(Splinter meeting to discuss the 2011 AG5x situation
Vienna, 05 Jul 2024

A while ago, asteroid 2011 AG5x showed a 1/5 chance of flying through a keyhole in 2028 which will bring it on a direct collision course with the Earth in 2040. The Committee of Peaceful Uses of Outer Space (COPUOS) has to be briefed on this event. A small expert group shall produce a concise analysis of the situation, list possible mitigation options, and advice COPUOS on how to proceed.

Background information

The Mt. Lemmon Sky Survey discovered Asteroid 2011 AG5x over 20 years ago, on 08 Jan 2011. Initial computations placed the object on the top of the 'risk list' of both the European NEODyS system and the JPL Sentry system. The impact probability was first computed to be 1/625, based on observations from discovery to about Sep 2011. Initial proposals by R. Schweikart (Association of Space Explorers) to study possible impact missions were followed up on a very low scale. In April 2012, new 'precovery' observations were found in images obtained by the Pan-STARRS telescope (08 Nov 2010). These images increased the impact probability to 1/500.

2011 AG5x will fly by the Earth in a distance of about 1.4 Mio km (fictive) on 11 Jun 2028. During this flyby it has a chance of flying through a so-called 'keyhole' – a certain distance range of about +/-150 km where it would be deflected such that it will impact the Earth in 2040.

In a workshop held at the Goddard Space Flight Center on 29 May 2012, a number of experts came together and discussed the matter. Studies were prepared by the European NEOShield project (company Deimos/Spain) and JPL to analyze the situation. The conclusion was that deflection mission possibilities would be available even after the keyhole passage. A deflection before the keyhole passage would, however, require much less energy and might be preferred. The next observational slot for this asteroid would only be in Sep 2013. It was decided to wait until then for further action. The assumption was that the impact risk could be retired after these observations. Observations in Sep 2013 showed that the impact risk was now 1/200 – still not enough to merit attention.

Now (in Jul 2024) the latest computations show an increase in the impact risk to 1/5 (20 %). This is considered high enough to bring this up to COPUOS. This splinter meeting has the task to discuss the matter and prepare ideas to be presented to COPUOS with a recommendation for future action.

Physical properties

After its initial discovery, the asteroid only barely became brighter than 24 mag, meaning that no physical property observations were possible so far. The absolute magnitude was determined from the initial observations to be 21.8 mag, resulting in an estimated size from about 120 m to 260 m.

