SATELLITE_SURTUR
SW_SATELLITE_JARNSAXA
SW_SATELLITE_GREIP
SW_SATELLITE_TARQEQ

SW_SATELLITE_GRIDR
SW_SATELLITE_ANGRBODA
SW_SATELLITE_SKRYMIR
SW_SATELLITE_GERD
SW_SATELLITE_EGGTHER
SW_SATELLITE_BELI
SW_SATELLITE_GUNNLOD
SW_SATELLITE_THIAZZI
SW_SATELLITE_ALVALDI
SW_SATELLITE_GEIRROD

SW_SATELLITE_ARIEL
SW_SATELLITE_UMBRIEL
SW_SATELLITE_TITANIA
SW_SATELLITE_OBERON
SW_SATELLITE_MIRANDA
SW_SATELLITE_URANUS

SW_SATELLITE_CORDELIA
SW_SATELLITE_OPHELIA
SW_SATELLITE_BIANCA
SW_SATELLITE_CRESSIDA
SW_SATELLITE_DESDEMONA
SW_SATELLITE_JULIET
SW_SATELLITE_PORTIA
SW_SATELLITE_ROSALIND
SW_SATELLITE_BELINDA
SW_SATELLITE_PUCK
SW_SATELLITE_PERDITA
SW_SATELLITE_MAB
SW_SATELLITE_CUPID

SW_SATELLITE_CALIBAN
SW_SATELLITE_SYCORAX
SW_SATELLITE_PROSPERO
SW_SATELLITE_SETEBOS
SW_SATELLITE_STEPHANO
SW_SATELLITE_TRINCULO
SW_SATELLITE_FRANCISCO
SW_SATELLITE_MARGARET
SW_SATELLITE_FERDINAND

SW_SATELLITE_TRITON
SW_SATELLITE_NEREID
SW_SATELLITE_NAIAD
SW_SATELLITE_THALASSA
SW_SATELLITE_DESPINA
SW_SATELLITE_GALATEA
SW_SATELLITE_LARISSA
SW_SATELLITE_PROTEUS
SW_SATELLITE_HIPPOCAMP
SW_SATELLITE_NEPTUNE

SW_SATELLITE_HALIMEDE
SW_SATELLITE_PSAMATHE
SW_SATELLITE_SAO
SW_SATELLITE_LAOMEDEIA
SW_SATELLITE_NESO

SW_SATELLITE_CHARON
SW_SATELLITE_NIX
SW_SATELLITE_HYDRA
SW_SATELLITE_KERBEROS
SW_SATELLITE_STYX
SW_SATELLITE_PLUTO

SwSatelliteOpenSystemFile
SwSatelliteCloseSystemFile

SwSatelliteLoadRockElements

SwSatelliteSetShapeParameters

SwSatelliteGetStateVector
SwSatelliteGetGravitationalConstant
SwSatelliteGetOrbitalElements
SwSatelliteGetClampStatus
SwSatelliteGetObjectSystem
SwSatelliteGetEphemerisName
SwSatelliteGetShapeParameters
SwSatelliteGetOrientationMatrix
SwSatelliteGetOrientationParameters
SwSatelliteGetBodyFixedCoordinates
SwSatelliteGetObjectName

SwSatelliteHasShapeAndOrient

SBDB

Utilities to access JPL's small-body catalog of orbital elements via individual JSON data files:

- Orbital elements and covariance matrix;
- Non-gravitational parameters (NGP);
- Object and orbit identifiers;
- Object size (if any).

SBDB API SYMBOLS

SwSbdbSetDataRecordDirectory
SwSbdbLoadDataRecord

SwSbdbGetObjectIdentifiers
SwSbdbGetOrbitIdentifiers
SwSbdbGetOrbitalElements
SwSbdbGetCovarianceMatrix
SwSbdbGetNonGravitationalParameters
SwSbdbGetObjectSize

SKYWARE

Initialisation and termination of the SkyWare computational engine:

SKYWARE API SYMBOLS

SwSkyWareContext (*struct-type*)

SwSkyWareOpen
SwSkyWareClose

SMALL–BODY

Ephemerides of small bodies via interpolation of custom discrete-state ephemeris files:

- ICRS state-vector relative to reference object;
- Specification of orientatation and shape parameters;
- Orientation matrix and rate.

