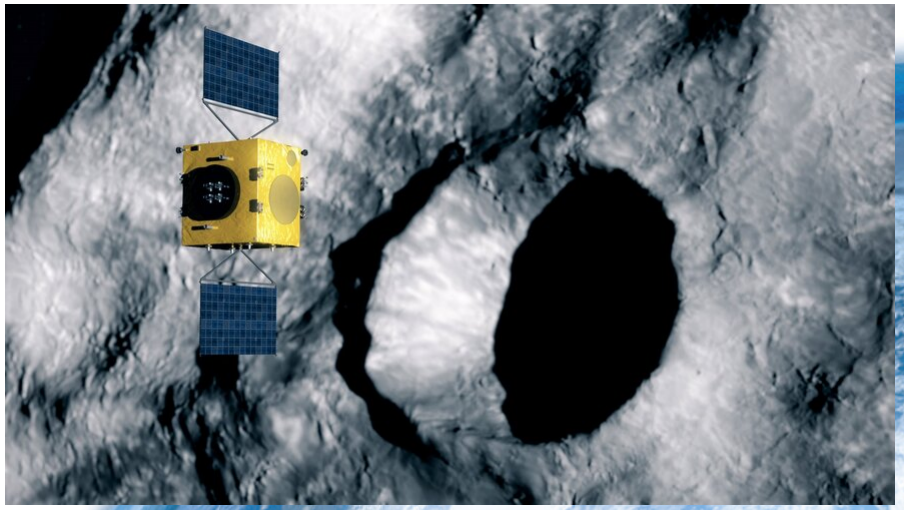
Current NEO-related Activities in Germany

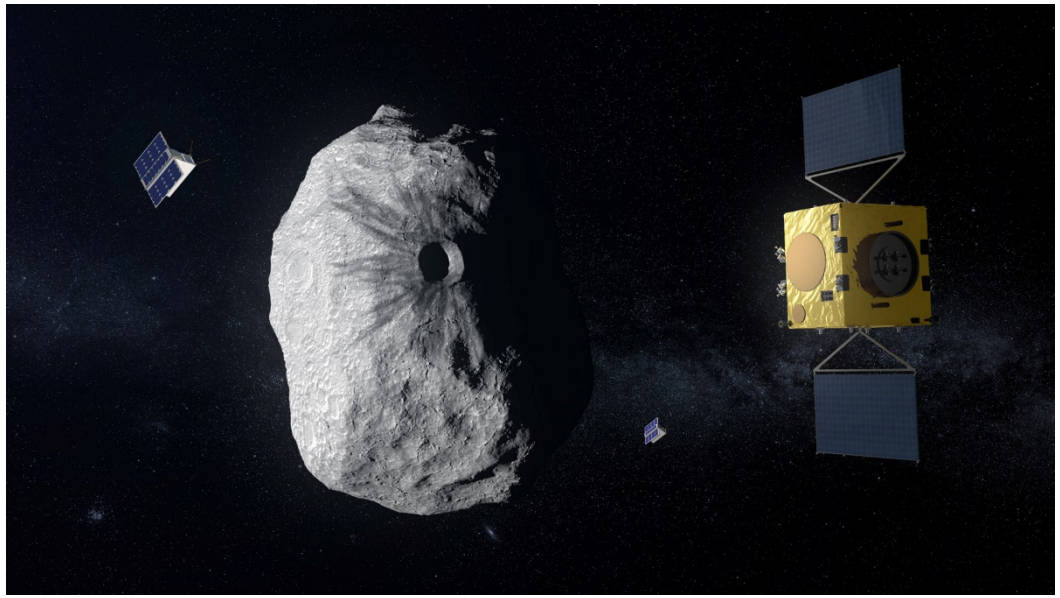
Alan Harris
DLR Institute of Planetary Research, Berlin

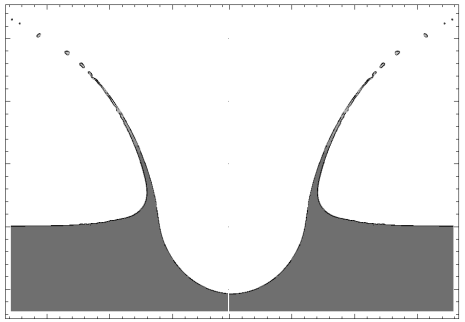
Including text + images provided by:
S. Ulamec (DLR)
J.-B. Vincent (DLR)
K. Wünnemann (MfN, Berlin)



Main NEO-related Missions and Projects with German participation

1. **Hera** – Europe's reconnaissance mission to Didymos and Dimorphos, planned for launch in 2024, following and complementing NASA's DART impactor.
2. **NEO-MAPP** – EU-funded project (Feb. 2020 – Jan. 2023) with work packages in support of Hera science.
3. **Impact Effects Engineering Tool** – ESA contract (Deimos, MfN)
4. **Destiny+** – JAXA/DLR mission to 3200 Phaethon.





