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The dangerous asteroid (29075) 1950 DA.

We computed impact solutions of the potentially dangerous asteroid (29075) 1950 DA based on 768 optical observations from
1950 February 22.23014 to 2021 July 4.618248, and twelve radar observations from 2001 March 03 to 2012 May 01.
We selected 770 observations.
We followed the orbit of the asteroid (29075) 1950 DA forward in the future, searching for close approaches with the Earth, which can
lead to possible impacts up to the year 2881.
According to the NEODyS website, the asteroid (29075), 1950 DA belongs to the so-called 'special group' of asteroids, which now contains one more asteroid (101955) Bennu.
They are subject to an individual procedure for calculating possible collisions with Earth.
Earlier, in [1], we presented the current state of calculations of possible collisions for two more asteroids: (99942) Apophis and
(410777) 2009 FD. The latter two no longer pose a threat to the Earth.

Asteroid (29075) 1950 DA is discovered at Mount Hamilton on 1950 February 22 by C. A. Wirtanen.
Orbit type of asteroid is Apollo and Potentially Hazardous Asteroid.
To compute possible impact solution of the asteroid (29075) 1950 DA with the Earth,
we used the OrbFit software with the JPL DE431 ephemerides, weighting and selecting observations according to the Near Earth Objects Dynamic Site (NEODyS) (https://newton.spacedys.com/neodys/index.php?pc=4.1), two different error models, 4 and 17 additional massive asteroids, and the Yarkovsky effects. We searched for the possible impacts using the non-gravitational parameter A2, computed directly from observations. A2 is non-gravitational transverse acceleration parameter.

To compute the possible collisions of the asteroid (29075) 1950 DA with the Earth, we used the publicly available OrbFit v. 5.0.5 and 5.0.7 software. These versions can compute orbits and search for possible impacts with the Earth using dynamical parameters connected to the non-gravitational perturbations. We calculated the non-gravitational parameter A2. In the OrbFit v.5.0.5, we used the error model 'fcct14'[2, 3]. According to the OrbFit v5.0.7, we used the error model 'vftc17'[4].

To compute possible impacts of the asteroid (29075) 1950 DA with the Earth, we integrated the equation of motions until
JD375000.5 TDT, i.e. to 2182-September-24.0. We used the parameter sigma_LOV = 5 and calculated 601 clones (VAs). We used the JPL DE431 Solar System model and an additional four first numbered asteroids and 17 massive asteroids as described in [5] and [6].
We used the selection and weighting of observations according to the NEODyS site: https://newton.spacedys.com/neodys/.

Table 1. Orbital elements are computed with different error models and the different number of perturbing asteroids.
error model 'fcct14'
case A: 4 additional massive asteroids
! Keplerian elements: a(au), e, i(deg), long. node(deg), arg. peric.(deg), mean anomaly(deg)

KEP 1.6986657304560822E+00 0.507736034230615 12.1673340701948 356.6558464582163 224.6831539020569 319.9225244493315
! RMS 1.19598E-09 3.13983E-08 4.54400E-06 8.05458E-06 9.26998E-06 2.71691E-06
epoch: MJD 59200.0 TDT
Absolute magnitude, H=17.103
A2=(-5.1369 +/- 1.2415)E-15 au/d^2
RMS=0.4860"

case B: 17 additional massive asteroids
! Keplerian elements: a(au), e, i(deg), long. node(deg), arg. peric.(deg), mean anomaly(deg)
KEP 1.6986657274567998E+00 0.507736035357336 12.1673339625045 356.6558457836590 224.6831545130312 319.9225262120117
! RMS 1.19598E-09 3.13983E-08 4.54400E-06 8.05458E-06 9.26998E-06 2.71691E-06
epoch= MJD 59200.0 TDT
Absolute magnitude, H=17.103
A2=(-6.1613 +/- 1.2415)E-15 au/d^2
RMS=0.4860"

error model 'vftc17'
case C: 17 additional massive asteroids

! Keplerian elements: a(au), e, i(deg), long. node(deg), arg. peric.(deg), mean anomaly(deg)
KEP 1.6986657263744549E+00 0.507736067693964 12.1673394202673 356.6558423569089 224.6831628043528 319.9225279069679
! RMS 1.00367E-09 2.10108E-08 4.21386E-06 6.39501E-06 7.43450E-06 2.21388E-06
epoch=MJD 59200.0 TDT
Absolute magnitude, H=17.187
A2=(-6.9123 +/- 1.2348)E-15
RMS=0.4855"

We can see that non-gravitational transverse acceleration parameter A2 has a small value, about -6.0 E-15 au/d^2, and a slight differ
using different error models and additional massive perturbing asteroids

Table 2. Impact risk table for different error models and different number of perturbing asteroids.

date YYYY/MM	s_LOV	p_RE	Exp. En. MT	PS
'fcct14' error model				
4 additional perturbing asteroids				
2880/03/16.992	1.512	2.52E-05	2.81E+00	-1.97
17 additional perturbing asteroids				
2880/03/16.992	2.339	5.70E-06	6.36E-01	-2.62
'vftc17' error model				
17 additional perturbing asteroids				
2880/03/16.992	2.757	1.87E-06	1.85E-01	-3.14 ,

where s_LOV denotes the position along the line of variation, LOV, in the sigma space and values of sigma are here in the interval [-5,5].
Table 2 also presents the probability of Earth impact (p_RE) and Palermo Scale (PS). PS is the new hazard scale [7]. Expected energy (Exp. En.) denotes impact energy multiplied by impact probability.
Units are in megatons MT (1 MT=4.184E15 J).

We can see that date of possible impact is the same for different error models and additional perturbing massive asteroids.
However, the probability of Earth impact is most significant for four additional perturbing massive asteroids.
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References:
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[2] Chesley S. et al. (2010) Icarus, 210, 158.
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[4] Veres P. et al. (2017), Icarus, 296, 139.
[5] del Vigna et al. (2018) A&A, 617, A61.
[6] Farnocchia, D. (2013), Icarus, 224,1.
[7] Chesley et al. (2002), Icarus, 159, 423.