Practical session 11

Down to Earth

Prof. Paul Roche
Sophie Bartlett
Univ. of South Wales

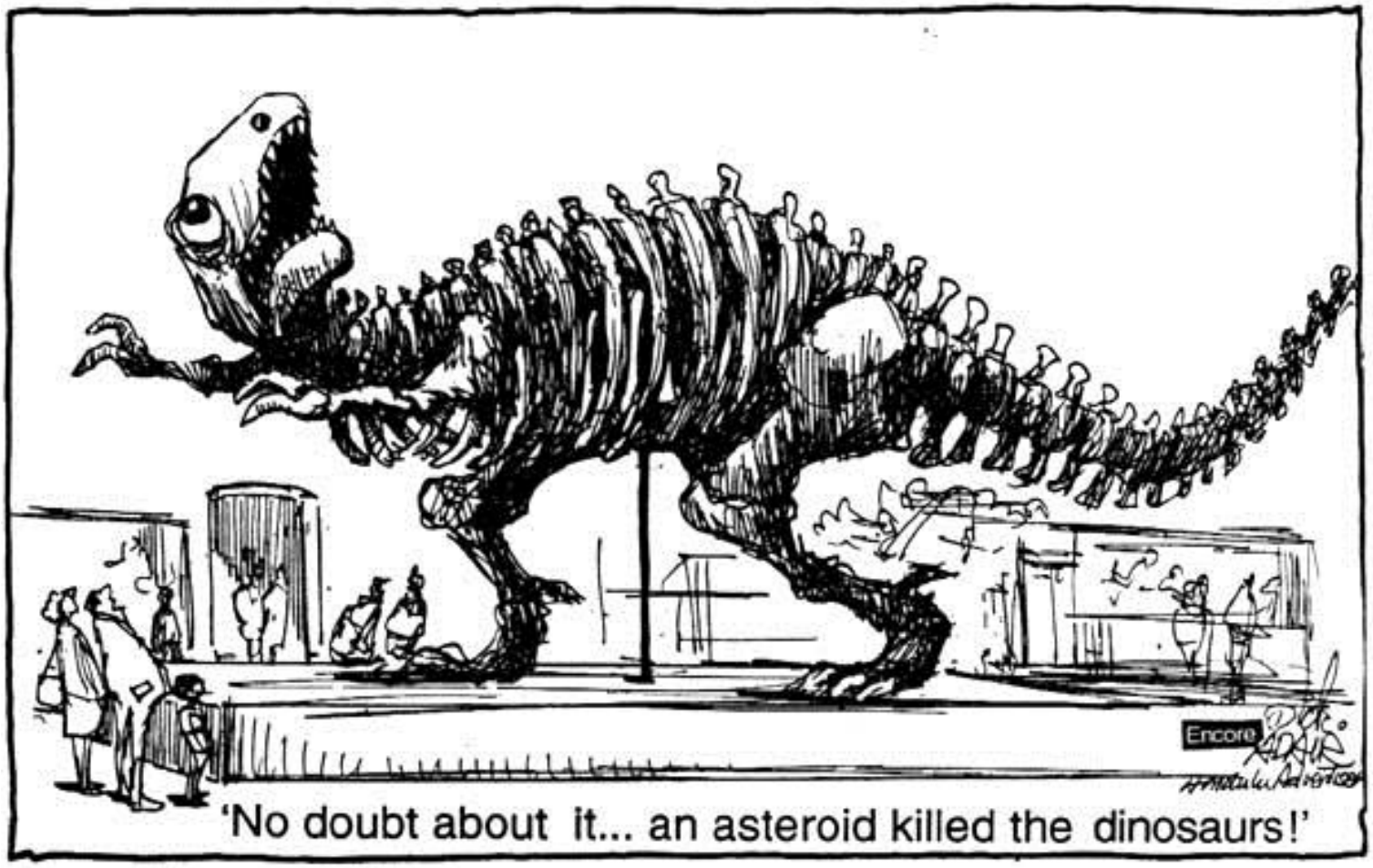
Part 1: Down to Earth: Simulating asteroid and comet impacts