SMALL–BODY API SYMBOLS

SwSmallBodyObject (*int-type*)

SwSmallBodyAllocateObjects
SwSmallBodyFreeObjects
SwSmallBodyOpenFile
SwSmallBodyCloseFile
SwSmallBodyCloseAllFiles

SwSmallBodySetShapeParameters
SwSmallBodySetOrientationParameters
SwSmallBodySetVelocityInterpolation

SwSmallBodyGetStateVector
SwSmallBodyGetOrientationMatrix
SwSmallBodyGetBodyFixedCoordinates
SwSmallBodyGetEphemerisName
SwSmallBodyGetClampStatus
SwSmallBodyGetObjectName
SwSmallBodyGetReferenceObject

SwSmallBodyHasShapeAndOrient

STAR

Ephemerides of stars:

- Object loading from Gaia or generic Tycho2-like catalog data;
- Support for Gaia DR2 and EDR3/DR3 frame rotation and spin corrections;
- ICRS barycentric state-vector;
- Propagated star data retrieval, including the covariance matrix for the astrometric parameters;
- Propagated star data printing in spherical and rectangular coordinates;
- Orientation and shape parameters;
- Orientation matrix and rate.

STAR API SYMBOLS

SwStarObject (*int-type*)
SwStarData (*struct-type*)

SwStarGaiaCatalog (*enum-type*)
SW_STAR_CAT_GDR1
SW_STAR_CAT_GDR2
SW_STAR_CAT_GEDR3
SW_STAR_CAT_GDR3
SW_STAR_CAT_GDR4
SW_STAR_CAT_GDR5
SW_STAR_NUM_GAIA_CATALOGS

SwStarAllocateObjects
SwStarFreeObjects
SwStarLoadObjectFromUserData
SwStarLoadObjectFromGaiaCatalog
SwStarUnloadObject
SwStarUnloadAllObjects

SwStarSetGaiaCatalogDirectory
SwStarSetObserverPosition

SwStarSetShapeParameters

SwStarGetStateVector
SwStarGetPropagatedData
SwStarGetShapeParameters
SwStarGetOrientationMatrix
SwStarGetObjectName
SwStarGetObjectDataSource

SwStarPrintPropagatedData

SwStarHasShapeAndOrient

STATION

Ephemerides of observing stations on any Solar System body:

- Object loading in planetodetic or rectangular coordinates;
- ICRS body-centric state-vector;
- Orientation matrix (body-fixed to the topocentric frame transformation).

STATION API SYMBOLS

SwStationObject (*int-type*)

SwStationAllocateObjects
SwStationFreeObjects
SwStationLoadObjectFromPlanCoords
SwStationLoadObjectFromRectCoords
SwStationUnloadObject
SwStationUnloadAllObjects

SwStationGetStateVector
SwStationGetBaseObject
SwStationGetRectangularCoordinates
SwStationGetPlanetodeticCoordinates
SwStationGetOrientationMatrix
SwStationGetObjectName

TIME

Time-scale conversions and sidereal time models:

- Determination of TT–UT1, TT–TDB, TCG–TT, TCB–TDB, TAI–UTC, and TAI–GPS;
- Conversion of UTC to UT1, TT, and TDB given TAI–UTC and UT1–TAI;
- GMST, GAST, Equation-of-the-Equinoxes, and their rates relative to a uniform time-scale, obtained from IAU-1994, IAU-2000, and IAU-2006 sidereal time models;
- Equation-of-the-Origins, and its rate relative to a uniform time-scale, obtained from IAU-2000 and IAU-2006 sidereal time models;
- Earth Rotation Angle and rate;
- UT1–TAI and XLOD update.

TIME API SYMBOLS

SwSiderealModel (*enum-type*)
- SW_SIDEREAL_IAU1994
- SW_SIDEREAL_IAU2000A
- SW_SIDEREAL_IAU2000B
- SW_SIDEREAL_IAU2006A
- SW_SIDEREAL_IAU2006B
- SW_SIDEREAL_NUM_MODELS

SwTimeLoadTAImUTC
SwTimeSetUT1mTAI
SwTimeSetTTmUT1
SwTimeSetTTmTDB

SwTimeTransformUTC

SwTimeGetUT1mTAI
SwTimeGetTTmTAI
SwTimeGetTAImUTC
SwTimeGetTTmUT1
SwTimeGetTAImGPS
SwTimeGetTCGmTT
SwTimeGetTTmTDB
SwTimeGetTCBmTDB

SwTimeGetEarthRotationAngle
SwTimeGetEquEquinoxes
SwTimeGetEquOrigins
SwTimeGetGMST
SwTimeGetGAST

TIRS

Terrestrial Intermediate Reference System:

- ITRS coordinates of the CIP (x,y,z) and the TIO locator (s'), and their rates;
- TIRS matrix and rate (ITRS to TIRS frame transformation);
- Polar motion (x_p,y_p) and rates update;
- TIO locator and rate update.

