

## 演習課題4

- ・ Dynamic Frameで太陽-地球固定座標系を定義せよ
  - sun\_earth\_fixed.tfの空欄を埋めて完成させること
- ・ 課題2で作成したcruise.cを改造し、はやぶさの打ち上げからイトカワ到着までの軌道情報を上記の太陽-地球固定座標系で計算せよ
- ・ 結果をgnuplotで図示せよ

## <cruise.cからの変更点>

spkpos c()関数でカーネルからのデータを読み込む際の座標系指定を書き換えた

```

...
...
//Convert et to UTC time string
et2utc_c ( et, "ISOC", 0, STRLEN, utc );
printf("%s\t",utc);

spkpos_c ( "MUSES-C", et, "SUN_EARTH_FIXED", "NONE", "SUN", hayabusa_pos_J2k, &lt_hayabusa);
spkpos_c ( "ITOKAWA", et, "SUN_EARTH_FIXED", "NONE", "SUN", itokawa_pos_J2k, &lt_itokawa);
spkpos_c ( "EARTH", et, "SUN_EARTH_FIXED", "NONE", "SUN", earth_pos_J2k, &lt_earth);

```

```
printf (" %9.4ft%9.4ft%9.4ft%9.4ft%9.4ft%9.4ft%9.4ft%9.4ft\n",
        hayabusa_pos_J2k[0], hayabusa_pos_J2k[1], hayabusa_pos_J2k[2],
        itokawa_pos_J2k[0], itokawa_pos_J2k[1], itokawa_pos_J2k[2],
        earth_pos_J2k[0], earth_pos_J2k[1], earth_pos_J2k[2],
        It hayabusa);
```