Orbital properties

An orbit plot is shown in

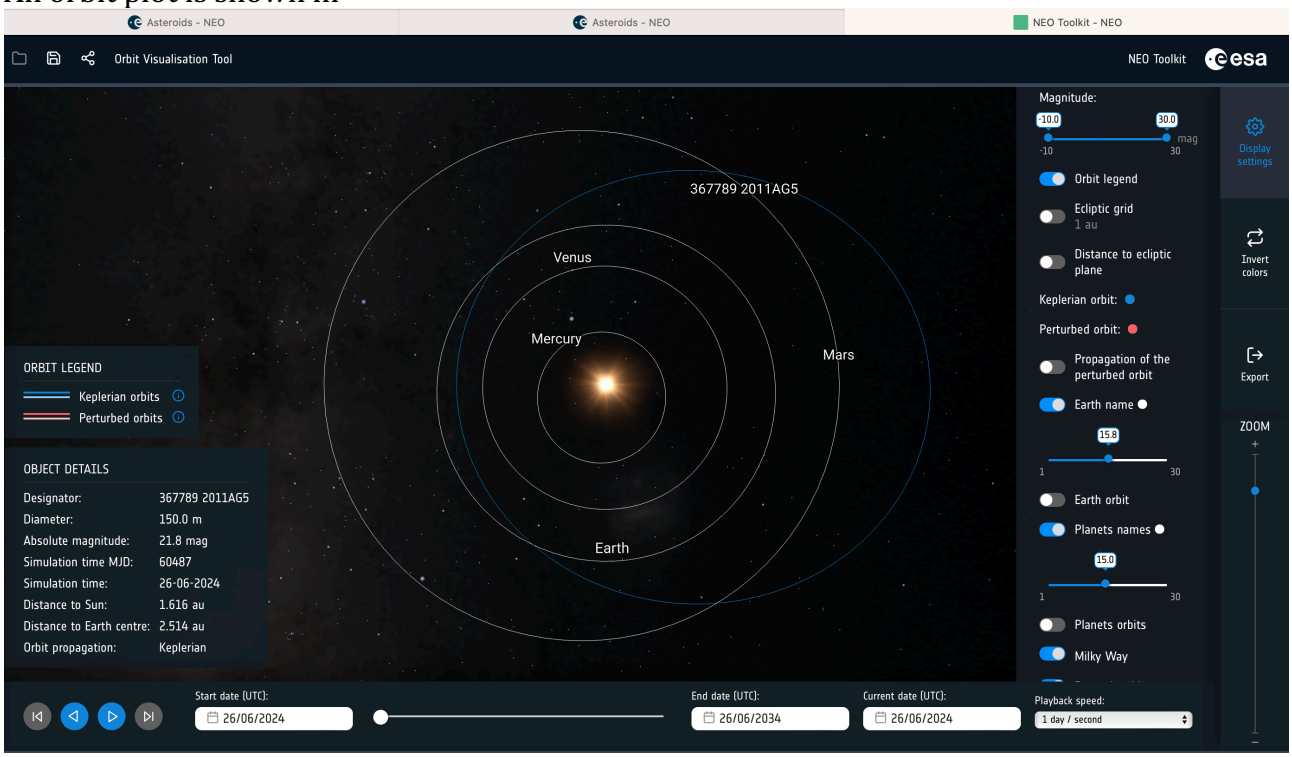


Figure 1, with the positions of the planets and the asteroid given for 26 Jun 2024.

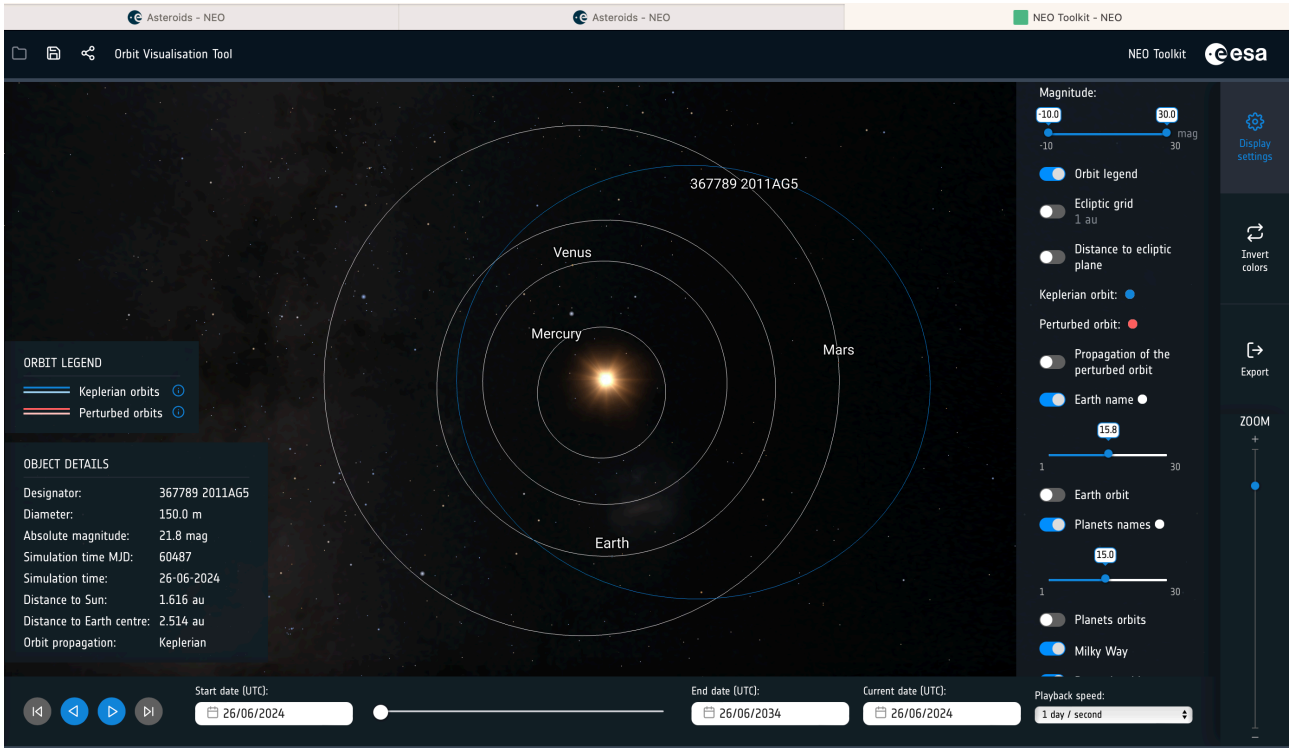


Figure 1: Orbit plot for 2011 AG5x. The planetary positions are for 26 Jun 2024.

