FORTHCOMING CLOSE APPROACHES OF JUPITER AND SATURN TO GEODETIC RADIO SOURCES

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ABSTRACT. In this paper[1], a list of apparent close approaches of Jupiter and Saturn to the geodetic radio sources for the years 2008-2050 has been obtained making use of the EPOS software package. We have found 79 events with distance tolerance of $10'$, including four occultations of radio sources by Jupiter and one occultation by the Saturn's ring.

1. INTRODUCTION

Very long baseline interferometry (VLBI) observations of astrometric radio sources at epochs of close approaches of greatest Solar system planets Jupiter and Saturn allow us to measure such important physical effects as light deflection and signal retardation and thus help in testing GR (see e.g. Kopeikin, 2001). Unfortunately, these events are rather rare phenomena. On the other hand, their observations need considerable resources. So, it is important to foreseen these encounters well in advance.

Although pre-computation of the approaches of Solar System bodies to radio sources with the accuracy required for scheduling of VLBI observations at a level of several arcseconds is not very difficult task for astronomers, and interested groups perform their own computation of epochs of these events, we hope that the approach list presented in this paper would be interesting for VLBI community because it allows us to have an overview of the forthcoming encounters of Jupiter and Saturn with a radio sources for better scheduling of observing experiments.

2. LIST OF APPROACHES

The list of approaches of Jupiter and Saturn to geodetic radio sources presented in Table 1 has been obtained making use of the EPOS software package (Ephemeris Program for Objects of Solar system) developed at Pulkovo Observatory (L'vov et al., 2001) which is a versatile tool for ephemeris computations in astronomy and celestial mechanics. The list of the radio sources we have checked is available at `http://www.gao.spb.ru/english/as/ac_vlbi/sou_car.dat`.

The computations were made for the period till 2050. We have chosen the distance tolerance of $10'$. Commonly speaking, such a tolerance is too large for the ground based VLBI, especially for Saturn. However we believe this extended distance range may be useful for planning of space based observations, more sensitive to the physical effects under investigation. In total, 79 events were found. It is interesting to note that due to the "loops" of the planet's apparent path on the sky some source may have up to three successive apparent approaches with various values of angular distance. Four events for Jupiter are occultations, and one event for Saturn is an occultation by the Saturn's ring; they all are marked with asterisk.

It should be mentioned that the angular distance between the planet and radio source given in Table 1 is computed for the geocenter, and may change by $1-2$" with change of the observer's location on the Earth. As to space VLBI, the angular distance may change up to the value of relation between geocentric and planetocentric distances of the spacecraft, depending on the positional angle.

More details on events considered in this paper, as well as circumstances of other Solar System phenomena, can be computed on request.

[1]The full version of this paper is published in Solar System Research, 2009, v. 43, No. 4, p. 313.

Table 1: List of close approaches of Jupiter and Saturn to geodetic radio sources

Date Y M D	Planet	Source	Dist, arcmin	Date Y M D	Planet	Source	Dist, arcmin
2008 11 19	Jupiter	1922-224	1.4	2029 03 15	Jupiter	1333-082	7.2
2009 02 10	Saturn	1125+062	1.3	2029 09 28	Jupiter	1352-104	0.8
2009 03 08	Jupiter	2104-173	4.6	2030 11 30	Saturn	0409+188	5.1
2009 06 25	Saturn	1109+076	2.4	2031 02 23	Jupiter	1734-228	4.3
2011 07 03	Jupiter	0210+119	5.7	2031 06 07	Jupiter	1734-228	0.9
2011 09 13	Jupiter	0229+131	2.5	2031 10 05	Jupiter	1723-229	5.2
2012 02 04	Jupiter	0201+113	8.2	2032 04 03	Saturn	0503+216	1.2
2012 02 20	Jupiter	0210+119	5.7	2033 02 04 *	Jupiter	2104-173	0.3
2013 02 28	Jupiter	0420+210	3.6	2033 02 27	Jupiter	2126-158	6.9
2013 10 23	Jupiter	0723+219	2.1	2033 05 24	Saturn	0620+227	3.4
2013 11 07	Jupiter	0725+219	7.0	2034 01 28	Jupiter	2245-091	5.3
2013 11 22	Jupiter	0723+219	5.8	2034 06 15	Saturn	0723+219	0.6
2015 06 19	Saturn	1548-177	2.6	2034 07 16	Saturn	0741+214	2.6
2015 11 19	Saturn	1614-195	1.1	2035 05 13	Jupiter	0201+113	6.7
2016 11 22	Saturn	1658-217	3.2	2035 05 24	Jupiter	0210+119	2.9
2017 10 13	Jupiter	1352-104	1.1	2037 01 16	Saturn	1013+127	1.2
2017 12 13	Saturn	1752-225	1.2	2037 05 28	Jupiter	0558+234	5.1
2019 10 28	Jupiter	1723-229	3.1	2037 07 24	Saturn	1013+127	3.9
2020 08 02	Jupiter	1922-224	1.3	2037 08 27	Jupiter	0725+219	2.7
2020 10 24	Jupiter	1922-224	5.9	2037 09 19	Jupiter	0741+214	0.5
2021 02 19	Jupiter	2104-173	2.4	2041 09 11	Jupiter	1352-104	1.2
2021 08 10	Saturn	2044-188	0.3	2043 02 01 *	Jupiter	1734-228	0.0
2021 12 08	Saturn	2044-188	1.9	2043 10 18	Saturn	1459-149	3.7
2022 11 13	Jupiter	2354-021	2.7	2044 02 27	Saturn	1548-177	0.5
2022 12 04	Jupiter	2354-021	2.9	2045 01 20	Jupiter	2104-173	3.2
2023 04 13	Saturn	2221-116	0.5	2045 02 12	Jupiter	2126-158	4.7
2023 04 18	Saturn	2223-114	4.6	2045 05 29	Jupiter	2245-091	7.6
2023 06 11	Jupiter	0210+119	0.5	2045 09 20	Jupiter	2223-114	3.8
2023 11 05	Jupiter	0229+131	3.3	2045 09 20	Saturn	1614-195	0.8
2024 01 02	Jupiter	0210+119	6.6	2045 09 24 *	Jupiter	2221-116	0.3
2024 01 04	Saturn	0220-119	6.2	2045 12 04	Jupiter	2223-114	7.8
2024 03 18	Saturn	2252-090	2.6	2046 01 10	Jupiter	2245-091	1.4
2025 09 15	Jupiter	0723+219	3.6	2046 09 17	Saturn	1658-217	0.9
2025 09 18 *	Jupiter	0725+219	0.2	2047 04 28	Jupiter	0201+113	4.9
2025 10 25	Jupiter	0741+214	0.5	2047 05 08	Jupiter	0210+119	5.1
2025 11 29	Jupiter	0741+214	4.6	2047 10 17	Saturn	1752-225	6.1
2026 04 01	Saturn	0019-001	7.9	2048 11 28	Saturn	1853-226	5.4
2026 10 18	Saturn	0037+011	2.4	2049 05 11	Jupiter	0558+234	2.2
2028 05 20	Saturn	0208+106	1.3	2049 08 29	Jupiter	0741+214	3.0
2028 10 24 *	Saturn	0223+113	0.2				

3. REFERENCES

Kopeikin S.M., 2001, Testing the Relativistic Effect of the Propagation of Gravity by Very Long Baseline Interferometry. Astrophys. J., **556**, No. 1, pp. L1–L5.

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