TIRS API SYMBOLS

SwTirsSetPolarMotion
SwTirsSetTIOLocator

SwTirsGetPolarMotion
SwTirsGetTIOLocator
SwTirsGetCoordinates
SwTirsGetMatrix

TRANSFORM

Utilities for the conversion between rectangular, spherical, and planetodetic coordinate systems:

- Rectangular coordinates and rates to spherical coordinates and rates, and vice versa;
- Rectangular coordinates and rates to planetodetic coordinates and rates, and vice versa;
- Rectangular-to-spherical partial derivatives (3x3 and 6x6 Jacobian matrices and inverses);
- Rectangular-to-planetodetic partial derivatives (3x3 and 6x6 Jacobian matrices and inverses);
- Rectangular-to-plane-of-sky partial derivatives (3x3 and 6x6 Jacobian matrices and inverses).

TRANSFORM API SYMBOLS

SwTransformRect2Sph
SwTransformGetRect2SphPartials3
SwTransformGetRect2SphPartials6

SwTransformSph2Rect
SwTransformGetSph2RectPartials3
SwTransformGetSph2RectPartials6

SwTransformPlan2Rect
SwTransformGetPlan2RectPartials3
SwTransformGetPlan2RectPartials6

SwTransformRect2Plan
SwTransformGetRect2PlanPartials3

SwTransformGetRect2PlanPartials6

SwTransformGetRect2ADRPartials6
SwTransformGetRect2TNRPartials6

TWO–BODY

Two-body orbital elements and propagation:

- Transformation of asteroid and comet elements to generic elements;
- State-vector to osculating elements;
- Partial derivatives with respect to state-vector;
- Partial derivatives with respect to osculating elements;
- State propagation and state-transition matrix;
- Two-body 2nd-order Newtonian equations-of-motion and variational equations for the partial derivatives;
- Solution of the Kepler equation for ellipses and hyperbolae, and the Barker equation for parabolae;
- Solution of the equinoctial Kepler equation for ellipses.

TWO–BODY API SYMBOLS

SwTwoBodyElements (*struct-type*)
SwAsteroidElements (*struct-type*)
SwCometElements (*struct-type*)

SwTwoBodyElement (*enum-type*)
- SW_TWO_BODY_ECC
- SW_TWO_BODY_SLR
- SW_TWO_BODY_PCD
- SW_TWO_BODY_SMA
- SW_TWO_BODY_MM
- SW_TWO_BODY_MA
- SW_TWO_BODY_EA
- SW_TWO_BODY_TA
- SW_TWO_BODY_PCT
- SW_TWO_BODY_INC
- SW_TWO_BODY_NODE
- SW_TWO_BODY_ARGP
- SW_TWO_BODY_NUM_ELEMENTS

SwTwoBodyConvertAsteroidElements
SwTwoBodyConvertCometElements

SwTwoBodyGetElementsFromState
SwTwoBodyGetGradients
SwTwoBodyGetInverseGradients
SwTwoBodyGetEquationsOfMotion

SwTwoBodyPropagateState

SwTwoBodySolveKeplerELP
SwTwoBodySolveKeplerHYP
SwTwoBodySolveBarkerPRB
SwTwoBodySolveKeplerEQN

UTILITY

Miscellaneous transformation utilities:

- Normalise degrees to the range 0-360°;
- Normalise radians to the range 0-2π;
- Decimal degrees to degrees, arcminutes and arcseconds, and vice versa;
- Decimal degrees to hours, minutes and seconds, and vice versa;
- Hours, minutes and seconds to decimal hours;
- Decimal degrees to DMS string;
- Decimal degrees to HMS string;
- Machine-endianess;
- 2-byte, 4-byte, and 8-byte swapping;
- Evaluation of orientation parameters;
- Orientation parameters to Euler angles and vice versa;
- Construction of a covariance matrix from standard errors and correlations;
- Determination of the correlation matrix from a covariance matrix;
- Orientation matrix of the Galactic coordinate frame;
- Projection, viewing, and modelling matrices for use in 3D graphics applications via 4D homogeneous coordinates.

UTILITY API SYMBOLS

SwEndian (*enum-type*)
- SW_LITTLE_ENDIAN
- SW_BIG_ENDIAN

SwOrientationCoefficients (*struct-type*)

SwUtilityNormaliseDegrees
SwUtilityNormaliseRadians

SwUtilityConvertDegrees2DMS
SwUtilityConvertDegrees2HMS

SwUtilityConvertDMS2Degrees
SwUtilityConvertDMS2Hours
SwUtilityConvertHMS2Degrees
SwUtilityConvertHMS2Hours

SwUtilitySetDegreesStringGrouping
SwUtilityGetDegreesString

SwUtilitySetDMSStringGrouping
SwUtilityGetDMSString

SwUtilitySetHMSStringGrouping
SwUtilityGetHMSString

SwUtilityGetHostEndian
SwUtilitySwapBytes2
SwUtilitySwapBytes4
SwUtilitySwapBytes8