Part 2: Faulkes Telescope Project: remote control telescopes

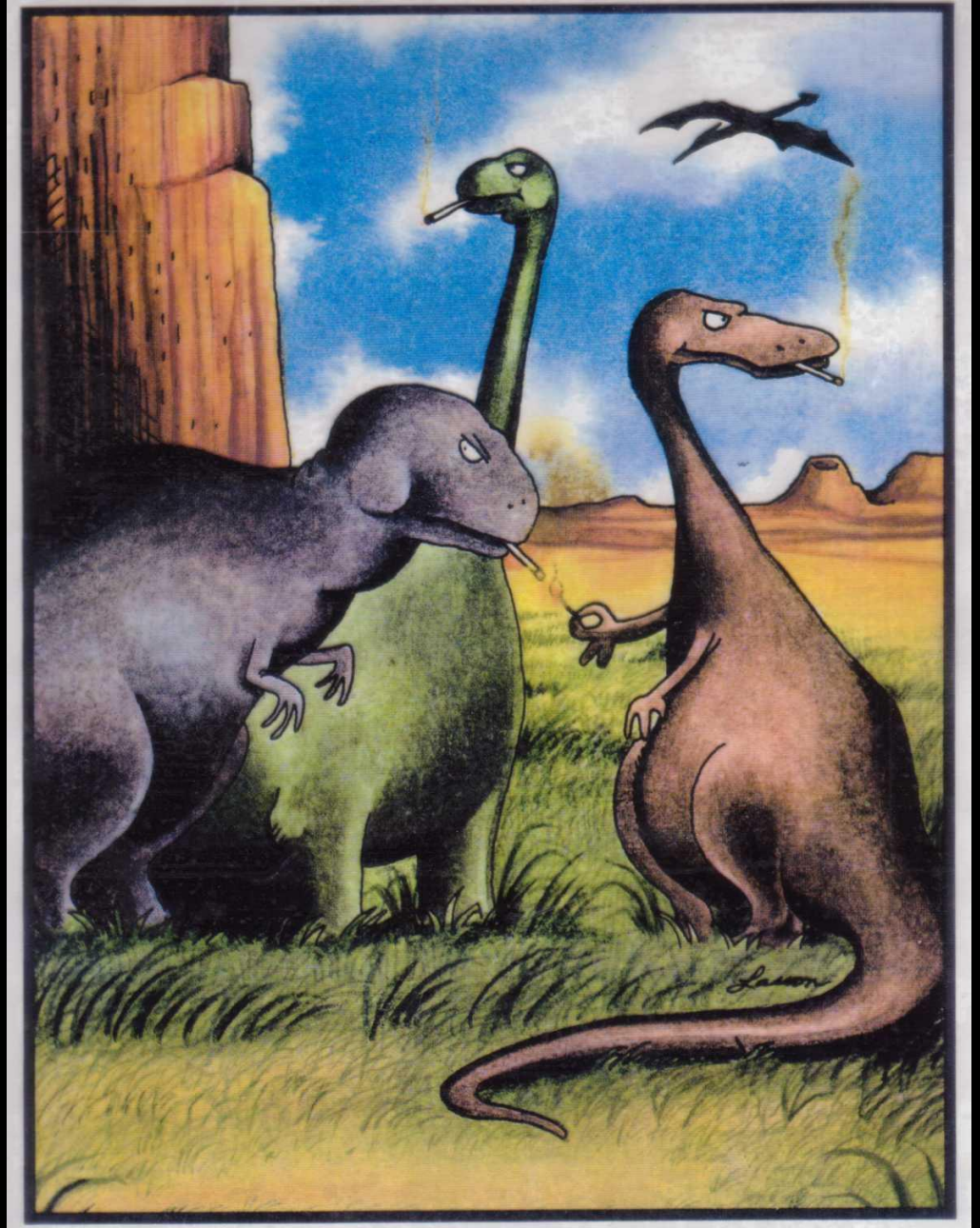
Down to Earth

Simulating asteroid and comet impacts

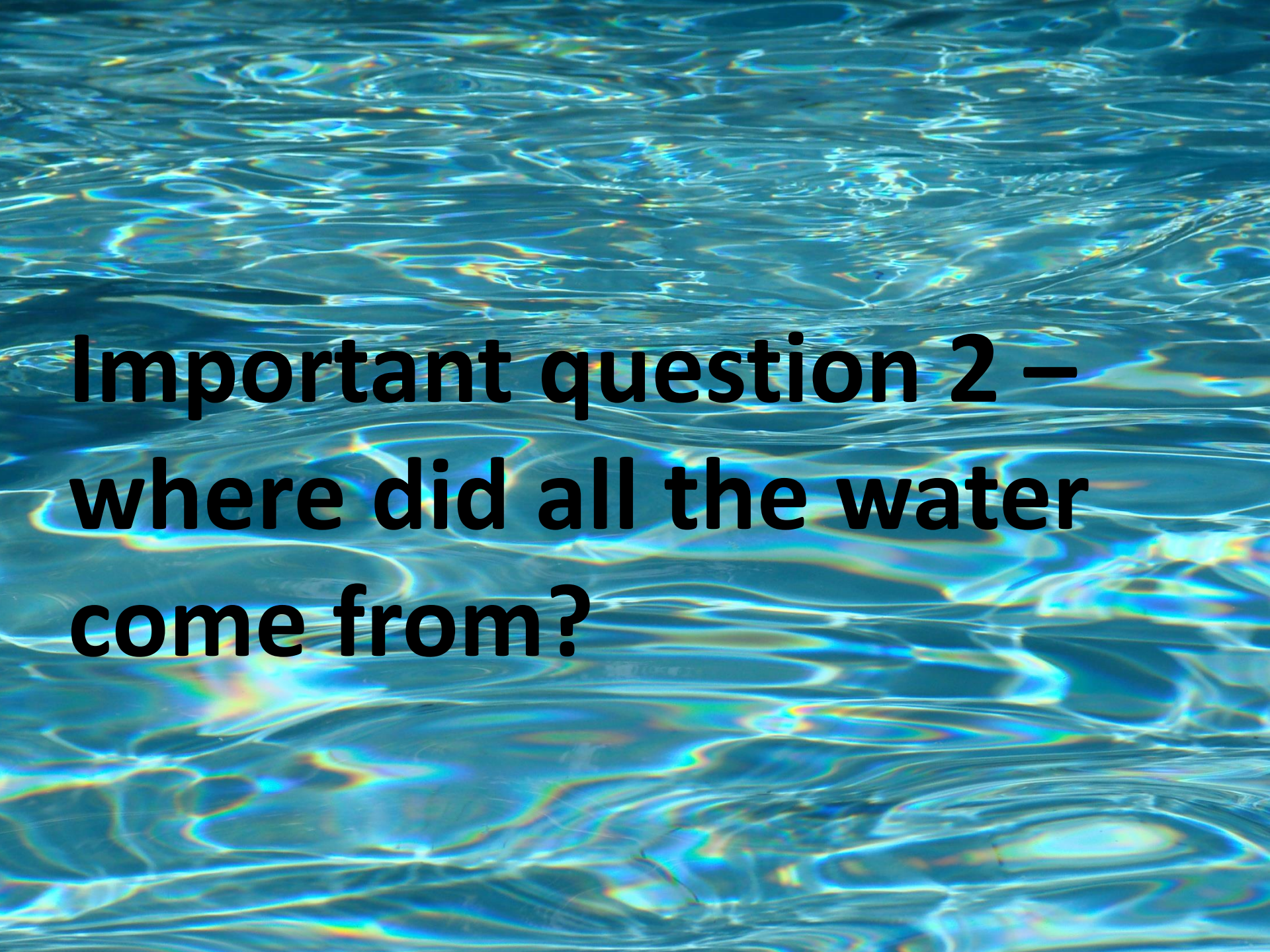
Death, Destruction and Dinosaurs…

