

Video-clip collection of the European Space Agency

Image courtesy of ESA & NASA

Films about science or even pseudo-science can be powerful tools in the classroom. **Heinz Oberhammer** from the Cinema and Science project provides a toolkit for using the video-clip collection of the European Space Agency.



Distant view of the comet Tempel 1, the target of NASA's *Deep Impact* mission (artist's impression)



Comet Tempel 1 observed in visible light and infrared light (artist's view)

Image courtesy of NASA, Jet Propulsion Laboratory-Caltech, and T. Pyle (Spitzer Science Center)

In the classroom, video clips about science or even pseudo-science can be used to stimulate discussion and raise interest in scientific subjects. The Cinema and Science (CISCI) website^{w1}, due to launch in December 2006, will describe a wide variety of film scenes, providing explanations

and background information to help teachers prepare inspiring, film-based lessons.

This article on the video-clip collection of the European Space Agency^{w1} (ESA) provides a sample of the content being developed by CISCI, including explanations for pupils and background information for teachers.

The Hubble Space Telescope

The Hubble Space Telescope is a collaboration between ESA and NASA^{w2}. It is a long-term, space-based observatory. The observations are carried out in visible, infrared and ultraviolet light. In many ways Hubble has revolutionised modern astronomy, not only by being an efficient tool for making new discoveries, but also by driving astronomical research in general.

The website of the Hubble Space Telescope^{w3} provides a wealth of images and video clips to view and download.

Basic explanation

Comets consist of ice and dust and are therefore often called 'dirty snowballs'. When comets approach the Sun, the ice melts and boils and particles are thrown out. These particles are then dispersed by wind from the Sun, forming the characteristic comet tail. Tempel 1 is a cigar-shaped comet about 224 cubic kilometres in size.

In the video clip, we see the impact of the 370-kilogram projectile (impactor) released by the mother spacecraft *Deep Impact* with the inner part of the Tempel 1 comet on July 4, 2005. The comet is named after Ernst Wilhelm Leberecht Tempel, who discovered it in 1859. The mission is named after the film *Deep Impact*, a 1998 blockbuster film.

The impact on the comet Tempel 1 was observed by the spacecraft, the Hubble Space Telescope and observatories around the world. First results show that there is about twice as much dust than ice in the comet, sug-



Cinema and Science (CISCI)

BACKGROUND

The CISCI project involves ten partners from Europe and the USA, and is part of the larger NUCLEUS project funded by the European Commission. The planned 160 content units will cover physics, biology, chemistry, mathematics, informatics and other science subjects and will be available on the CISCI website^{w1} in English and the languages of the CISCI partners.

gesting that comets are 'icy mudballs', rather than 'dirty snowballs', as previously believed.

Advanced explanation

Mission *Deep Impact*

Some of the scientific questions that the *Deep Impact* mission was designed to answer were:

- What are the basic properties of the comet: how is its surface formed, how dense is it, how strongly is it held together and how massive is it?
- What is the composition of the comet?
- Can the course of a comet be altered to reduce the effect of, or to avoid, a collision with Earth?

The asteroid Apophis

On the evening of April 13, 2029, the asteroid Apophis, with a volume of 320 cubic kilometres, will pass Earth at a distance of only 36 650 kilo-

metres. This is about the height of our geo-stationary satellites and about ten times closer than our moon. Apophis will then be visible with the naked eye over Europe.

On April 13, 2036, Apophis will then pass Earth at a height of only 3400 kilometres (about half Earth's radius). According to present calculations, the chance of it hitting Earth is about 1:8000. It would crash into the Pacific Ocean with a speed of about 50 000 kilometres an hour, corresponding to an explosive force of about 100 million tons of TNT. It would create a 2500-metre-deep crater in the ocean, causing tsunamis up to 20 metres high. The Asian tsunami in

2004 was only half that high. The costs in infrastructure alone along the North American coast would amount to approximately US\$400 billion. However, sustained global effects are not anticipated.

