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Galileo Spacecraft Trajectory SPK file, Robert Jacobson's 2007 Solution
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     Created by Boris Semenov, NAIF/JPL, September 8, 2011.


Objects in the Ephemeris
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     This file contains trajectory data for the Galileo spacecraft
     (NAIF ID -77) with respect to the Jupiter Barycenter (5) in the
     J2000 inertial reference frame.

     It also contains ephemerides of the Sun (10), planetary
     barycenters (1-9), Mercury (199), Venus (299), Earth (399), Moon
     (301), Mars (499), and Jupiter (599) and of a few Jovian
     satellites -- Io (501), Europa (502), Ganymede (503), Callisto
     (504), Amalthea (505), and Thebe (514).

     The planetary ephemerides included in this SPK are version DE405;
     the satellite ephemerides included in this file are version
     JUP230.


Approximate Time Coverage
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     The Galileo trajectory stored in this SPK file provides nearly
     continuous coverage for the primary mission (1995-JUL-01 ...
     1998-JAN-01) and partial coverage with many large gaps for
     extended missions (1998-JAN-01...2003-SEP-22), specifically:

        Start of Interval (ET)              End of Interval (ET)
        ----------------------------        ----------------------------
        1995 NOV 21 00:00:00.000            1995 DEC 08 00:00:00.000
        1995 DEC 08 06:30:00.000            1997 JAN 15 00:00:00.000
        1997 JAN 16 00:00:00.000            1998 JAN 23 00:00:00.000
        1998 MAR 14 00:01:03.185            1998 MAY 01 00:00:00.000
        1998 JUN 27 00:01:03.184            1998 AUG 24 00:00:00.000
        1999 JAN 01 00:00:00.000            1999 MAR 15 00:00:00.000
        1999 APR 11 00:00:00.000            1999 JUL 23 00:00:00.000
        1999 AUG 03 00:00:00.000            1999 AUG 27 00:00:00.000
        1999 AUG 28 14:00:00.000            1999 SEP 30 00:00:00.000
        1999 OCT 01 15:00:00.000            1999 NOV 02 00:00:00.000
        1999 NOV 11 02:00:00.000            1999 DEC 14 00:00:00.000
        1999 DEC 23 00:00:00.000            2000 JAN 24 18:00:00.000
        2000 FEB 06 06:00:00.000            2000 MAR 10 00:00:00.000
        2000 APR 07 13:10:00.000            2000 MAY 30 00:00:00.000
        2000 OCT 31 08:00:00.000            2001 JAN 04 00:00:00.000
        2001 APR 29 00:00:00.000            2001 JUL 16 00:00:00.000
        2001 JUL 16 12:30:00.000            2001 OCT 25 00:00:00.000
        2001 DEC 04 00:00:00.000            2002 NOV 26 08:00:00.000

     The planetary and satellite ephemerides provided in this SPK file
     covers the following continuous time interval:

        Start of Interval (ET)              End of Interval (ET)
        ----------------------------        ----------------------------
        1995 NOV 21 00:00:00.000            2002 NOV 26 08:00:00.000


Status
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     This file contains reconstructed Galileo trajectory determined by
     Robert A. Jacobson, Solar System Dynamics group, in 2007. It is
     intended for use in support of the Galileo experiment data
     processing and for archiving with the Planetary Data System (PDS).


Pedigree
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     This file was created by Boris Semenov using individual trajectory
     arc solutions for the primary and extended mission trajectory arcs
     provided in the form of NIO files by Robert A. Jacobson in 2007.
     These NIO files were converted to SPK format using the NIOSPK
     program and then merged together with DE405/LE405 planetary
     ephemerides and JUP230 satellite ephemerides using the SPKMERGE
     program. The SPKMERGE log is provided in the Appendix 1 of these
     comments.


Segment Boundary Discontinuities
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     This SPK file contains a large number of Galileo trajectory SPK
     segments that came from original individual SPK files. Although,
     each segment provides continuous trajectory within the interval
     that it covers, in general a position and velocity discontinuity
     exists at the boundary of the segment and the segments whose
     coverage immediately precede and follow it. The times and
     magnitudes of these discontinuities are provided in the Appendix 2
     of these comments.


Contacts
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     If you have questions regarding this data contact

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Appendix 1: SPKMERGE Log
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     The log from the SPKMERGE run that created this SPK is below.