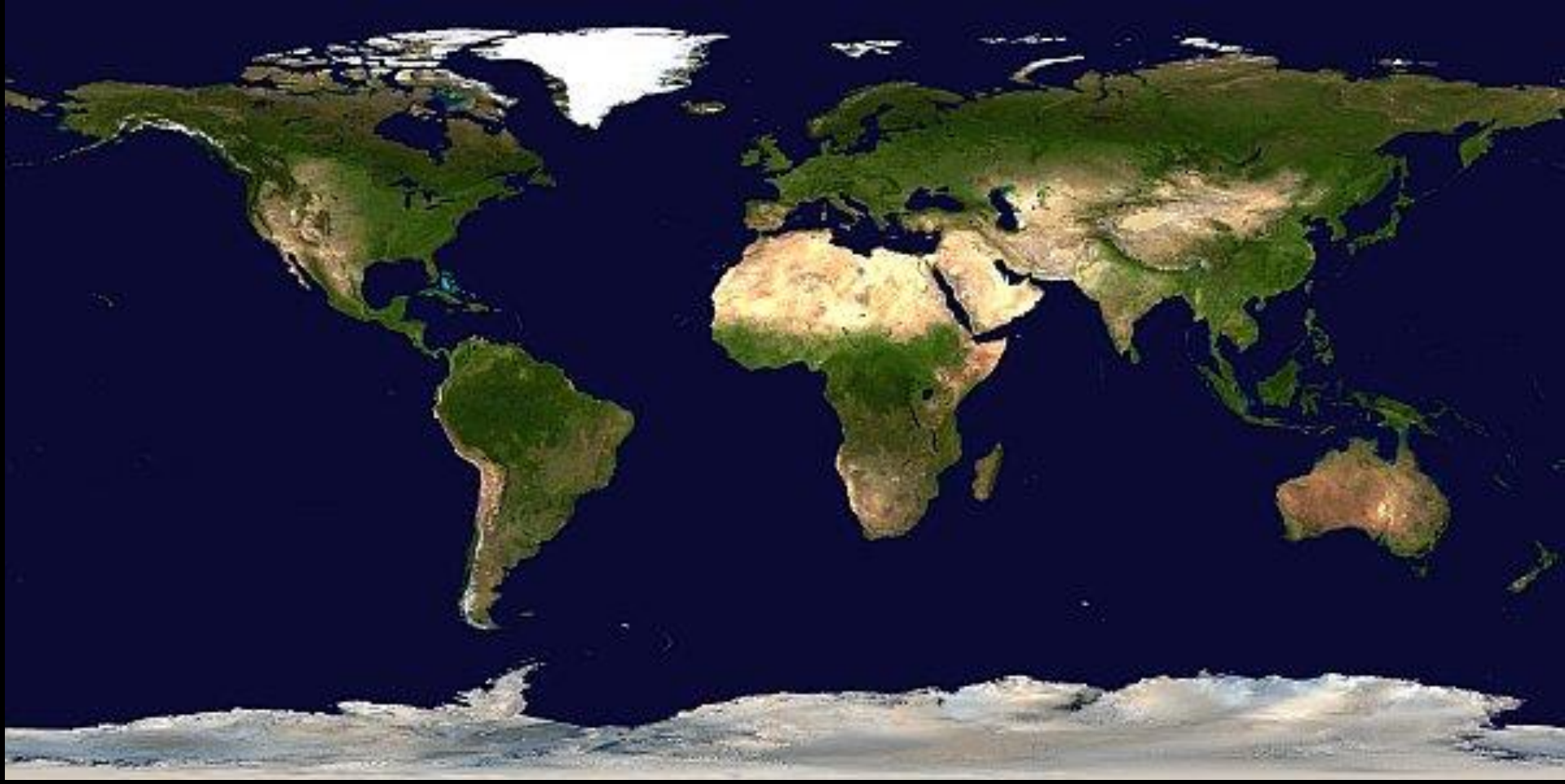


Important question 1 – what killed the dinosaurs?



The real reason dinosaurs became extinct.


Important question 2 – where did all the water come from?



Water, water, everywhere…

But where did it come from?

