This document describes the MPC_ORB.JSON format.

This document is generated programatically from a schema file.

000:Top Level of MPC-ORB.JSON object
   version: 0.4
   title: Best Fit Orbit Data for Single Solar System Object
   description: Standardized MPC JSON format for the exchange of orbit-fit
     data. Designed to communicate the best-fit orbit for a single minor planet
     or comet.
   type: object
   Required Properties: ['CAR', 'COM', 'designation_data',
     'orbit_fit_statistics', 'non_grav_booleans', 'magnitude_data',
     'epoch_data', 'moid_data', 'categorization', 'software_data',
     'system_data']
   Allowed Properties: ['CAR', 'COM', 'designation_data', 'software_data',
     'system_data', 'orbit_fit_statistics', 'non_grav_booleans',
     'magnitude_data', 'epoch_data', 'moid_data', 'categorization']

001:CAR
   type: object
   description: Cartesian Element Specification: Description of the best-fit
     orbit based on a cartesian coordinate system (plus any non-gravs). Contains
     the best-fit orbit and covariance matrix. Heliocentric coordinates.
   Allowed Properties: ['coefficient_specification', 'coefficient_names',
     'coefficient_values', 'coefficient_uncertainties', 'eigenvalues',
     'covariance']
   Required Properties: ['coefficient_names', 'coefficient_values',
     'coefficient_uncertainties', 'eigenvalues', 'covariance']

002:coefficient_specification
   description: Description of fitted quantities within Cartesian element
     specification.
   type: object
   Allowed Properties: ['x', 'y', 'z', 'vx', 'vy', 'vz', 'yarkovski', 'srp',
     'A1', 'A2', 'A3', 'DT']

003:x

Cartesian Position Component [See below for detailed specification]

004:y

Cartesian Position Component [See below for detailed specification]

005:z

Cartesian Position Component [See below for detailed specification]

006:vx

Cartesian Velocity Component [See below for detailed specification]

007:vy

Cartesian Velocity Component [See below for detailed specification]

008:vz

Cartesian Velocity Component [See below for detailed specification]

009:yarkovski

Yarkovski Component [See below for detailed specification]

010:srp

Physical Units associated with Solar-Radiation Pressure Component [See below for detailed specification]

011:A1

Physical Units associated with A1, A2 & A3 non-grav components [See below for detailed specification]

012:A2

Physical Units associated with A1, A2 & A3 non-grav components [See below for detailed specification]

013:A3

Physical Units associated with A1, A2 & A3 non-grav components [See below for detailed specification]

014:DT

Physical Units associated with DT non-grav component [See below for detailed specification]

015:coefficient_names

description: Names of the cartesian elements (and any non-grav components) used in this fit. Of length 6 if gravity-only, or 7-10 if we have non-gravs.

type: array

minItems: 6

maxItems: 10

items: {'type': 'string', 'enum': ['x', 'y', 'z', 'vx', 'vy', 'vz', 'yarkovski', 'srp', 'A1', 'A2', 'A3', 'DT']}

016:coefficient_values

Numerical values of the best-fit orbital elements (and any non-grav components). Of length 6 if gravity-only, or 7-10 if we have non-gravs. [See below for detailed specification]

017:coefficient_uncertainties

Uncertainties on the best-fit orbital elements (and any non-grav components). N.B. These correspond to the square-root of the diagonal terms in the coverance matrix. Of length 6 if gravity-only, or 7-10 if we have non-gravs. [See below for detailed specification]

018:eigenvalues

Eigenvalues for the orbital elements (and any non-gravitational parameters). Of length 6 if gravity-only, or 7-10 if we have non-gravs. [See below for detailed specification]

019:covariance

Covariance matrix elements (upper triangular) for the orbital elements (and any non-gravitational parameters). Reconstructed square matrix is of size 6x6 if gravity-only, or 7x7 -to- 10x10 if we have non-grav parameters. [See below for detailed specification]

020:COM

description: Description of the best-fit orbit using cometary coordinates (plus any non-gravs) in heliocentric coordinates. Contains the best-fit orbit and covariance matrix.