        ; gll_951120_021126_raj2007.bsp LOG FILE

        ; Created 2011-09-08/10:35:09.15.
        ;
        ; BEGIN SPKMERGE COMMANDS

        LEAPSECONDS_KERNEL   = naif0008.tls

        SPK_KERNEL           = gll_951120_021126_raj2007.bsp
          LOG_FILE           = gll_951120_021126_raj2007.log
          SOURCE_SPK_KERNEL  = gll.-1.Io.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
            BEGIN_TIME       = 1995 NOV 20 23:58:58.817
            END_TIME         = 1995 DEC 07 23:58:58.817
          SOURCE_SPK_KERNEL  = gll.00.Ganymede0.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
            BEGIN_TIME       = 1995 DEC 08 06:28:58.817
            END_TIME         = 1996 MAY 31 23:58:57.815
          SOURCE_SPK_KERNEL  = gll.01.Ganymede1.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
            BEGIN_TIME       = 1996 MAY 31 23:58:57.815
            END_TIME         = 1996 AUG 05 23:58:57.817
          SOURCE_SPK_KERNEL  = gll.02.Ganymede2.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
            BEGIN_TIME       = 1996 AUG 05 23:58:57.817
            END_TIME         = 1996 SEP 10 23:58:57.818
          SOURCE_SPK_KERNEL  = gll.03.Callisto3.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
            BEGIN_TIME       = 1996 SEP 10 23:58:57.818
            END_TIME         = 1996 NOV 26 23:58:57.817
          SOURCE_SPK_KERNEL  = gll.04.Europa4.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
            BEGIN_TIME       = 1996 NOV 26 23:58:57.817
            END_TIME         = 1997 JAN 14 23:58:57.816
          SOURCE_SPK_KERNEL  = gll.06.Europa6.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
            BEGIN_TIME       = 1997 JAN 15 23:58:57.816
            END_TIME         = 1997 MAR 14 23:58:57.814
          SOURCE_SPK_KERNEL  = gll.07.Ganymede7.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
            BEGIN_TIME       = 1997 MAR 14 23:58:57.814
            END_TIME         = 1997 APR 21 23:58:57.814
          SOURCE_SPK_KERNEL  = gll.08.Ganymede8.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
            BEGIN_TIME       = 1997 APR 21 23:58:57.814
            END_TIME         = 1997 JUN 03 23:58:57.815
          SOURCE_SPK_KERNEL  = gll.09.Callisto9.jup230.bsp
            INCLUDE_COMMENTS = NO
            BODIES           = -77
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    BEGIN_TIME       = 1997 JUN 03 23:58:57.815
    END_TIME         = 1997 AUG 08 23:58:56.817
  SOURCE_SPK_KERNEL  = gll.10.Callisto10.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1997 AUG 08 23:58:56.817
    END_TIME         = 1997 OCT 19 23:58:56.818
  SOURCE_SPK_KERNEL  = gll.11.Europa11.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1997 OCT 19 23:58:56.818
    END_TIME         = 1997 NOV 09 23:58:56.817
  SOURCE_SPK_KERNEL  = gll.12.Europa12.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1997 NOV 09 23:58:56.817
    END_TIME         = 1998 JAN 22 23:58:56.815
  SOURCE_SPK_KERNEL  = gll.14.Europa14.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1998 MAR 14 00:00:00.000
    END_TIME         = 1998 APR 30 23:58:56.815
  SOURCE_SPK_KERNEL  = gll.16.Europa16.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1998 JUN 27 00:00:00.000
    END_TIME         = 1998 AUG 23 23:58:56.817
  SOURCE_SPK_KERNEL  = gll.19.Europa19.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1998 DEC 31 23:58:56.816
    END_TIME         = 1999 MAR 14 23:58:55.814
  SOURCE_SPK_KERNEL  = gll.20.Callisto20.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1999 APR 10 23:58:55.814
    END_TIME         = 1999 JUN 04 23:58:55.815
  SOURCE_SPK_KERNEL  = gll.21.Callisto21.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1999 JUN 04 23:58:55.815
    END_TIME         = 1999 JUL 22 23:58:55.816
  SOURCE_SPK_KERNEL  = gll.22.Callisto22.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1999 AUG 02 23:58:55.817
    END_TIME         = 1999 AUG 26 23:58:55.817
  SOURCE_SPK_KERNEL  = gll.23.Callisto23.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1999 AUG 28 13:58:55.817
    END_TIME         = 1999 SEP 29 23:58:55.818
  SOURCE_SPK_KERNEL  = gll.24.Io24.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1999 OCT 01 14:58:55.818
    END_TIME         = 1999 NOV 01 23:58:55.817
  SOURCE_SPK_KERNEL  = gll.25.Io25.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1999 NOV 11 01:58:55.817
    END_TIME         = 1999 DEC 13 23:58:55.817
  SOURCE_SPK_KERNEL  = gll.26.Europa26.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 1999 DEC 22 23:58:55.816
    END_TIME         = 2000 JAN 24 17:58:55.815
  SOURCE_SPK_KERNEL  = gll.27.Io27.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 2000 FEB 06 05:58:55.815
    END_TIME         = 2000 MAR 09 23:58:55.814
  SOURCE_SPK_KERNEL  = gll.28.Ganymede28.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 2000 APR 07 13:08:55.814
    END_TIME         = 2000 MAY 29 23:58:55.815
  SOURCE_SPK_KERNEL  = gll.29.Ganymede29.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
    BEGIN_TIME       = 2000 OCT 31 07:58:55.817
    END_TIME         = 2001 JAN 03 23:58:55.816
  SOURCE_SPK_KERNEL  = gll.30.Callisto30.jup230.bsp
    INCLUDE_COMMENTS = NO
    BODIES           = -77
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              BEGIN_TIME       = 2001 APR 28 23:58:55.814
              END_TIME         = 2001 JUL 15 23:58:55.816
            SOURCE_SPK_KERNEL  = gll.31.Io31.jup230.bsp
              INCLUDE_COMMENTS = NO
              BODIES           = -77
              BEGIN_TIME       = 2001 JUL 16 12:28:55.816
              END_TIME         = 2001 AUG 27 23:58:55.817
            SOURCE_SPK_KERNEL  = gll.32.Io32.jup230.bsp
              INCLUDE_COMMENTS = NO
              BODIES           = -77
              BEGIN_TIME       = 2001 AUG 27 23:58:55.817
              END_TIME         = 2001 OCT 24 23:58:55.818
            SOURCE_SPK_KERNEL  = gll.33.Io33.jup230.bsp
              INCLUDE_COMMENTS = NO
              BODIES           = -77
              BEGIN_TIME       = 2001 DEC 03 23:58:55.817
              END_TIME         = 2002 JAN 22 23:58:55.815
            SOURCE_SPK_KERNEL  = gll.34.Amalthea34.jup230.bsp
              INCLUDE_COMMENTS = NO
              BODIES           = -77
              BEGIN_TIME       = 2002 JAN 22 23:58:55.815
              END_TIME         = 2002 NOV 26 07:58:55.817
            SOURCE_SPK_KERNEL  = jup230_planets.bsp
              INCLUDE_COMMENTS = NO
              BODIES           = 499, 299, 199, 399, 301, 10, 9, 8, 7,
                                 6, 5, 4, 3, 2, 1
              BEGIN_TIME       = 1995 NOV 20 23:58:58.817
              END_TIME         = 2002 NOV 26 07:58:55.817
            SOURCE_SPK_KERNEL  = jup230_satellites.bsp
              INCLUDE_COMMENTS = NO
              BODIES           = 599, 514, 505, 504, 503, 502, 501
              BEGIN_TIME       = 1995 NOV 20 23:58:58.817
              END_TIME         = 2002 NOV 26 07:58:55.817