Volcanoes

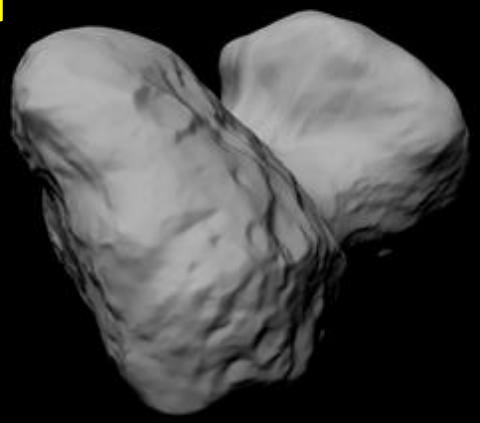
Comets

“Wet” asteroids

Latest news from Rosetta…

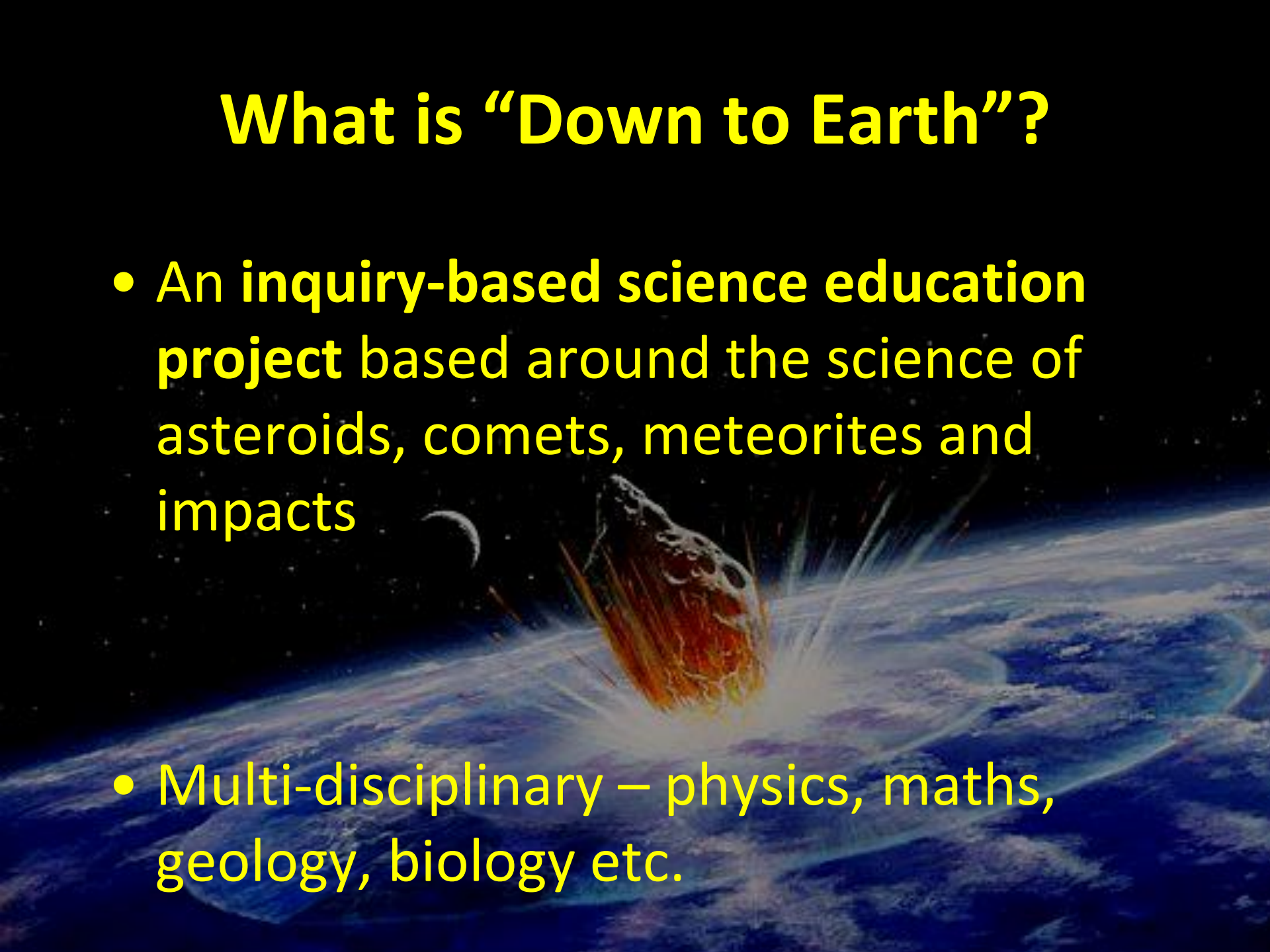
‘Science’ paper published yesterday

Isotope ratio of water from 67P does not match that seen in Earth’s oceans – suggests comets are **not** main source of water on Earth(?)