Allowed Properties: ['coefficient_specification', 'coefficient_names', 'coefficient_values', 'coefficient_uncertainties', 'eigenvalues', 'covariance']

Required Properties: ['coefficient_names', 'coefficient_values', 'coefficient_uncertainties', 'eigenvalues', 'covariance']

021:coefficient_specification

description: Description of allowed fitted quantities within the cometary coordinate specification system.

type: object

Allowed Properties: ['q', 'e', 'i', 'node', 'argperi', 'peri_time', 'yarkovski', 'srp', 'A1', 'A2', 'A3', 'DT']

022:q

Cometary Pericenter Distance [See below for detailed specification]

023:e

Cometary Eccentricity [See below for detailed specification]

024:i

Cometary Inclination [See below for detailed specification]

025:node

    Cometary Longitude of Ascending Node [See below for detailed specification]

026:argperi

    Cometary Argument of Pericenter [See below for detailed specification]

027:peri_time

    Cometary Time from Pericenter Passage [See below for detailed specification]

028:yarkovski

    Yarkovski Component [See below for detailed specification]

029:srp

    Physical Units associated with Solar-Radiation Pressure Component [See below for detailed specification]

030:A1

    Physical Units associated with A1, A2 & A3 non-grav components [See below for detailed specification]

031:A2

    Physical Units associated with A1, A2 & A3 non-grav components [See below for detailed specification]

032:A3

    Physical Units associated with A1, A2 & A3 non-grav components [See below for detailed specification]

033:DT

    Physical Units associated with DT non-grav component [See below for detailed specification]

034:coefficient_names

description: Names of the cometary elements (and any non-grav components) used in this fit. Of length 6 if gravity-only, or 7-10 if we have non-gravs.

type: array

minItems: 6

maxItems: 10

items: {'type': 'string', 'enum': ['q', 'e', 'i', 'node', 'argperi', 'peri_time', 'yarkovski', 'srp', 'A1', 'A2', 'A3', 'DT']}

035:coefficient_values

Numerical values of the best-fit orbital elements (and any non-grav components). Of length 6 if gravity-only, or 7-10 if we have non-gravs. [See below for detailed specification]

036:coefficient_uncertainties

Uncertainties on the best-fit orbital elements (and any non-grav components). N.B. These correspond to the square-root of the diagonal terms in the coverance matrix. Of length 6 if gravity-only, or 7-10 if we have non-gravs. [See below for detailed specification]

037:eigenvalues

Eigenvalues for the orbital elements (and any non-gravitational parameters). Of length 6 if gravity-only, or 7-10 if we have non-gravs. [See below for detailed specification]

038:covariance

Covariance matrix elements (upper triangular) for the orbital elements (and any non-gravitational parameters). Reconstructed square matrix is of size 6x6 if gravity-only, or 7x7 -to- 10x10 if we have non-grav parameters. [See below for detailed specification]

039:designation_data

type: object
description: The designations, numbers and names that may be associated
  with the object
Allowed Properties: ['permid', 'packed_primary_provisional_designation',
  'unpacked_primary_provisional_designation', 'orbfit_name',
  'packed_secondary_provisional_designations',
  'unpacked_secondary_provisional_designations', 'iau_name']
Required Properties: ['iau_name', 'orbfit_name',
  'packed_primary_provisional_designation', 'permid',
  'unpacked_primary_provisional_designation',
  'packed_secondary_provisional_designations',
  'unpacked_secondary_provisional_designations']

040:permid
  type: ['null', 'string']

041:packed_primary_provisional_designation
  type: string

042:unpacked_primary_provisional_designation
  type: string

043:orbfit_name
  type: string

044:packed_secondary_provisional_designations
  type: array
  items: {'type': 'string'}

045:unpacked_secondary_provisional_designations
  type: array
  items: {'type': 'string'}

046:iau_name

   type: string

047:software_data

   type: object

   description: Details of the software used to perform orbital fit and to
     create mpcorb output file

   Allowed Properties: ['fitting_software_name', 'software_version',
     'fitting_datetime', 'mpcorb_schema_version', 'mpcorb_schema_sha256',
     'mpcorb_creation_datetime']

   Required Properties: ['fitting_software_name', 'fitting_software_version',
     'fitting_datetime', 'mpcorb_version', 'mpcorb_creation_datetime']