<得られた出力>

左から順にHayabusaの位置(X, Y, Z), Itokawaの位置(X, Y, Z), 地球の位置(X, Y, Z), 地球-はやぶさ間の距離

```

#SPICE tutorial -- less ,/cruise_scf.txt -- 177x25
#hayabusa_pos_X Y Z itokawa_pos_X Y Z earth_pos_X Y Z hayabusa_distance
2003-05-09T00:00:00 15090416.6584 0.0486 0.0249 -10801458.9969 -16128092.4672 593800.5628 15090416.6080 0.0000 0.0000 593.657
2003-05-09T01:00:00 15092625.4322 1193.7122 5841.7235 -18797767.9891 -13687164.6025 5939117.2482 15090596.9580 -0.0000 0.0000 593.7502
2003-05-09T02:00:00 15093654.2831 2408.0155 10803.4598 -187948724.0599 -136828323.4218 5929425.5182 15090723.5511 0.0000 0.0000 593.8005
2003-05-09T03:00:00 15095345.1288 3643.9534 15125.2315 -187983725.4021 -136362990.8953 5917133.1698 15090844.3825 0.0000 0.0000 593.8681
2003-05-09T04:00:00 15097030.9449 4098.9286 20167.0411 -187866682.6222 -136434551.9933 5910486.1997 15090974.4546 0.0000 0.0000 593.9154
2003-05-09T05:00:00 15098676.7668 6175.7440 25208.8888 -187829595.7221 -136524386.6860 5903634.6049 150911298.7698 0.0000 0.0000 593.9709
2003-05-09T06:00:00 15100339.3899 7473.6024 30258.7732 -187792464.7016 -136604954.9438 5896562.3820 15091272.336 0.0000 0.0000 594.0267
2003-05-09T07:00:00 15102012.9693 8792.6866 35292.6942 -187755289.5619 -136685596.7378 5889597.5277 15091445.1395 0.0000 0.0000 594.0827
2003-05-09T08:00:00 15103705.4284 10132.8594 40334.6536 -187718078.3039 -136766232.8360 5882662.0386 15091567.1990 -0.0000 0.0000 594.1390
2003-05-09T09:00:00 15105339.7180 11494.4637 45376.6509 -187688886.9284 -136846886.8112 5875656.9114 15091698.5115 -0.0000 0.0000 594.1935
2003-05-09T10:00:00 15106910.8377 12977.5222 50439.6861 -187659190.4367 -136927383.5341 5868690.1765 15091830.9706 -0.0000 0.0000 594.2480