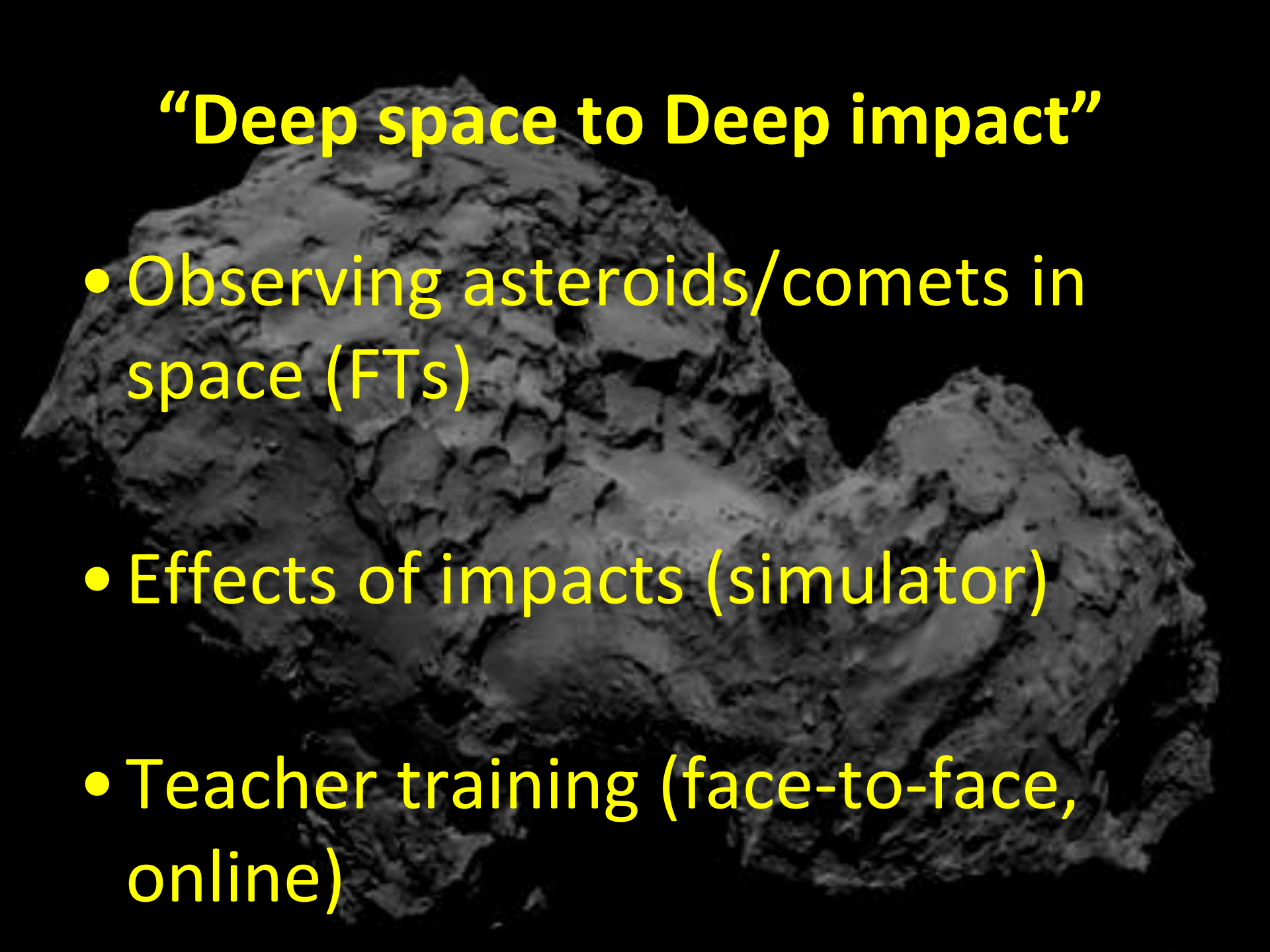


What is “Down to Earth”?

- An **inquiry-based science education project** based around the science of asteroids, comets, meteorites and impacts



- Multi-disciplinary – physics, maths, geology, biology etc.



"Deep space to Deep impact"

- Observing asteroids/comets in space (FTs)
- Effects of impacts (simulator)
- Teacher training (face-to-face, online)

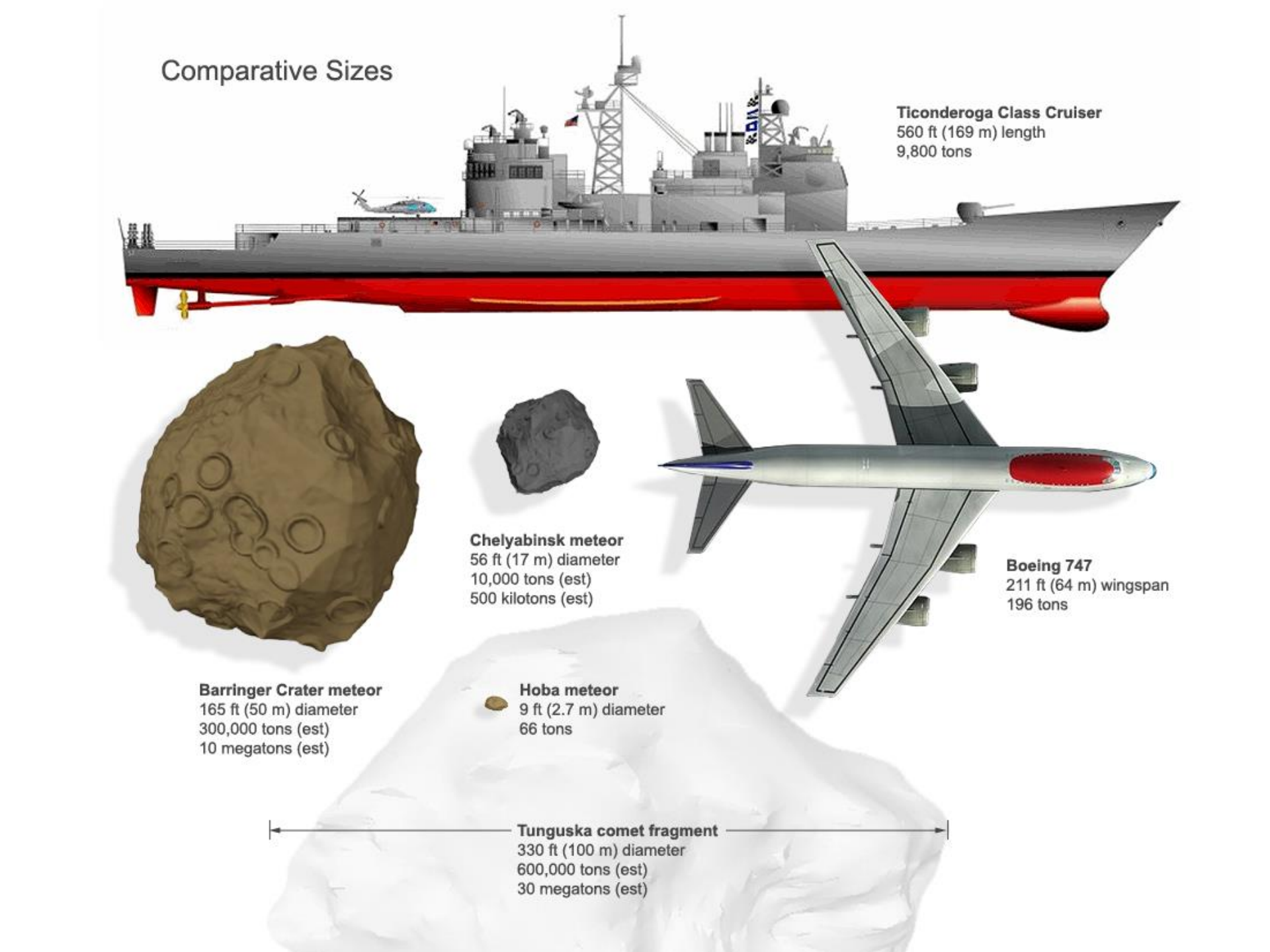
“Deep space to Deep impact”

