Asteroid Impact – the ultimate disaster

©Werner Grandl

A-3430 Tulln, Dr.Billrothstrasse 6, Austria
archigran@gmx.at

1. Introduction:

The number of known Near Earth Objects (NEOs), such as asteroids and comet nuclei has increased continuously within the last decades. It is time to get serious about detecting and deflection techniques to protect the planet Earth (and the moon) from future impacts by hazardous NEOs.
An amazing example was the small asteroid AL00667 (30 meters in diameter), which has been detected on 13 January 2004. The warning time would have been too short, when the asteroid passed the earth two days later.
In May 2009 a new object "2009 HC82", which needs 3.4 years to orbit the sun, has been detected. This celestial body has a diameter of approximately 2.5 kilometres and crosses Earth orbit just in a distance of 3.4 million kilometres. This is approx. nine times the distance of the moon.

2. The Torino Scale:

The Torino Scale, created by Professor Richard P. Binzel at the Massachusetts Institute of Technology (MIT), is a method for categorizing the impact hazard associated with Near Earth Objects such as asteroids and comets. It is intended as a tool for astronomers and the public to assess the seriousness of collision predictions, by combining probability statistics and known kinetic damage potentials into a single threat value. (1)

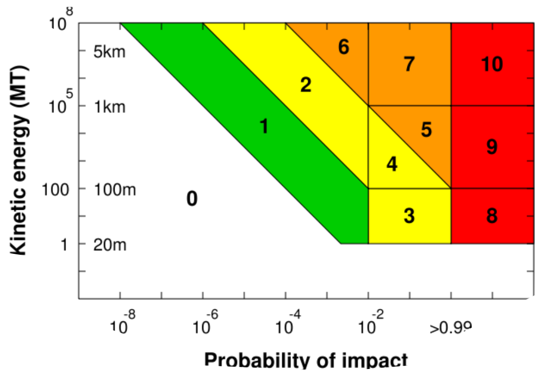

Figure 1:

The Torino Scale uses a scale from 0 to 10. A 0 indicates an object with a negligibly small chance of collision with Earth. A 1 indicates a pass near the Earth with no unusual level of danger.
The levels from 2 to 4 are meriting attention by astronomers. Current calculations give a 1% or greater chance of collision capable of localized destruction.
The levels 5 to 6 are threatening, predicting close or very close encounters to Earth, but an impact is still uncertain.
At level 7 international contingency planning is warranted, especially to determine urgently whether a collision will occur. The levels 8 to 10 describe **certain collisions (red)**. A collision of level 8 or 9

causes “local” destruction for an impact und probably a tsunami. Such an event may occur between once per 60 years and once per several 10.000 years.
At level 10 a collision is **certain.** It causes a global climatic catastrophe, extinguishing most of the living species on land and even human civilisation, and it maybe the “End of Days” for mankind.
Such a cosmic disaster is expected once per 100,000 years or less often. (2)

A frequently asked question is about the probability of asteroid impacts mentioned above. Most of the impacts were spread over the early geological history of Earth during billions of years but some of these events we can find at the beginning of human history:
The Greek philosopher Plato (427 to 347 B.C.) tells in one of his famous dialogues “Timaios”, that in the past many disasters, “either caused by fire or water” would have devastated the Earths surface, killing a majority of humans. Although he is referring to old Egyptian priests for this information, he explains in the astonishing words of modern science:“This is not a legend, but really caused by the aberration of earth-orbiting celestial bodies…” (3)
Today it becomes more and more evident, that Plato exactly described NEO- impacts, probably such of Torino Scale 8.
Another historical impact is the so called “Tunguska Event” of 1908 in Siberia.
Scientists assume, that an Ice-comet has been exploded some kilometres over the uninhabited land surface of Siberia, causing a crater and the sudden death of millions of trees and the local fauna.

3. The Problem of calculating an asteroids orbit :

According to Brian Marsden of the Minor Planet Center, England, it is impossible to calculate an asteroids orbit seriously by using available terrestrial telescopes: “The small spread of those initial observations really means that we have two, and only two independent fixes of the object in the sky. To obtain the benefit of the maximum time span it is usual to take those independent points to be the first and last observations, but other pairs will give much the same information. What is that information? Well, the two positions are each described by two coordinates on the sky background (like latitude und longitude on the surface of the earth), so we have just *four* independent pieces of information altogether. But the orbit of an object we can reasonably presume to be travelling in a conic with the sun at a focus requires *six* pieces of information in order uniquely to define it! We are completely missing *two* pieces of information…” (4)
By observations from only a couple of days a celestial object traces a small arc on the sky from which it is impossible to get good orbital parameter estimation to be able to predict the collision probability.
Recent work (*Milani* and *Knezevic*) tried to work out a new method for short arcs, but nevertheless the observation time is too short to make precise predictions.