048:fitting_software_name

   description: name of software used to perform orbit-fit

   type: string

   enum: ['orbfit']

049:software_version

   description: version of software used to perform orbit-fit

   type: string

050:fitting_datetime

   description: datetime at which the orbit fitting software was executed
     [null should only allowed for template]

   type: ['null', 'string']

051:mpcorb_schema_version

   description: version of the mpcorb schema used to validate this json

   type: string

   enum: ['0.1', '0.2', '0.3']

052:mpcorb_schema_sha256

description: sha256 hash of the mpcorb schema used to create this json
type: string

053:mpcorb_creation_datetime
description: datetime at which the mpcorb software was executed to create
this json [null should only allowed for template]
type: ['null', 'string']

054:system_data
type: object
description: Ephemeris model assumed when integrating the motion of the
object, and the frame of reference used to specify the best-fit orbital
elements.
Allowed Properties: ['eph', 'refplane', 'EclipticObliquityArcseconds',
'refframe', 'force_model']
Required Properties: ['eph', 'refsys', 'EclipticObliquityArcseconds',
'refframe', 'force_model']

055:eph
description: The ephemeris model used in the orbit-fit, E.g. DE431
type: string
enum: ['DE431', 'DE441']

056:refplane
description: The X-Y Reference Plane
type: string
enum: ['Equatorial', 'Ecliptic']

057:EclipticObliquityArcseconds
description: Obliquity angle from JPL 777 (heliocentric IAU76/J2000
ecliptic)
type: string
enum: ['84381.448']

058:refframe

    description: The frame of reference for the best-fit orbital elements

    type: string

    enum: ['ICRF']

059:force_model

    description: The planetary / asteroidal perturbers that were used in the
      orbit-fit. [need to decide exactly how to populate: url-link?]

    type: string

    enum: ['????']

060:orbit_fit_statistics

    type: object

    description: Summary fit statistics associated with the best-fit orbit, the
      observations used, etc

    Allowed Properties: ['sig_to_noise_ratio', 'snr_below_3', 'snr_below_1:',
      'U_param', 'score1', 'score2', 'orbit_quality', 'normalized_RMS',
      'not_normalized_RMS', 'nobs_total', 'nobs_total_sel', 'nobs_optical',
      'nobs_optical_sel', 'nobs_radar', 'nobs_radar_sel', 'arc_length_total',
      'arc_length_sel', 'nopp', 'numparams']

061:sig_to_noise_ratio

    description: SNR of the orbital parameters

    type: array

    items: {'type': 'number'}

062:snr_below_3

    description: True if any value in the SNR list is <3, False otherwise

    type: boolean

063:snr_below_1:

    description: True if any value in the SNR list is <1, False otherwise

type: boolean

064:U_param
  description: U parameter per
    https://minorplanetcenter.net/iau/info/UValue.html
  type: number

065:score1
  description: 1st score for numbering ...
  type: number

066:score2
  description: 2nd score for numbering ...
  type: number

067:orbit_quality
  description: Orbit quality: good, poor, unreliable, no orbit (def = good)
  type: string

068:normalized_RMS
  description: Normalized RMS (def = 0)
  type: number

069:not_normalized_RMS
  description: Not normalized RMS (def=0)
  type: ['null', 'number']

070:nobs_total
  description: Total number of all observations (optical + radar) available
  type: number

071:nobs_total_sel
  description: Total number of all observations (optical + radar) selected

type: number

072:nobs_optical

   description: Total number of optical observations available

   type: number

073:nobs_optical_sel

   description: Total number of optical observations selected

   type: number

074:nobs_radar

   description: Total number of radar observations available

   type: number

075:nobs_radar_sel

   description: Total number of radar observations selected

   type: number

076:arc_length_total

   description: Arc length over nobs_total

   type: ['number', 'string']

077:arc_length_sel

   description: Arc length over nobs_total_sel

   type: ['number', 'string']