- Classroom activities (talks, demos)
- Online resources (D2E website)
- Meteorite loan box scheme (resources to schools)

Chelyabinsk meteor, 15/02/13

https://www.youtube.com/watch?v=tq02C_3FvFo

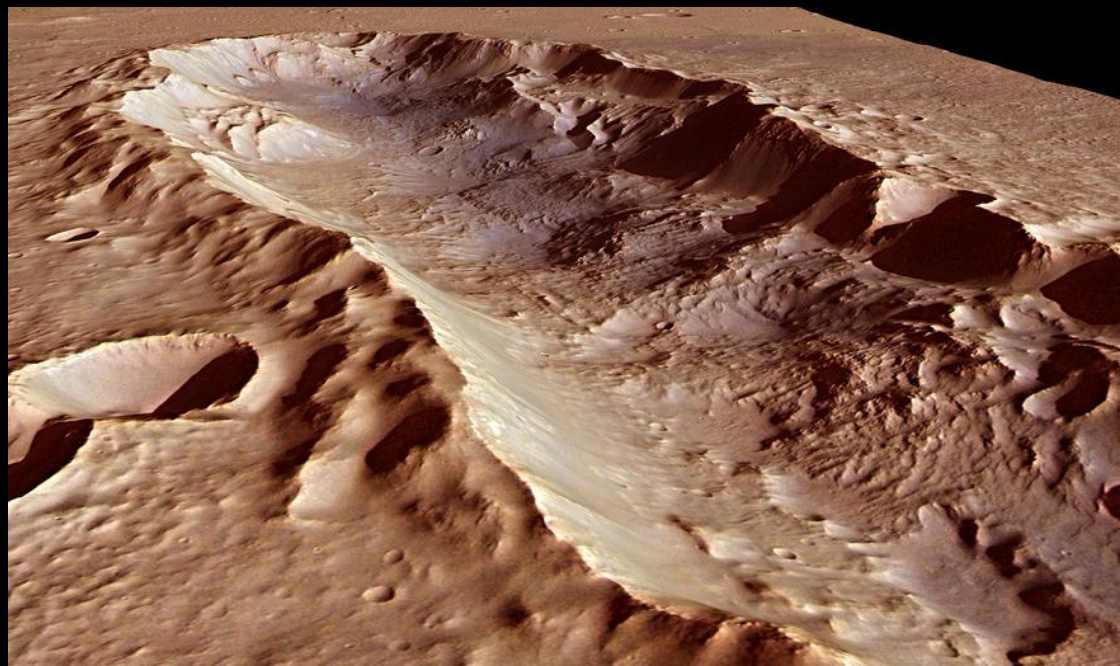

AP


Comparative Sizes
Ticonderoga Class Cruiser
560 ft (169 m) length
9,800 tons
Chelyabinsk meteor
56 ft (17 m) diameter
10,000 tons (est)
500 kilotons (est)
Boeing 747
211 ft (64 m) wingspan
196 tons
Barringer Crater meteor
165 ft (50 m) diameter
300,000 tons (est)
10 megatons (est)
Hoba meteor
9 ft (2.7 m) diameter
66 tons
Tunguska comet fragment
330 ft (100 m) diameter
600,000 tons (est)
30 megatons (est)

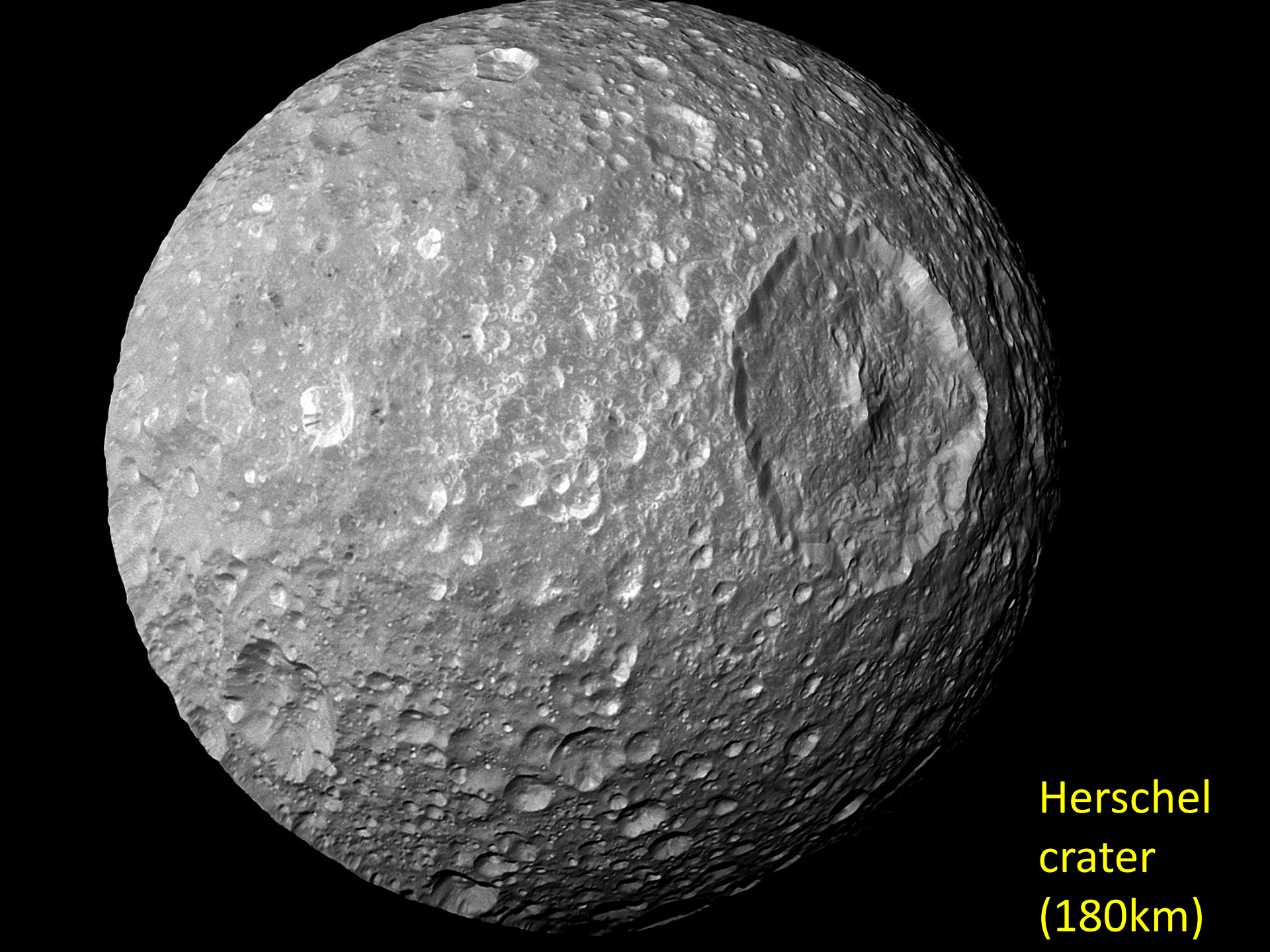
Mimas
(Saturn)