Hera

- Hera is the European reconnaissance mission to the Didymos system which complements NASA's kinetic-impactor mission, DART, with the aim of returning precise information on the effects of the DART impact.
- Germany participates primarily via industry but is also well represented in the core investigation team by:

  S. Ulamec, DLR (Management Board Chair),

  J.-B. Vincent, DLR (Data Analysis WG Lead),

  K. Wünnemann, Museum für Naturkunde, Berlin (Impact Modeling WG Lead).
- The German aerospace company, OHB System AG, Bremen, is the ESA prime contractor for Hera and is responsible for the design and construction of the spacecraft. The German company Jena-Optronik is providing a camera, with J.-B. Vincent (DLR) as instrument PI.
- Launch date: 2024; arrival: end 2026; duration of operations: at least 6 months.

NEO-MAPP ('NEO Modelling and Payloads for Protection')

15 partners; funded Feb. 2020-Jan. 2023

Tasks with German leadership or significant participation

1. Advanced payload synergies (DLR) - focusing on Hera

Develop innovative and synergetic measurement and data-analysis strategies that combine multiple payloads, to ensure optimal data exploitation for NEO missions.

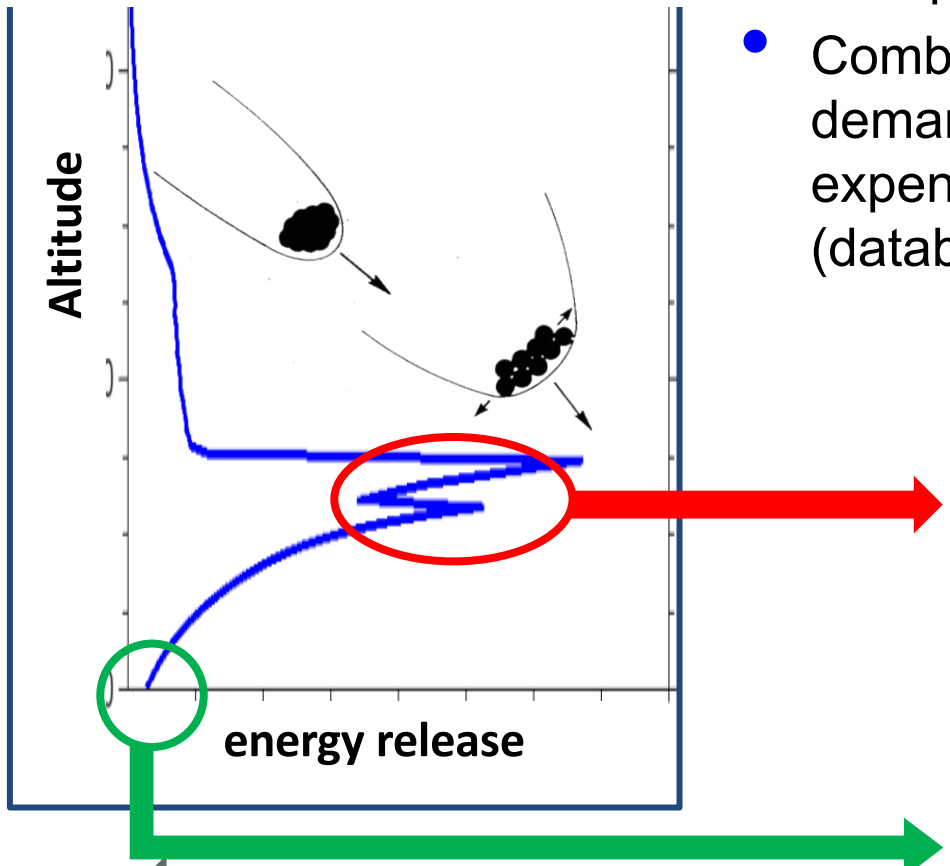
2. Simulation of the collision of a kinetic impactor with an asteroid by coupling different numerical approaches (MfN, Berlin)