078:nopp

   description: Number of oppositions

   type: number

079:numparams

   description: Number of parameters used for fit: E.g. 6-orbital params plus
    N-non_grav params

type: integer

080:non_grav_booleans
  type: object
  description: Booleans to indicate whether any non-gravitational parameters
    are used in the orbit-fit. The actual fitted values and their covariance
    properties are reported within the CAR and COT parameter sections.
  Allowed Properties: ['non_gravs', 'non_grav_model',
    'non_grav_coefficients']
  non_grav_units: {'description': 'Physical Units associated with any non-
    gravitational fit-parameters.', 'type': 'object', 'properties':
    {'yarkovski_coeff': {'type': 'string', 'enum': ['10^(-10)*au/day^2']},
    'srp_coeff': {'type': 'string', 'enum': ['m^2/ton']}, 'A1_coeff': {'type':
    'string', 'enum': ['au/day^2']}, 'A2_coeff': {'type': 'string', 'enum':
    ['au/day^2']}, 'A3_coeff': {'type': 'string', 'enum': ['au/day^2']},
    'DT_coeff': {'type': 'string', 'enum': ['day']}}, 'required':
    ['yarkovski_coeff', 'srp_coeff', 'A1_coeff', 'A2_coeff', 'A3_coeff',
    'DT_coeff']}
  Required Properties: ['non_gravs', 'non_grav_model',
    'non_grav_coefficients']

081:non_gravs
  description: Boolean to indicate whether any non-gravitational parameters
    are used in the orbit-fit.
  type: boolean

082:non_grav_model
  description: Booleans to indicate which specific non-gravitational model is
    used in the orbit-fit.
  type: object
  Allowed Properties: ['yarkovski', 'srp', 'marsden', 'yc', 'yabushita']
  Required Properties: ['yarkovski', 'srp', 'marsden', 'yc', 'yabushita']

083:yarkovski

  description: Yarkovski model
    (https://www.sciencedirect.com/science/article/pii/S0019103513000456)
    boolean
  type: boolean

084:srp

  description: Solar Radiation Pressure model () boolean
  type: boolean

085:marsden

  description: Marsden model () boolean
  type: boolean

086:yc

  description: Yeomans & Chodas model () boolean
  type: boolean

087:yabushita

  description: Yabushita model
    (https://www.sciencedirect.com/science/article/pii/S0019103513000456)
    boolean
  type: boolean

088:non_grav_coefficients

  description: Booleans to indicate which non-gravitational coefficients are
    used in the orbit-fit.
  type: object
  Allowed Properties: ['yarkovski', 'srp', 'A1', 'A2', 'A3', 'DT']
  Required Properties: ['yarkovski', 'srp', 'A1', 'A2', 'A3', 'DT']

089:yarkovski

  description: Yarkovski Coefficient A1 boolean

type: boolean

090:srp

  description: SRP Coefficient A2 boolean

  type: boolean

091:A1

  description: Non-Gravitational Coefficient A1 boolean

  type: boolean

092:A2

  description: Non-Gravitational Coefficient A2 boolean

  type: boolean

093:A3

  description: Non-Gravitational Coefficient A3 boolean

  type: boolean

094:DT

  description: Non-Gravitational Coefficient DT boolean: Only used in yc
    (Yeomans & Chodas) model

  type: boolean

095:magnitude_data

  type: object

  description: The absolute magnitude, H, and slope parameter, G, information
    derived from the fitted orbit in combination with the observed apparent
    magnitudes.

  Allowed Properties: ['H', 'G', 'G1', 'G2', 'G12', 'photometric_model']

  Required Properties: ['photometric_model', 'H', 'G']

096:H

  type: number

097:G
  type: number

098:G1
  type: ['null', 'number']

099:G2
  type: ['null', 'number']

100:G12
  type: ['null', 'number']

101:photometric_model
  type: string
  enum: ['????']