The observation of small celestial bodies is also limited by the terrestrial atmosphere.
Telescopes in space, e.g. on the moon or in the Lagrange points will sooner or later be necessary to find hazardous asteroids in time.

4. A new Method for the early Detection of Near Earth Objects :

The importance of such an early precise orbit determination of a PHA (Potential Hazardous Asteroid) is evident: If the collision probability is very high (Torino scale 8, 9, 10), measurements have to be started as early as possible to avoid a collision.
In 2006 the author and Professor Rudolf Dvorak, Institute of Astronomy, University of Vienna, Austria, proposed to post Robotic Telescopes in the Lagrange Points L4 and L5 of the Sun-Earth system.

The two Lagrange Points, 60 degrees ahead and behind Earth, and the Earth always build a triangle with a distance of approx. 1.7 Astronomical Units between two of the vertices.
Combined with terrestrial telescopes (e.g. LINEAR Lincoln Near Asteroid Research, New Mexico) these Twin-Telescopes will enable astronomers to define an asteroids orbit by the required *six* quantities. By this space-based array of observatories we could detect especially small objects, like "sub-kilometre"- NEOs, very early.
(see figure 2)

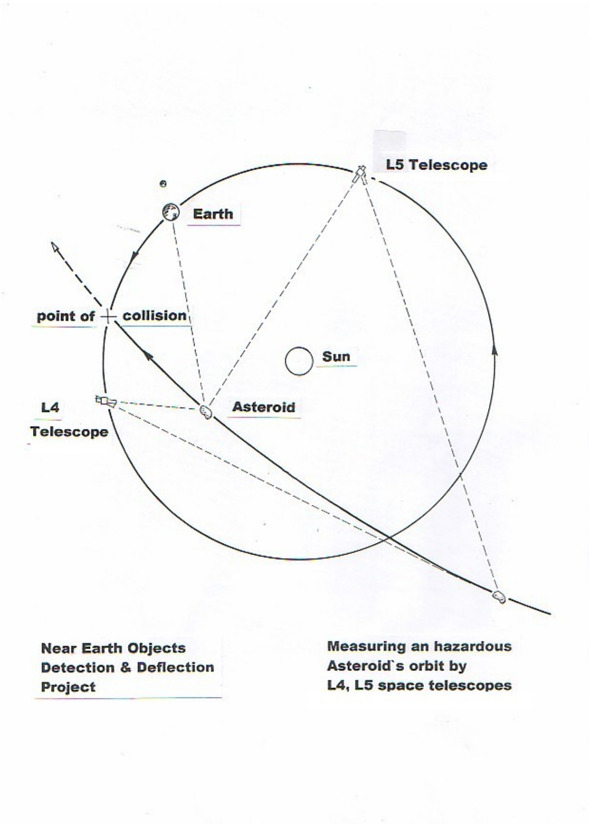

Figure 2: space-based surveying of a hazardous celestial body

Each Robotic Telescope could require a maximum payload of 6 tons. The new European ARIANE 5 ESC-B launcher with a payload capacity of 12 tons or a similar rocket can carry the two telescopes into Earth orbit. From orbit to the Lagrange Points of the Sun-Earth System the robotic telescopes are propulsed by ion-engines.

Each telescope may consist of some main components as follows:
-Reflecting Telescope Assembly
-Support System Module, containing scientific instruments, command and data handling electronics, antennas and a solar or nuclear energy facility
-Manoeuvre Thrusters, to turn an adjust the telescope at the Lagrange Point
-Main Engine, e.g. an ion engine, using caesium or mercury ions for propulsion;
(See figures 3 and 4)