Target properties determine:

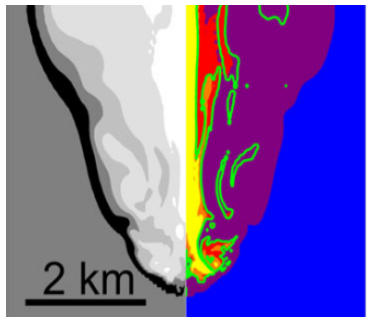
- Efficiency of Momentum transfer
- Crater morphology + morphometry
- Ejecta mass
- Global scale effects
- Impact seismicity

The Impact Effects Engineering Tool (ESA contract)

Considered impact scenarios:
Stones diameter: 20–200 m
Irons diameter: 3 –50 m
Impact velocity: 11-40 km/s
Entry angles: 15 – 90°



- Contractor consortium for software development based on previous contract (The Impact Effects Knowledge-Base)
  DEIMOS (Lead, industry partner) and MfN
- Fast prediction of atmospheric and ground impact effects
- Combines fast semi-analytical models (parameterized approach) and demanding and computationally expensive computer simulations (database of pre-run simulations)



Small bodies tend to disrupt in the atmosphere
→ Atmospheric blast wave
→ Radiation of heat

Larger bodies and iron objects can reach the ground
→ Formation of craters or crater fields

Destiny+ (=Demonstration and Experiment of Space Technology for INterplanetary voYage

JAXA, Univ. Stuttgart, DLR

- Destiny+, selected by the Japanese space agency JAXA/ISAS for launch in 2024, will fly by the active asteroid (3200) Phaethon in early 2028 and observe dust using a dust analyzer and map its surface to understand the mechanisms of dust ejection. The spacecraft will pass as close as 500 km to the surface of Phaethon at a speed of 36 km/s.

- The scientific payload consists of a telescopic camera, a multi-band camera, and the Destiny+ Dust Analyzer (DDA), provided by the Univ. of Stuttgart with support from DLR.

- A new dust accelerator for test and calibration purposes became operational in March 2022 at the Univ. of Stuttgart, in which 100-nm-diameter metal or silicate particles can be accelerated in vacuum to velocities of 50 km/s. Such velocities are typical of those encountered by spacecraft making measurements of interstellar dust.

German Space Situational Awareness Centre ("Weltraumlagezentrum")

- Established on July 1, 2009, it became part of the new German Armed Forces Space Command on July 13, 2021. The Centre is commanded by a civilian/military dual leadership (DLR/Bundeswehr) and is situated near the town of Uedem, near the German-Dutch border.

- It is tasked with protecting German space-based civilian and military systems. Its brief includes publishing forecasts of the entry of objects into the Earth's atmosphere and the potential for damage (includes asteroids in addition to space debris - the Centre operates in collaboration with ESA).

- The Centre would likely play an important role in providing information and advice to federal and state governments in Germany in the event of a persistent and significant impact hazard.