The (fictious) situation during the flyby on 11 Jun 2028 is shown in Figure 2. The image shows on the x-axis the distance to the Earth + 1.4 Mio km; the y-axis shows the flyby distance to the Earth during a subsequent return. The bar indicates the current uncertainty of the flyby. As

can be seen, about 1/5 of the uncertainty results in distances where the asteroid would be deflected such that the flyby distance in 2040 would be less than 1 Earth radius.

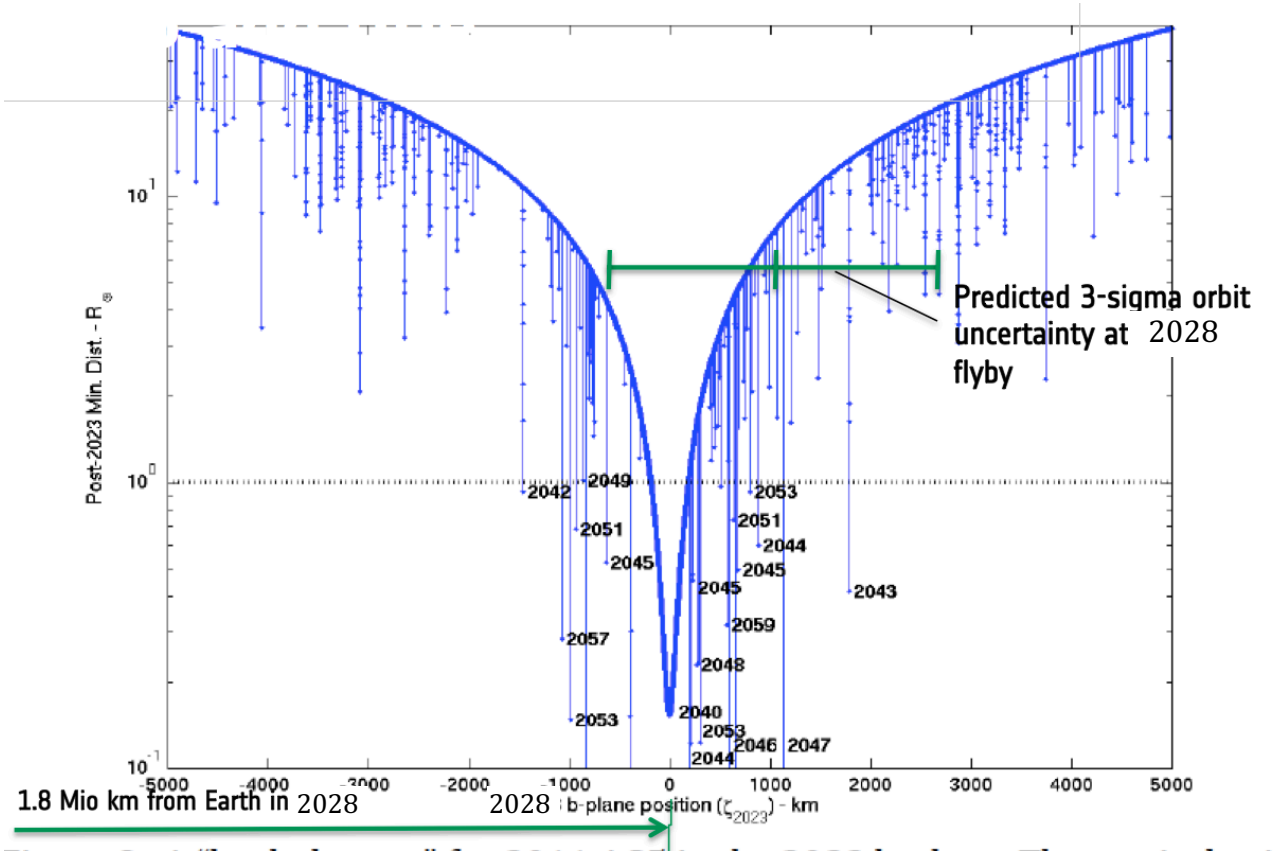


Figure 2: (Fictious) keyhole map for the 2028 flyby.