           ; END SPKMERGE COMMANDS
```

Appendix 2: Segment Boundary Discontinuity Summary

This SPK file contains a large number of Galileo trajectory SPK segments that came from original individual SPK files. Although, each segment provides continuous trajectory within the interval that it covers, in general a position and velocity discontinuity exists at the boundary of the segment and the segments whose coverage immediately precede and follow it. The times and magnitudes of these discontinuities are provided in the table included in this Appendix.

The top portion of the table contains the name of this SPK file. All descriptive lines in the top portion of the file start with the ``#'' character to allow direct plotting of the data in the freeware ``gnuplot'' application.

The table consists of 4 columns. The first column contains the UTC time of that segment boundary. The last three columns (2..4) contain view coordinate frame components -- ``down track'' (this direction is parallel to the velocity vector), ``normal to plane'' (this direction is computed as cross product of position vector by velocity vector) and ``in plane'' (this direction is computed as a cross product of ``down track'' by ``normal to plane'') -- of the difference between the state vectors computed at that UTC time defining segment boundary at which a discontinuity exists.

The pairs of segments and discontinuity times are determined using an algorithm that emulates the standard SPK loading priority -- ``last loaded segment takes precedence''. Therefore, the discontinuities summarized in the file are those which a user reading file would actually see.

The difference components in the view coordinate frame were computed for each discontinuity using the following algorithm:

- A single state was computed from each pair of segment the J2000 frame at the time of discontinuity.

- For this pair of states, a position difference vector was computed by subtracting the state computed from the segment with higher priority from the state computed from segment with lower priority. Then, a frame transformation matrix rotating these difference vectors from J2000 to the view coordinate frame defined by the state obtained from the higher priority segment was computed, and the position difference vector was rotated to the view frame coordinates using this matrix.

```
      The Galileo trajectory segment boundary discontinuities for this
      file are:

         #
         # Summary of discontinuities at segment boundaries for
         # SPK file gll_951120_021126_raj2007.bsp:
         #
         #  BOUNDARY TIME (UTC)   DOWNTRK INPLANE  NORMAL
         #----------------------- ------- ------- -------
         1996-05-31T23:58:57.815   0.002  -0.001   0.000
         1996-08-05T23:58:57.816   0.003  -0.014   0.001
         1996-09-10T23:58:57.817  -0.002   0.005  -0.000
         1996-11-26T23:58:57.817   0.025   0.069   0.001
         1997-03-14T23:58:57.814   0.152  -0.183  -0.001
         1997-04-21T23:58:57.814   0.001   0.006  -0.001
         1997-06-03T23:58:57.815   0.047  -0.123  -0.001
         1997-08-08T23:58:56.816  -0.008   0.048   0.000
         1997-10-19T23:58:56.817  -0.020   0.012  -0.001
         1997-11-09T23:58:56.817   0.021   0.070   0.000
         1999-06-04T23:58:55.815  -5.081   0.142 -12.740
         2001-08-27T23:58:55.817  -0.232   0.299  -3.908
         2002-01-22T23:58:55.815   1.356  -4.014  90.828


   End of comments.
```