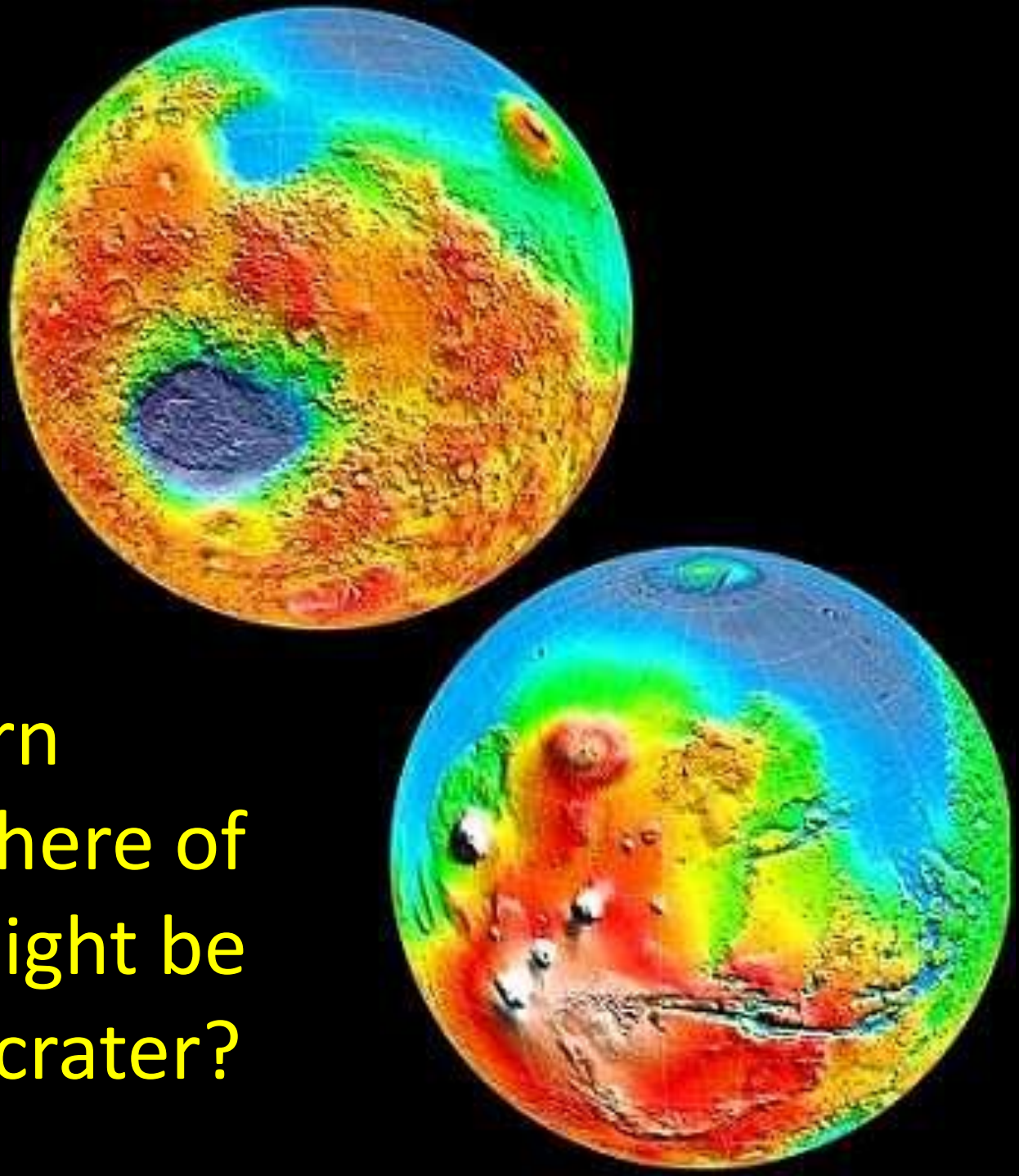
Callisto
(Jupiter)

Craters are
everywhere!



