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The Potentially Dangerous Asteroid (29075) 1950 DA

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Abstract

I present behavior of the dynamically interesting potentially dangerous asteroid (29075) 1950 DA. Using the public available OrbFit software I studied orbit of asteroid 900 years forward in the future searching for close approaches with the Earth, which lead to possible impact in 2880.

Keywords: ***Asteroids; Dynamic; Celestial mechanic; Near-Earth Objects; Orbit determination***

Introduction

The asteroid (29075) 1950 DA was discovered on February 22, 1950 by the (IAU 662) Lick-Observatory, Mount Hamilton (IAUC 1258). It was observed for 19 days in 1950 till March, 12 and then lost because of the short observational arc [1]. On December 31, 2000, it was observed by J.E. Rogers from (IAU 670) Camarillo Observatory, recovered as 2000 YK66 and 2 hours later was recognized as 1950 DA(MPEC 2001-A-26). Between these dates the asteroid (29075) 1950 DA was observed on September 30, 1981 by Siding Spring Observatory-DSS (IAU 260). Asteroid (29075) 1950 DA belongs to the Apollo group, comprising 9194 members as of July 5, 2018), and is one of 18345 known Near-Earth Asteroids at this time http://www.minorplanetcenter.net/iau/lists/Unusual.html. According to the JPL NASA: https://ssd.jpl.nasa.gov/sbdb.cgi#top, its absolute magnitude is 17.1, suggesting a diameter of about 2.0 km (see also next Section). Asteroid (29075) 1950 DA is dynamically interesting. According to my computattions, it will pass close to the Earth on March 02.28506, 2032 at about 0.0758 au ($11.3x10^6$ km).

Computations of Giorgini from JPL NASA [1] are based on observations till 2002 (214 optical observations and 12 radar observations). Now, July 5, 2018 we have 576 and 12 observations, respectively, and the longer observational arc. Sitarski [2] determined the asteroid’s orbit based on 231 optical observations from the period February 22, 1950 to December 18, 2004 and applied his cracovian methods to find an impact orbit for 2880.

The Initial Orbital Elements of Asteroid (29075) 1950 DA

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The orbit of the asteroid (29075) 1950 DA was computed using the freely distributed OrbFit software, version 5.0.5 (http://adams.dm.unipi.it/~orbmaint/orbfit/). This new version includes the new error model and the debiasing and weighting scheme described by [3] and the DE431 version of JPL's planetary ephemerides. The NEODyS site (http://newton.dm.unipi.it/neodys/) and the OrbFit software used above given star catalog debiasing and an error model with assumed astrometric RMS errors computed from the tests in the above paper. We can compute the Yarkovsky non-gravitational effect as a model uncertainty, that is solves for 7 parameters instead of 6, i.e. only orbital parameters. This applies both to the orbit determination (at the initial epoch) and to the propagations used in the impact monitoring procedure.

Nongravitational effects in orbital motion of asteroid can be taken into account in various ways. The simplest one is to assume the existence of a secular change of semimajor axis of the orbit, *da/dt*. We can also compute the non-gravitational parameter *A2*. Negative value of *A2* for asteroid denotes that the mean semimajor axis drift da/dt<0 and hence asteroid can be retrograde rotator. Observational arc length is 24824 days (almost 68 years) so it is possible to compute non-gravitational parameter *A2*.

The orbital elements given in **TABLE 1** were computed using the JPL Planetary and Lunar Ephemerides DE431 and additional perturbations of the 16 massive asteroids were used by [4-6]: (1)Ceres, (2)Pallas, (4)Vesta, (10)Hygiea, (3)Juno, (9)Metis, (15)Eunomia, (16)Psyche, (29)Amphitrite, (31)Euphrosyne, (52)Europa, (65)Cybele, (87)Sylvia, (511)Davida, (532)Herculina and (704)Interamnia. And additionally I used perturbation of Pluto.

TABLE 1 lists the orbital parameters of asteroid (29075) 1950 DA, which were computed using the OrbFit software based on all 576 optical observations (of which 6 are rejected as outliers). from February 22.23014, 1950 to February 09.19461, 2018, and also on 12 radar observations from March 3, 2001to 2012 May 1, 2012.