2003-05-09T11:00:00 15108085.7526 14267.7872 55468.7492 -187628441.8722 -137008098.6772 58618471.7285 15091928.9658 0.0000 0.0000 594.3002
2003-05-09T12:00:00 15109253.4391 15708.4132 60502.8704 -187568752.1052 -137088877.6989 5854743.6658 150921247.9927 0.0000 0.0000 594.3565
2003-05-09T13:00:00 15122248.8712 17156.4513 65585.0199 -18753312.2680 -137169310.0839 5847474.9598 150922666.3427 -0.0000 0.0000 594.4240
2003-05-09T14:00:00 15123978.0234 18626.3547 70587.077 187493828.3175 -137249985.7977 5840475.5789 150924083.9885 -0.0000 0.0000 594.4817
2003-05-09T15:00:00 151257162.8710 19811.2264 75629.4339 -187456380.2544 -1373308494.8111 5833375.5493 150925500.8427 -0.0000 0.0000 594.5397
2003-05-09T16:00:00 15127461.81 21632.1698 80671.6986 -187418728.0797 -137411877.0946 5826274.8552 150926916.9978 0.0000 0.0000 594.5979
2003-05-09T17:00:00 151292132.5442 23168.2855 85714.0019 -18738111.7490 -137491652.6191 58191973.4939 150928332.4265 -0.0000 -0.0000 594.6553
2003-05-09T18:00:00 151309726.3197 24726.6785 90756.334 187343451.3982 -137572221.3552 581271.4614 150929747.1314 0.0000 -0.0000 594.7163
2003-05-09T19:00:00 151327392.6843 26307.4508 95798.7247 -187305746.8931 -137652783.2738 5805866.7539 150931161.1151 0.0000 0.0000 594.7740
2003-05-09T20:00:00 151345131.6177 27910.7652 100804.1444 -187267699.2794 -13773338.3457 5799856.361 150932574.3883 0.0000 0.0000 594.8331
2003-05-09T21:00:00 151362967.0979 29536.6715 105926.0030 -187230388.5555 -13781398.5555 57939161.2237 150933982.9237 0.0000 0.0000 594.8924
2003-05-09T22:00:00 151380627.0699 31185.6715 110926.1087 -187192360.7296 -137894427.8330 5787845.5411 150935390.7690 0.0000 0.0000 594.9522

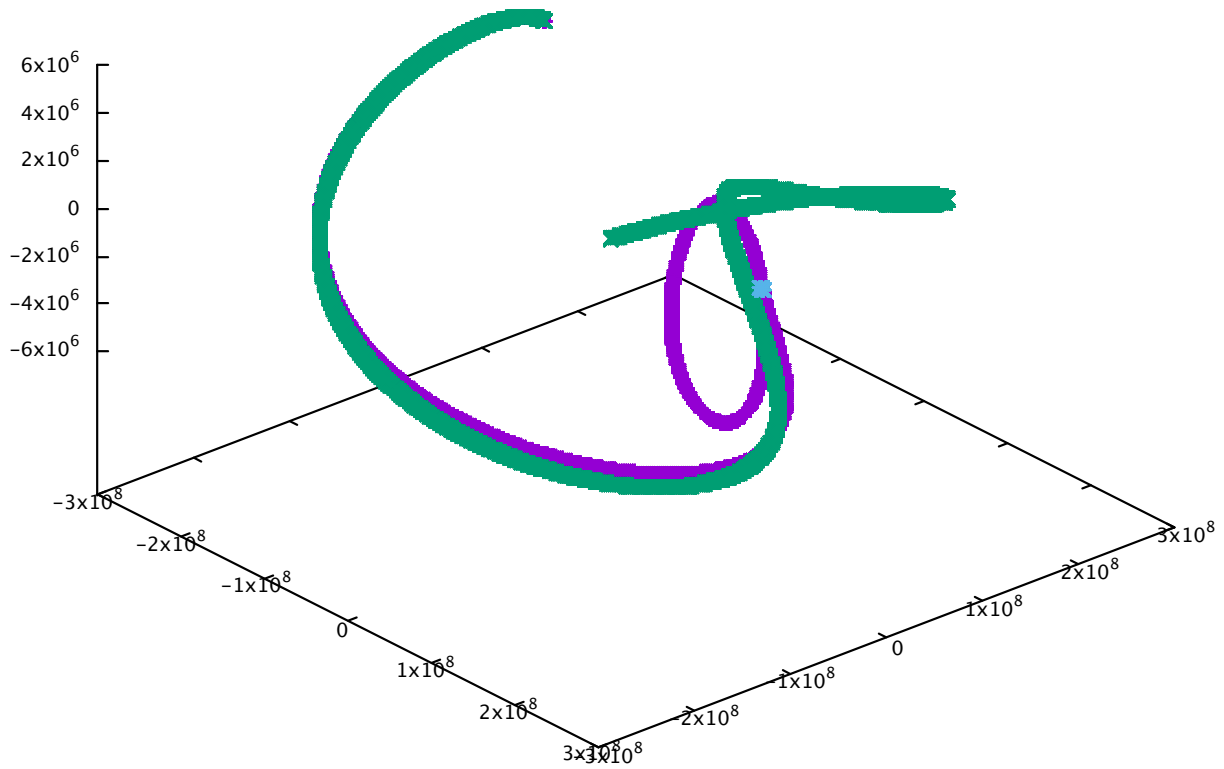
```