The ground track for the 2040 situation in case of an impact is shown in Figure 3. The nominal flyby position is on the extension of the red line to the right, about 3 Earth radii away from the Earth.

Figure 3: Ground track of 2011 AG5x in 2040.

Today, we will prepare a bit the technical part of the scenario, in several groups:

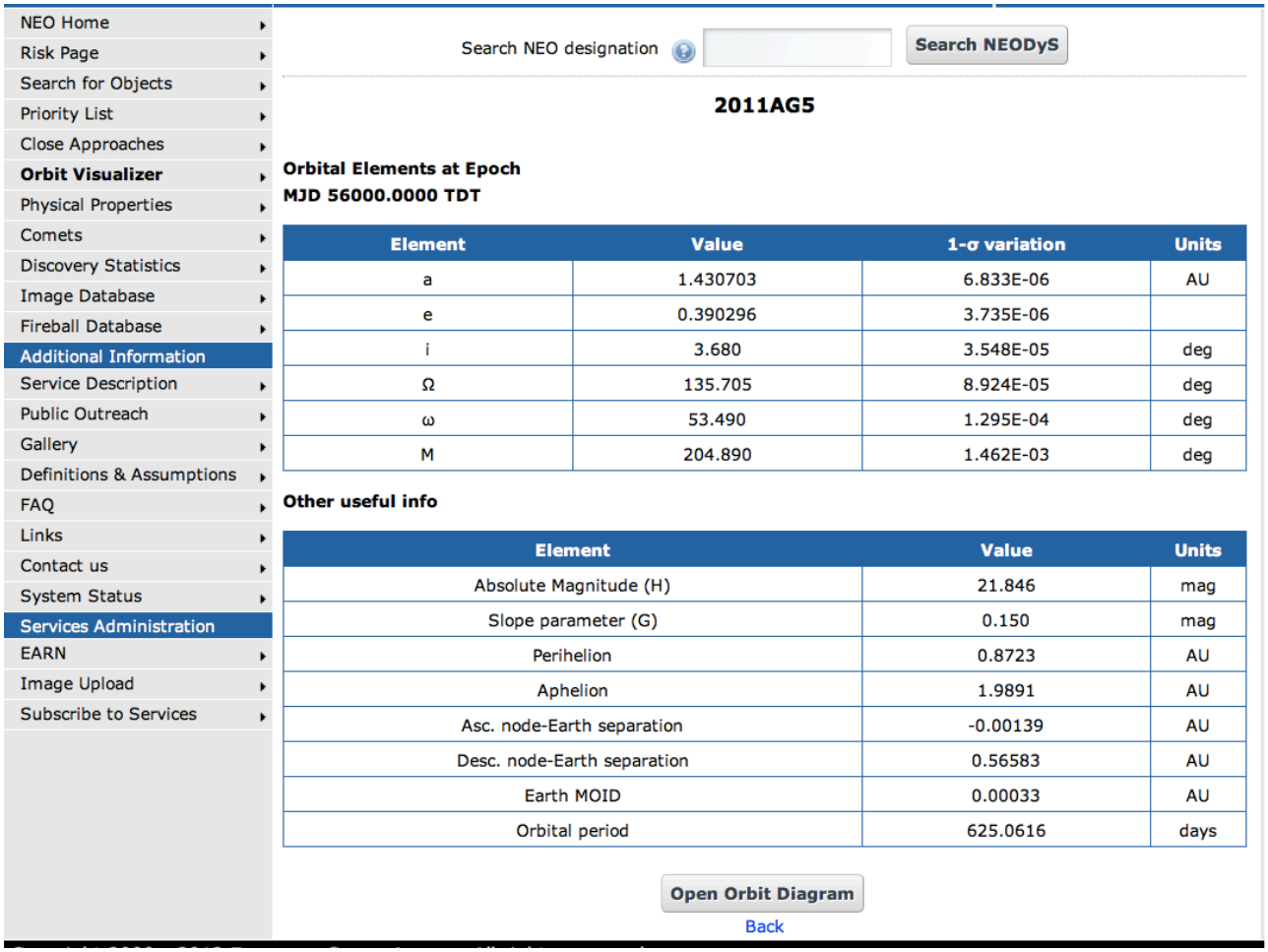
(1) Can this object be deflected? Before the flyby, after? How many 'DART'-type spacecraft would we need?
(2) What if we use an ion-beam shepherd?
(3) What would be the effects if it hit? What kind of information would we present to the emergency response agencies?