TABLE 1 **Keplerian orbital elements**

semimajor axis	1.69853729475696 ± 1.08961E-9 au
eccentricity	0.5079907792308 ± 3.20793E-8
inclination	12.16964176754 ± 4.56135E-6 deg
longitude node	356.67753537197 ± 8.10688E-6 deg
argument of perihelion	224.65716201213 ± 9.28745E-6 deg
mean anomaly	234.67603804158 ± 2.35067E-6 deg
non-gravitational parameter	A2 (-6.03004 ± 1.24958)E-15 au/d^2

MJD58200.0 TDT = JD2458200.5 = March 23, 2018

All angles relate to the *J2000* equator and equinox.

The **TABLE 1** also includes their 1-σ uncertainties, which are the square roots of the diagonal elements of the computed covariance matrix. *RMS* is the quadratic mean of the residuals between the calculated orbit and all 588 observations used in the solution.

I computed directly from the OrbFit software an absolute magnitude *H* of (17.064 ± 0.507) mag. Hence, I calculated the diameter *D* of the asteroid from its *H* and albedo p_v using the formula of [7]:

$$D = 1329 * 10^{-H/5} p_v^{-1/2},$$

where *D* is in km.

For H = (17.064±0.507) mag and albedo of 0.07 (EAR_A_COMPIL_5_NEOWISEDIAM_V1_0[neos] (http://adsabs.harvard.edu/abs/2011ApJ...743..156M), I find the diameter of (29075) 1950 DA to be between 1.5 km and 2.5 km.

Close Approaches Analysis of Asteroid (29075) 1950DA till 2300

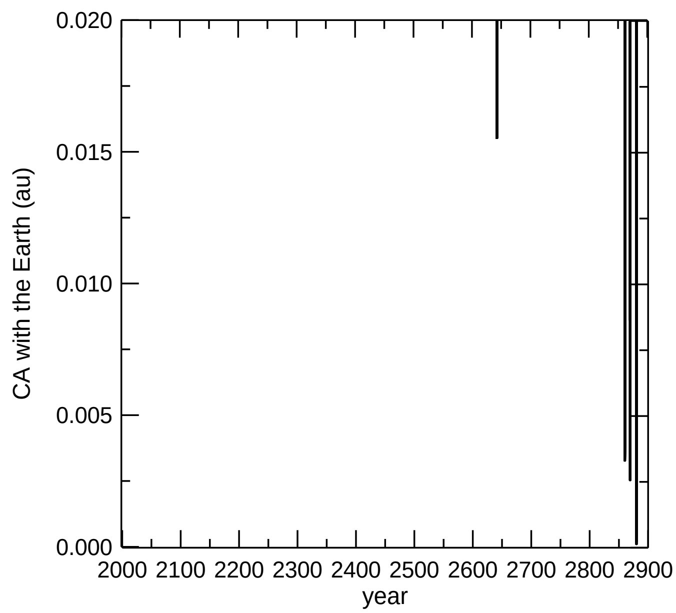

FIG. 1. **Close approaches of asteroid (29075) 1950 DA with the Earth**.

FIG. 1 presents close approaches (CA) between the Earth and asteroid (29075) 1950 DA between 2000 and 2900. I showed only CA<0.02 au. They are computed using orbital elements and non-gravitational parameter *A2* from **TABLE 1** The first CA is in 2641 at 0.0155 au. The deepest CAs begin in 2860 at 0.0033 au with possible impact with the Earth in 2880.

Possible Impact Solutions

Next, using starting orbital elements from **TABLE 1** and 601 Vitual Asteroids (clones) (VAs) with 3-σ uncertainties, and propagating them till 2900 I searched for impacts with the Earth. **TABLE 2** presents possible impact solution for 2880.

TABLE 2. **Possible impact solution for 2880.**

Date of impact	March 16.992, 2880
Impact Probability	2.00E-05
Mass	3.05E12 kg
Impact velocity	17.99 km/s
Impact energy	1.18E5 MT
1 MT	4.2E15 J

Conclusion

The main goal of my work is to present methods which allow us to follow the orbit of the potentially dangerous asteroid (29075) 1950 DA. I computed the minimum distances between the asteroid and the Earth in the time-span 900 years forward from now. I found impact solution for 2880. It is possible to recover asteroid (29075) 1950 DA in 2032 when the distance to the Earth will be of about 0.076 au. Optical and radar observations made during this close approach can refine the orbit of the asteroid and give more precise possible impact solutions.

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