## <gnuplotによるプロット>

```
gnuplot> splot "cruise_sef.txt" u 2:3:4, "cruise_sef.txt" u 5:6:7, "cruise_sef.txt" u 8:9:10
gnuplot> plot "cruise_sef.txt" u 2:3, "cruise_sef.txt" u 5:6, "cruise_sef.txt" u 8:9
gnuplot>
```

- splotによる三次元プロット

"cruise\_sef.txt" u 2:3:4 +  
"cruise\_sef.txt" u 5:6:7 ×  
"cruise\_sef.txt" u 8:9:10 \*

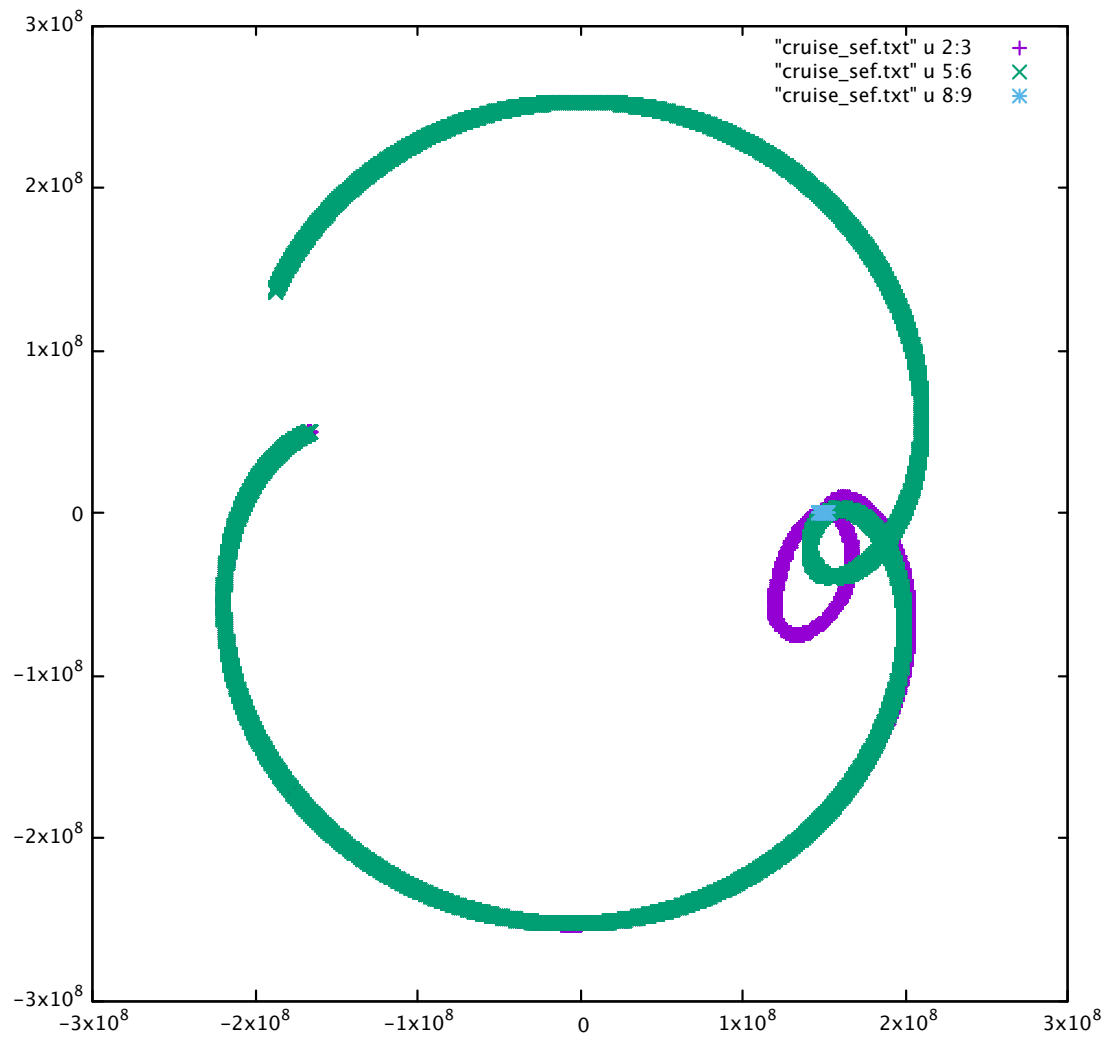


紫(u 2:3:4 - Hayabusaの軌道)

緑(u 5:6:7 - Itokawaの軌道)

青(u 8:9:10 - 地球の軌道)

- plotによる二次元プロット (Z軸を無視)



紫(u 2:3 - Hayabusaの軌道)

緑(u 5:6 - Itokawaの軌道)

青(u 8:9 - 地球の軌道)

<sun\_earth\_fixed.tfの内容>

KPL/FK

HAYABUSA Spacecraft Frames Definition Kernel

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This frame kernel contains a set of frame definitions for the Hayabusa spacecraft.

Version and Date

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Version 1.0 -- Apr. 22, 2012 -- Naru Hirata, Univ. of Aizu

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```
FRAME_SUN_EARTH_FIXED      = -130999
FRAME_-130999_NAME         = 'SUN_EARTH_FIXED'
FRAME_-130999_CLASS        = 5
FRAME_-130999_CLASS_ID    = -130999
FRAME_-130999_CENTER       = 10
FRAME_-130999_RELATIVE     = 'J2000'
FRAME_-130999_DEF_STYLE    = 'PARAMETERIZED'
FRAME_-130999_FAMILY       = 'TWO-VECTOR'
FRAME_-130999_PRI_AXIS     = 'X'
FRAME_-130999_PRI_VECTOR_DEF = 'OBSERVER_TARGET_POSITION'
FRAME_-130999_PRI_OBSERVER = 'SUN'
FRAME_-130999_PRI_TARGET   = 'EARTH'
FRAME_-130999_PRI_ABCORR   = 'NONE'
FRAME_-130999_SEC_AXIS     = 'Y'
FRAME_-130999_SEC_VECTOR_DEF = 'OBSERVER_TARGET_VELOCITY'
FRAME_-130999_SEC_OBSERVER = 'SUN'
FRAME_-130999_SEC_TARGET   = 'EARTH'
FRAME_-130999_SEC_ABCORR   = 'NONE'
FRAME_-130999_SEC_FRAME    = 'J2000'
```

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