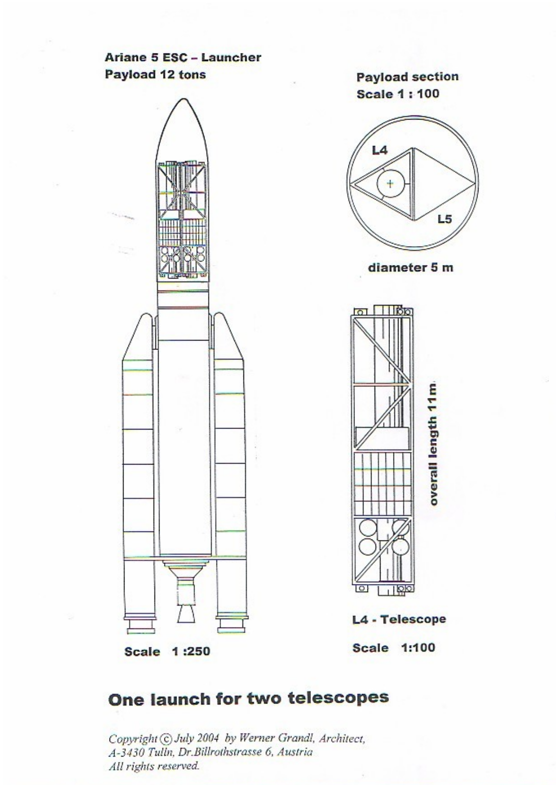

Figure 3: ARIANE 5 ESC-B launcher
with the payload of 2 Robotic
Telescopes

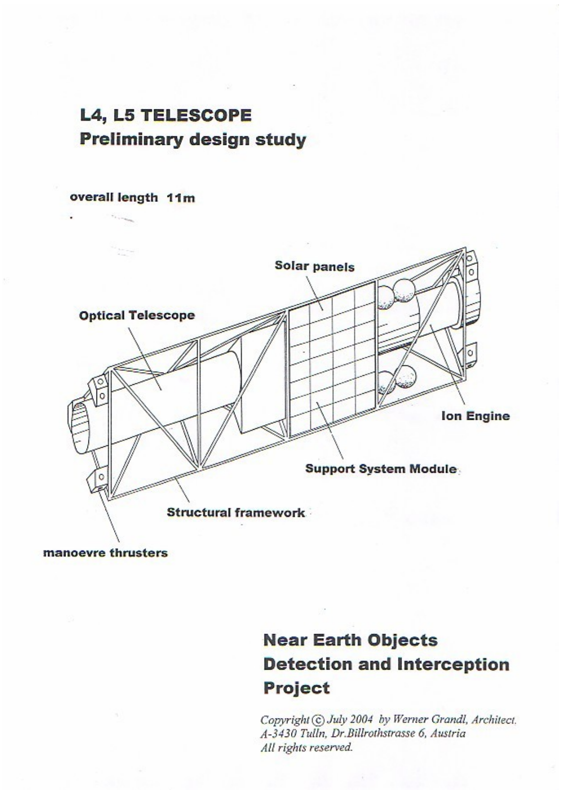

Figure 4: The L4, L5 Robotic Telescope

5. The final Challenge - Deflecting a Hazardous Asteroid:

When the Robotic Telescopes are deployed on the Lagrange Points of the Sun –Earth System, we should seriously face the deflection of hazardous NEOs.
At the *Planetary Defence Conference,* held 23-26 February 2004 in Orange County, California, by the AIAA, American Institute of Aeronautics and Astronautics, several techniques of deflection of dangerous asteroids and comets were discussed.
"Mark Barrera (Aerospace Corp.) presented a study of using nuclear explosions for deflecting a NEO with today`s space technology. One of the example scenarios was a 200 m asteroid with only 11 years warning, discovery in 2005, requiring use of current technology…… the goal is to reduce probability of impact below 1 in 100,000.
To achieve this goal we must deflect the error ellipsoid, which requires more than deflecting centreline of predicted orbit. Requires delta v of several cm/s depending on how early we can reach the asteroid and apply impulse. For nominal coupling of blast to object this plan requires a 1500 kg explosive package…….several launch windows (2008 – 2012) all require heavy – lift launch vehicle, with multiple interceptors to improve system reliability…". (5)

According with the above statement we propose to deploy Robotic Interceptors in the Lagrange Points L3, L4 and L5 of the Earth – Moon System.
Each interceptor should be built as a semi-autonomous robotic missile, consisting of the main components as follows:
-Guidance, Control & Communication Unit, including optical telescope and radar-equipment
-Blasting Charge, containing chemical or nuclear explosive
-Manoeuvre Thrusters
-Main Engine, propulsed by O_2/H_2-engines for quick start in case of alert;

Like the Robotic Telescopes the Robotic Interceptors could be carried into orbit by the ARIANE 5 ESC-B launcher or similar US, Russian, Indian or Chinese launchers.
The interceptors should be built modular to enable astronauts to change components, fuel tanks or to repair damages by micrometeorites after some years in space.