Next Friday, we pretend to be an advisory group for the United Nations COPUOS and have to propose what to do:

- What are the consequences of the impact? What are its uncertainties?
- How and when can the object be deflected? In which direction?
- Who should do it?

A short statement should be written which can be presented to COPUOS on how to proceed.

Appendix: Information about 2011 AG5x



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2011AG5

Orbital Elements at Epoch
MJD 56000.0000 TDT

Element	Value	1-σ variation	Units
a	1.430703	6.833E-06	AU
e	0.390296	3.735E-06	
i	3.680	3.548E-05	deg
Ω	135.705	8.924E-05	deg
ω	53.490	1.295E-04	deg
M	204.890	1.462E-03	deg

Other useful info

Element	Value	Units
Absolute Magnitude (H)	21.846	mag
Slope parameter (G)	0.150	mag
Perihelion	0.8723	AU
Aphelion	1.9891	AU
Asc. node-Earth separation	-0.00139	AU
Desc. node-Earth separation	0.56583	AU
Earth MOID	0.00033	AU
Orbital period	625.0616	days

[Open Orbit Diagram]
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Close approaches of 2011 AG5 until 2075 (from http://neo.ssa.esa.int)

367789 2011AG5

Close approaches for 367789 2011AG5 from 1950 to 2100							
Body	Date	MJD	Nominal distance (au)	Min possible distance (au)	Stretching (au)	Width (au)	Close approach probability
EARTH	1958-01-26.52672	36229.5	0.0953466	0.0953463	8.001E-6	4.321E-8	1.00E0
EARTH	1975-06-07.58238	42570.6	0.0938237	0.0938236	9.332E-6	9.676E-8	1.00E0
EARTH	1987-05-24.61077	46939.6	0.0747011	0.0747007	4.889E-6	1.022E-7	1.00E0
EARTH	1999-04-13.24985	51281.2	0.1359039	0.1359038	6.502E-7	9.284E-8	1.00E0
EARTH	2011-02-26.64069	55618.6	0.0956683	0.0956682	8.989E-8	5.336E-8	1.00E0
EARTH	2023-02-03.36842	59978.4	0.0121455	0.0121452	2.975E-6	4.654E-8	1.00E0
EARTH	2028-06-11.53296	61933.5	0.1342288	0.1342246	4.827E-5	9.202E-8	1.00E0
EARTH	2040-02-04.36590	66188.4	0.0072344	0.0072193	1.536E-4	4.707E-8	1.00E0
EARTH	2045-04-08.84836	68078.8	0.1404533	0.1404305	1.264E-3	6.523E-8	1.00E0
EARTH	2050-06-07.94935	69964.9	0.0748520	0.0739711	1.435E-2	8.543E-8	1.00E0
EARTH	2077-02-10.77552	79709.8	0.0415420	0.0371635	4.219E-2	5.079E-8	1.00E0
EARTH	2082-05-14.93798	81628.9	0.1051836	0.1047758	5.052E-3	9.493E-8	1.00E0

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Questions:

- What size/mass would you estimate for the object? Give a range!
- What would be the impact effects in the extreme cases?
- How much delta-v would you need to deflect the asteroid?
- Assume you have kinetic impactors with 3 t mass and v = 7 km/s available (Rosetta-sized spacecraft). How many do you need to deflect the asteroid? Assume you can launch them immediately and they need a year to get there.

For the table-top exercise, the following 'roles' are available:

- Political representative of ESA or NASA or JAXA or Chinese Space Agency (or any other agency of your choice) to COPUOS
- Technical expert of ESA or any other agency of your choice
- Head of UN-SPIDER, an agency that deals with disseminating information about natural threats, before and after they happen
- A journalist from a country of your choice
- Politician who doesn't believe in science, from a country of your choice
- Representative of the Space Generation Council (SGC) – young scientist
- Head of the local fire brigade who just happened to be there
- A chair person, chairing the whole meeting