Hayabusa 2 sample A0112

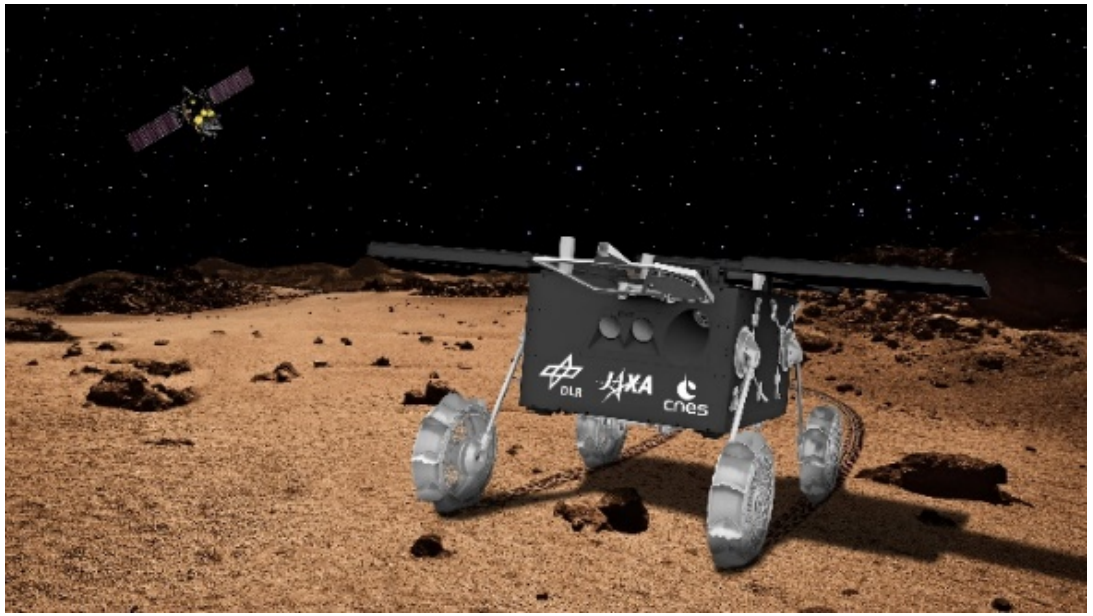
- The near-Earth asteroid (162173) Ryugu is a type of stony carbonaceous asteroid rich in water and organic material, which may be representative of sources of the seeds of life delivered to the nascent Earth billions of years ago.
- Hayabusa 2 collected 5.4 grams of rocky grains from Ryugu during two sampling touchdowns in 2018 and 2019.
- JAXA has assigned to the DLR Institute of Planetary Research in Berlin the dust particle A0112 from the samples that were brought to Earth in 2020 by the Hayabusa 2 mission.
- The 3-mm grain, which has a mass of 5.1 milligrams, arrived in Berlin on 25th August 2022, where it will be studied in the DLR's Planetary Spectroscopy and Planetary Sample Analysis Laboratories.

Contributions to JAXA Mars Moons eXploration (MMX) Mission

- JAXA Mission to investigate the Martian moons, Phobos and Deimos, including sample return from Phobos. Launch in 2024.

- Germany (DLR) is involved in the MMX Science Board including participation in the science teams on “Early Solar System Evolution”, “Surface Science and Geology” and “Origins of Phobos and Deimos”

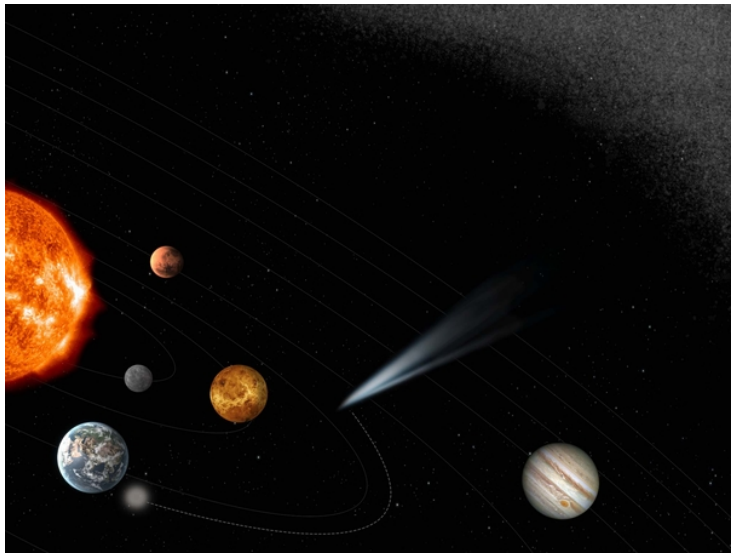
- Provision of CNES-DLR Rover as contribution to the MMX Mission:
  - Rover System with 4 Scientific insruments. Rover PI´s: S. Ulamec (DLR) and P. Michel (CNRS)
  - Raman Spectrometer, RAX (DLR, with contributions from INTA and JAXA)
  - Radiometer (miniRAD) (DLR)



Comet Interceptor

- The Comet Interceptor (CI) mission target will be an as-yet undiscovered comet. Comprising 3 spacecraft, CI will be the first mission to visit a long-period comet (or interstellar object) just starting its journey into the inner Solar System. The composite spacecraft will wait at L2 for a suitable target, then move off to intercept it. The three modules separate a few weeks prior to intercepting the target.

- CI will fly by the chosen target as it approaches Earth's orbit. Its three spacecraft will perform simultaneous observations from multiple points around the object.



- The spacecraft and the instruments passed their Preliminary Design Reviews in June 2022. Selection of the prime contractor will be announced by mid-October 2022.

- TU Braunschweig is developing a Flux-Gate Magnetometer as part of the Dust-Fields-Plasma analyser experiment. Further German scientific involvement is foreseen but details are not yet available. Launch is planned for 2029.

Thank you! Any questions, comments?