102:epoch_data
  type: object
  description: Data concerning the orbit epoch: I.e. The date at which the
    best-fit orbital coordinates are correct
  Allowed Properties: ['timesystem', 'timeform', 'epoch']
  Required Properties: ['epoch', 'timesystem', 'timeform']

103:timesystem
  type: string
  enum: ['TDB', 'TDT']

104:timeform
  type: string
  enum: ['JD', 'MJD']

105:epoch

type: number

106:moid_data
  type: object
  description: Calculated MOIDs (Minimum Orbital Interception Distances) at
    Epoch
  Allowed Properties: ['Venus', 'Earth', 'Mars', 'Jupiter', 'moid_units']

107:Venus
  type: ['null', 'number']

108:Earth
  type: ['null', 'number']

109:Mars
  type: ['null', 'number']

110:Jupiter
  type: ['null', 'number']

111:moid_units
  type: string
  enum: ['au']

112:categorization
  type: object
  description: Various different ways to categorize / sub-set orbit / object
    types
  Allowed Properties: ['object_type_str', 'object_type_int',
    'orbit_type_str', 'orbit_type_int', 'orbit_subtype_str',
    'orbit_subtype_int', 'parent_planet_str', 'parent_planet_int']
  Required Properties: ['object_type_str', 'object_type_int',
    'orbit_type_str', 'orbit_type_int', 'orbit_subtype_str',

'orbit_subtype_int']

113:object_type_str

   description: Object Type (String): E.g. Minor-Planet / Comet / Dual-Status
    / Binary MP / etc. For a full description of allowed object types, see
    https://minorplanetcenter.net/mpcops/documentation/object-types/
   type: string

114:object_type_int

   description: Object Type (Integer): E.g.   0   10   20
    1. For a full description of allowed object types, see
    https://minorplanetcenter.net/mpcops/documentation/object-types/
   type: ['null', 'number']

115:orbit_type_str

   description: Orbit Type (String): E.g. NEAs / MBAs / TNOs / etc. For a full
    description of allowed orbit types, see
    https://minorplanetcenter.net/mpcops/documentation/orbit-types/
   type: string

116:orbit_type_int

   description: Orbit Type (Integer): E.g. 0 /1/2/3/4/etc. For a full
    description of allowed orbit types, see
    https://minorplanetcenter.net/mpcops/documentation/orbit-types/
   type: ['null', 'number']

117:orbit_subtype_str

   description: Orbit Sub-Type (String): E.g. Apollo / Amor / ...
   type: string

118:orbit_subtype_int

   description: Orbit Sub-Type (Integer)
   type: ['null', 'number']

119:parent_planet_str

description: Parent Planet (String) if Natural Satellite

type: string

120:parent_planet_int

description: Parent Planet (Integer) if Natural Satellite

type: ['null', 'number']

121:coefficient_values

description: Numerical values of the best-fit orbital elements (and any
non-grav components). Of length 6 if gravity-only, or 7-10 if we have non-
gravs.

type: array

minItems: 6

maxItems: 10

items: {'type': 'number'}

122:coefficient_uncertainties

description: Uncertainties on the best-fit orbital elements (and any non-
grav components). N.B. These correspond to the square-root of the diagonal
terms in the coverance matrix. Of length 6 if gravity-only, or 7-10 if we
have non-gravs.

type: array

minItems: 6

maxItems: 10

items: {'type': 'number'}

123:eigenvalues

description: Eigenvalues for the orbital elements (and any non-
gravitational parameters). Of length 6 if gravity-only, or 7-10 if we have
non-gravs.

type: array

minItems: 6

maxItems: 10

items: {'type': 'number'}

124:covariance

description: Covariance matrix elements (upper triangular) for the orbital
elements (and any non-gravitational parameters). Reconstructed square
matrix is of size 6x6 if gravity-only, or 7x7 -to- 10x10 if we have non-
grav parameters.

type: object

properties: {'cov00': {'type': 'number'}, 'cov01': {'type': 'number'},
'cov02': {'type': 'number'}, 'cov03': {'type': 'number'}, 'cov04': {'type':
'number'}, 'cov05': {'type': 'number'}, 'cov06': {'type': ['null',
'number']}, 'cov07': {'type': ['null', 'number']}, 'cov08': {'type':
['null', 'number']}, 'cov09': {'type': ['null', 'number']}, 'cov11':
{'type': 'number'}, 'cov12': {'type': 'number'}, 'cov13': {'type':
'number'}, 'cov14': {'type': 'number'}, 'cov15': {'type': 'number'},
'cov16': {'type': ['null', 'number']}, 'cov17': {'type': ['null',
'number']}, 'cov18': {'type': ['null', 'number']}, 'cov19': {'type':
['null', 'number']}, 'cov22': {'type': 'number'}, 'cov23': {'type':
'number'}, 'cov24': {'type': 'number'}, 'cov25': {'type': 'number'},
'cov26': {'type': ['null', 'number']}, 'cov27': {'type': ['null',
'number']}, 'cov28': {'type': ['null', 'number']}, 'cov29': {'type':
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'number']}, 'cov37': {'type': ['null', 'number']}, 'cov38': {'type':
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'number']}, 'cov47': {'type': ['null', 'number']}, 'cov48': {'type':
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{'type': ['null', 'number']}, 'cov58': {'type': ['null', 'number']},
'cov59': {'type': ['null', 'number']}, 'cov66': {'type': ['null',