SwUtilityEvaluateOrientationParameters
SwUtilityConvertADW2SNP
SwUtilityConvertSNP2ADW

SwUtilityBuildCovarianceMatrix
SwUtilityExtractCorrelationMatrix

SwUtilityGetGalacticOrientationMatrix

SwUtilityPerspectiveMatrix
SwUtilityOrthographicMatrix
SwUtilityViewMatrix
SwUtilityOrientationMatrix
SwUtilityTranslationMatrix
SwUtilityFlattenMatrix

VECTOR

Vector mathematics:

- Vector addition, subtraction, scaling, linear combination, null-vector, and length;
- Normalisation of a vector and its rate;
- Vector dot and cross products;

- Frame transformation of a vector and its rate;
- Angle and angle-rate between vectors;
- Orthonormal set of vectors aligned with given vector.

VECTOR API SYMBOLS

SwVector (*array-type*)

SW_VECTOR_MAX_SIZE (*define*)

SwVectorAdd
SwVectorAdd2
SwVectorSubtract
SwVectorSubtract2
SwVectorScale
SwVectorScale2
SwVectorLinearCombination2

SwVectorLength
SwVectorNull
SwVectorIsNull

SwVectorDotProduct
SwVectorCrossProduct
SwVectorCrossProduct2

SwVectorNormalise
SwVectorNormalise2
SwVectorTransform
SwVectorTransform2

SwVectorAngleBetweenVectors
SwVectorOrthonormalSet

VIEW–POINT

Ephemerides of 'static' ephemeris objects which have a fixed relationship with existing dynamic objects:

- Object loading in spherical coordinates;
- ICRS position vector relative to reference object.

VIEW–POINT API SYMBOLS

SwViewPointObject (*int-type*)

SwViewPointAllocateObjects
SwViewPointFreeObjects
SwViewPointLoadObject
SwViewPointUnloadObject
SwViewPointUnloadAllObjects

SwViewPointGetObjectName
SwViewPointGetPositionVector
SwViewPointGetReferenceObject

SwViewPointUpdateCoordinates

Other API Symbols

SwInt8 (*int-type*)
SwInt16 (*int-type*)
SwInt32 (*int-type*)
SwInt64 (*int-type*)

SwUint8 (*int-type*)
SwUint16 (*int-type*)
SwUint32 (*int-type*)
SwUint64 (*int-type*)

SwSize (*int-type*)

SwBool (*enum-type*)
SW_FALSE
SW_TRUE

SW_TWO_PI (*define*)

SW_J2000 (*define*)

SW_MJD0 (*define*)

SW_JULIAN_CENTURY (*define*)

SW_SSB (*define*)

SW_PLANET_FIRST (*define*)
SW_PLANET_LAST (*enum-type*)

SW_ASTEROID_FIRST (*define*)
SW_ASTEROID_LAST (*enum-type*)

SW_SATELLITE_FIRST (*define*)
SW_SATELLITE_LAST (*enum-type*)

SW_SMALL_BODY_FIRST (*define*)
SW_SMALL_BODY_LAST (*define*)
SW_SMALL_BODY_MAX_NUM_OBJECTS (*define*)

SW_VIEW_POINT_FIRST (*define*)
SW_VIEW_POINT_LAST (*define*)
SW_VIEW_POINT_MAX_NUM_OBJECTS (*define*)

SW_STATION_FIRST (*define*)
SW_STATION_LAST (*define*)
SW_STATION_MAX_NUM_OBJECTS (*define*)

SW_EARTHSAT_FIRST (*define*)
SW_EARTHSAT_LAST (*define*)
SW_EARTHSAT_MAX_NUM_OBJECTS (*define*)

SW_MINOR_BODY_FIRST (*define*)
SW_MINOR_BODY_LAST (*define*)
SW_MINOR_BODY_MAX_NUM_OBJECTS (*define*)

SW_STAR_FIRST (*define*)
SW_STAR_LAST (*define*)
SW_STAR_MAX_NUM_OBJECTS (*define*)

SW_FOPEN_RT_MODE (*define*)
SW_FOPEN_WT_MODE (*define*)
SW_FOPEN_AT_MODE (*define*)

SW_FOPEN_RWT_MODE (*define*)
SW_FOPEN_WRT_MODE (*define*)

SW_FOPEN_RB_MODE (*define*)
SW_FOPEN_WB_MODE (*define*)
SW_FOPEN_AB_MODE (*define*)

SW_FOPEN_RWB_MODE (*define*)
SW_FOPEN_WRB_MODE (*define*)

SW_NAME_SIZE (*define*)
SW_PATH_SIZE (*define*)