The asteroid Apophis is named after the Egyptian god of evil, destruction and darkness. Two of the co-discoverers of the asteroid, Roy Tucker and David Tholen, are fans of the TV series *Stargate SG-1*; it is probable that they named the asteroid after a character in this series, played by the actor Peter Williams (see website about character Apophis in *Stargate SG-1*, below).

Table 1: Details of the video-clip collection of the European Space Agency

<i>Title</i>	Video-clip collection of the European Space Agency
<i>Description of film</i>	Collection of astronomical clips
<i>Film producer</i>	European Space Agency
<i>Scientific subject and topic</i>	Physics and astronomy
<i>Website</i>	www.spacetelescope.org/videos
<i>Purchase film</i>	www.spacetelescope.org/hubbleshop/webshop/webshop.php?show=sales&section=cdroms

Table 2: *Deep Impact* scene details

<i>Time interval</i>	heic0508f.mov 0:00:00 - 0:00:18
<i>Scientific keywords</i>	Comet, asteroid, impact
<i>Title of scene</i>	<i>Deep Impact</i> probe slams into comet
<i>Description of scene</i>	Animation showing the collision between the 370-kilogram projectile released by the spacecraft <i>Deep Impact</i> and the comet Tempel 1 on July 4, 2005

Redirecting Apophis

NASA is now making plans to land a transponder on the asteroid Apophis. A transponder is a tracking system similar to the ones used in commercial aircraft. This transponder could then determine the exact trajectory of Apophis, after which the asteroid could be hit and redirected using a spaceship with a mass of about 4 tons, to reduce the risk of an impact with Earth in 2036. In principle, this is possible and was demonstrated on a smaller scale by the mission *Deep Impact*.

Web references

- w1 – European Space Agency (ESA): www.esa.int
- w2 – National Aeronautics and Space Administration (NASA): www.nasa.gov
- w3 – The Hubble Space Telescope: www.spacetelescope.org

Resources

Websites about the mission *Deep Impact*

- NASA *Deep Impact* – science and technology, results, gallery and news:
<http://deepimpact.jpl.nasa.gov/home/index.html>
- Deep Impact*, Wikipedia – scientific background:
http://en.wikipedia.org/wiki/Deep_Impact_%28space_mission%29

Websites about Apophis

- Download a widget that counts down to the possible impact of Apophis with Earth:
www.widgetgallery.com/?search=apophis&x=0&y=0
- NASA Earth Risk Impact Summary of Apophis:
<http://neo.jpl.nasa.gov/risk/a99942.html>
- Apophis in *Stargate SG-1*, Wikipedia:
http://en.wikipedia.org/wiki/Apophis_%28Stargate%29
- The Spirits of Nature by Ottar Vendel – article about Egyptian gods: www.nemo.nu/ibisportal/0egyptintro/1egypt/index.htm

Websites about asteroids

- NASA Lunar and Planetary Science – Asteroids:
<http://nssdc.gsfc.nasa.gov/planetary/planets/asteroidpage.html>
- Asteroid, Wikipedia – scientific description:
<http://en.wikipedia.org/wiki/Asteroid>
- Asteroid Introduction – basic summary of comets,

including images: www.solarviews.com/eng/asteroid.htm

Asteroids – educational site about comets:
www.windows.ucar.edu/tour/link=/asteroids/asteroids.html

NASA/ESA Hubble Space Telescope Video Archive for ‘Asteroid’: www.spacetelescope.org/bin/videos.pl?searchtype=freesearch&string=Asteroid

Websites about impacts of comets or asteroids

- Impact event, Wikipedia – scientific description:
http://en.wikipedia.org/wiki/Impact_event
- Earth Impacts Effects Program – calculate the environmental consequences of impacts on Earth:
www.lpl.arizona.edu/impacteffects/
- Solar System Collisions – calculate the effects of impacts on different planets: <http://janus.astro.umd.edu/astro/impact/>

Websites about *Deep Impact* (film)

Internet Movie Database – background information:
www.imdb.com/title/tt0120647/

Websites about *Stargate SG-1* (TV series)

- Internet Movie Database – background information:
<http://us.imdb.com/title/tt0118480/>
- Stargate SG-1*, Wikipedia – scientific description:
http://en.wikipedia.org/wiki/Stargate_SG-1