'number']}, 'cov67': {'type': ['null', 'number']}, 'cov68': {'type':
['null', 'number']}, 'cov69': {'type': ['null', 'number']}, 'cov77':
{'type': ['null', 'number']}, 'cov78': {'type': ['null', 'number']},
'cov79': {'type': ['null', 'number']}, 'cov88': {'type': ['null',
'number']}, 'cov89': {'type': ['null', 'number']}, 'cov99': {'type':
['null', 'number']}}
required: ['cov00', 'cov01', 'cov02', 'cov03', 'cov04', 'cov05', 'cov11',
'cov12', 'cov13', 'cov14', 'cov15', 'cov22', 'cov23', 'cov24', 'cov25',
'cov33', 'cov34', 'cov35', 'cov44', 'cov45', 'cov55']

125:cartesian_posn
  type: object
  description: Cartesian Position Component
  properties: {'unit': {'description': 'Physical Units associated with
    Cartesian Position Component', 'type': 'string', 'enum': ['au']}}

126:cartesian_vel
  type: object
  description: Cartesian Velocity Component
  properties: {'unit': {'description': 'Physical Units associated with
    Cartesian Velocity Component', 'type': 'string', 'enum': ['au/day']}}

127:cometary_q
  type: object
  description: Cometary Pericenter Distance
  properties: {'unit': {'description': 'Physical Units associated with
    Cometary Pericenter Distance', 'type': 'string', 'enum': ['au']}}

128:cometary_e
  type: object
  description: Cometary Eccentricity
  properties: {'unit': {'description': 'Physical Units associated with
    Cometary Eccentricity', 'type': 'string', 'enum': ['null']}}

129:cometary_i

    type: object

    description: Cometary Inclination

    properties: {'unit': {'description': 'Physical Units associated with
      Cometary Inclination', 'type': 'string', 'enum': ['degrees']}}

130:cometary_node

    type: object

    description: Cometary Longitude of Ascending Node

    properties: {'unit': {'description': 'Physical Units associated with
      Cometary Longitude of Ascending Node', 'type': 'string', 'enum':
      ['degrees']}}

131:cometary_argperi

    type: object

    description: Cometary Argument of Pericenter

    properties: {'unit': {'description': 'Physical Units associated with
      Cometary Argument of Pericenter', 'type': 'string', 'enum': ['degrees']}}

132:cometary_peri_time

    type: object

    description: Cometary Time from Pericenter Passage

    properties: {'unit': {'description': 'Physical Units associated with
      Cometary Time from Pericenter Passage', 'type': 'string', 'enum':
      ['days']}}

133:yarkovski_coeff

    type: object

    description: Yarkovski Component

    properties: {'unit': {'description': 'Physical Units associated with
      Yarkovski non-grav component', 'type': 'string', 'enum':
      ['10^(-10)*au/day^2']}}

134:srp_coeff

  type: object

  description: Physical Units associated with Solar-Radiation Pressure
   Component

  properties: {'unit': {'description': 'Physical Units associated with
   component', 'type': 'string', 'enum': ['m^2/ton']}}

135:A123_coeff

  type: object

  description: Physical Units associated with A1, A2 & A3 non-grav components

  properties: {'unit': {'description': 'Physical Units associated with
   component', 'type': 'string', 'enum': ['m^2/ton']}}

136:DT_coeff

  type: object

  description: Physical Units associated with DT non-grav component

  properties: {'unit': {'description': 'Physical Units associated with
   component', 'type': 'string', 'enum': ['v']}}