6. The Mission:

If a hazardous object is detected, the "nearest" one of the three interceptors will be alerted by the Earth Station (or a future Lunar Base) and will start up rapidly.
When the interceptor is close enough to detect the hazardous NEO with it`s on-board telescope, it has to complete the mission autonomously.
The missile approaches the object laterally using radar scanning and approach control.
Immediately before the impact of the interceptor the blasting charge has to

explode. The detonation applies a lateral force to the NEO, which deflects the celestial body and changes it`s path. (See figure 5)

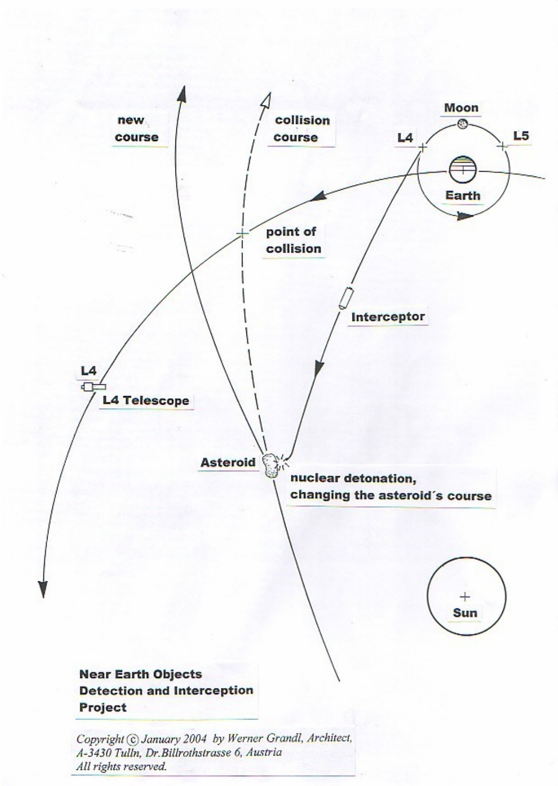

Figure 5: shows the trajectory of an interceptor, using the path velocity of L4 and finally deflecting an asteroid

7. Conclusion:

The threat of asteroid impacts is in the long run a question of survival of human civilization and even of the human species. It is necessary to inform the public about this problem. International cooperation of scientists and engineers all over the world will be essential. The goal is to ensure the survival of mankind on our planet and in the universe.

Tulln, Austria, 15 July 2019

8. Quotations:

(1) Wikipedia, the free encyklopedia
(2) Annals of the New York Academy of Science, Volume 822, 1977
(3) Stephanus, Volume III (in Latin language): Platonis opera quae extant omnia. Ex nova Ioannis Serrani interpretatione. Excudebat Henricus Stephanus; Gent 1578)
(4) Brian Marsden, CCNet 25/2004 - 23 February 2004
(5) David Morrison, NASA, 27 February 2004, NEO News, Planetary Defence 2

9. References:

(1) Lohinger, Dvorak, Froeschle : 1995, Encounter Frequency of Halley-like Comets with the Planets; *Earth, Moon and Planets,* V.71, p.225 -233
(2) Dvorak,R. : 1998, The Dynamic Evolution of the Atens (asteroids); *Celestial Mechanics and Dynamical Astronomy,* V.69, Issue ½, p.103 -118
(3) Dvorak, Pilat-Lohinger : 1999, On The dynamical evolution of the Atens and the Apollos; *Planetary and Space Science,* Volume 47, Issue 5, p.665-677
(4) H.Raumauf 2000, Neuklassifizierung von erdnahen Asteroiden, *Diploma Thesis,* University of Vienna
(5) Dvorak, Freistetter : 2001, Dynamical Evolution and collision of asteroids with the Earth; *Planetary and Space Science,* Volume 49, Issue 8, p.803-809
(6) Milani, Knezevic : 2005, From Astronomy to Celestial Mechanics: Orbit determination with very short arc; *Celestial Mechanics and Dynamical Astronomie;* Volume 92, Issue 1-3, pp.1-18