Mars

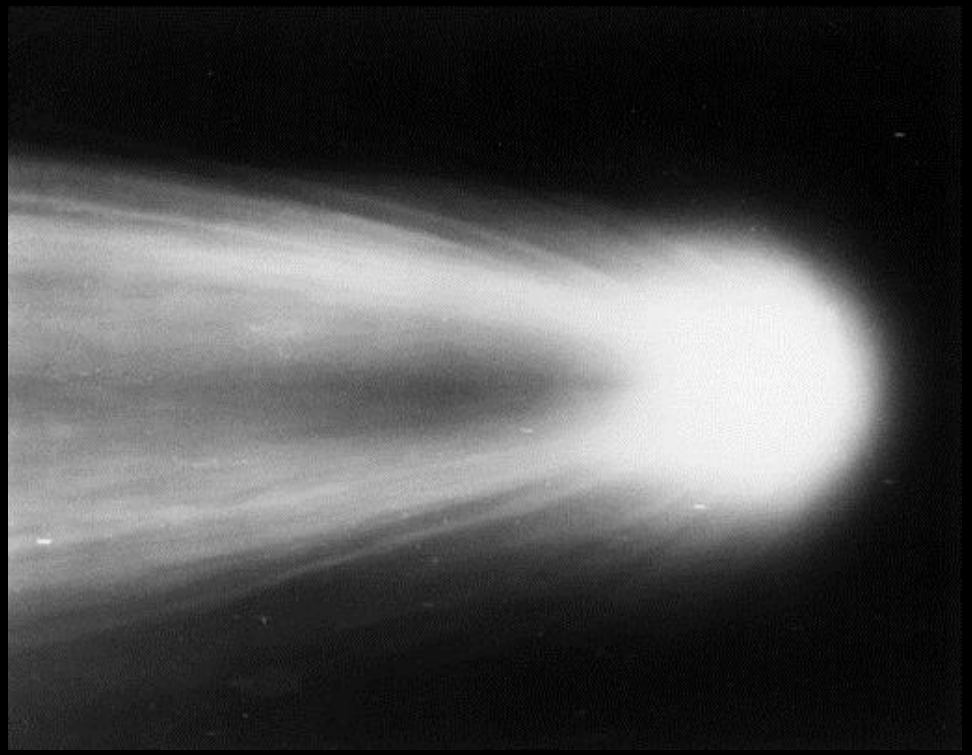

Herschel
crater
(180km)

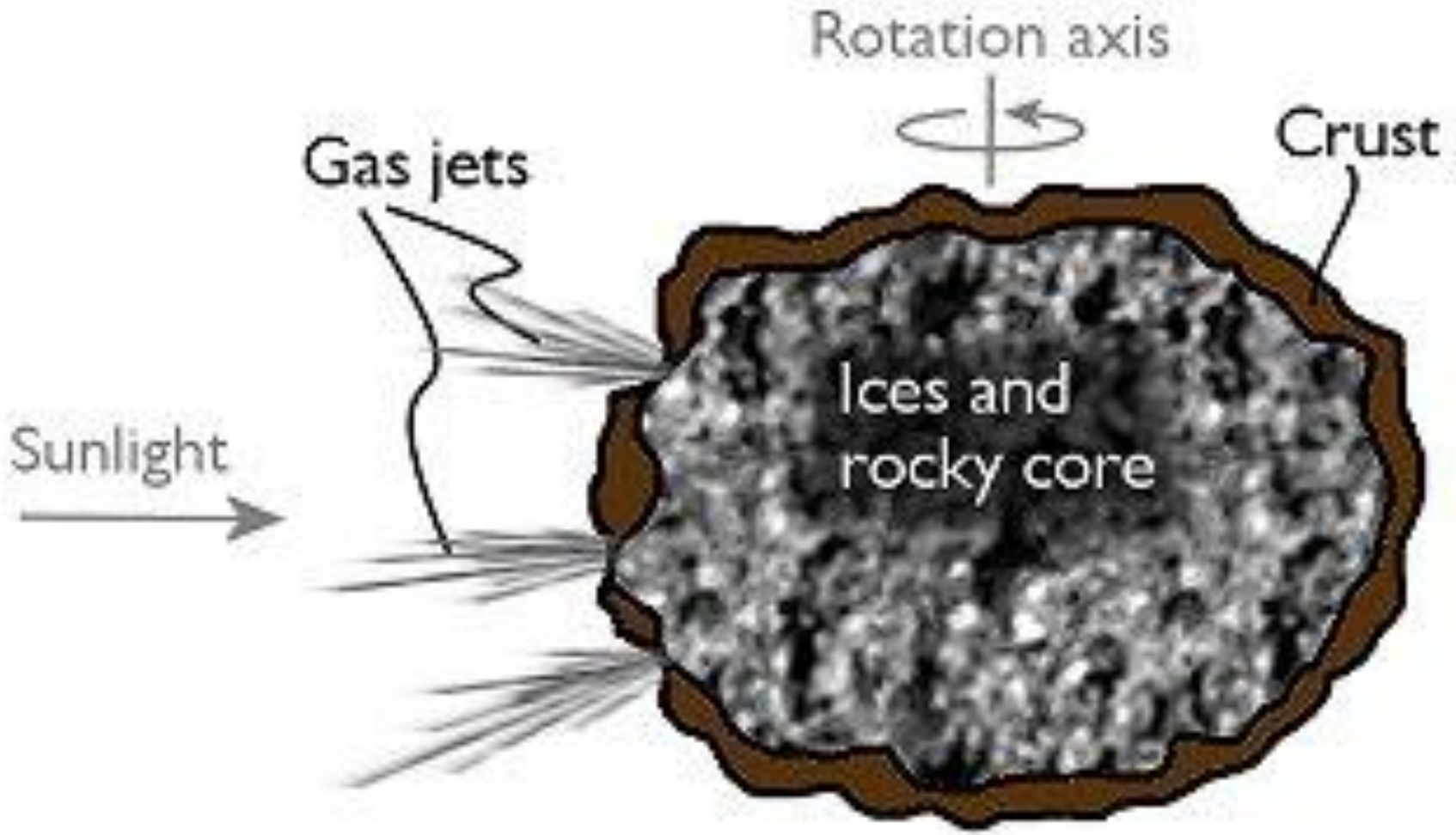


Northern hemisphere of Mars might be a giant crater?

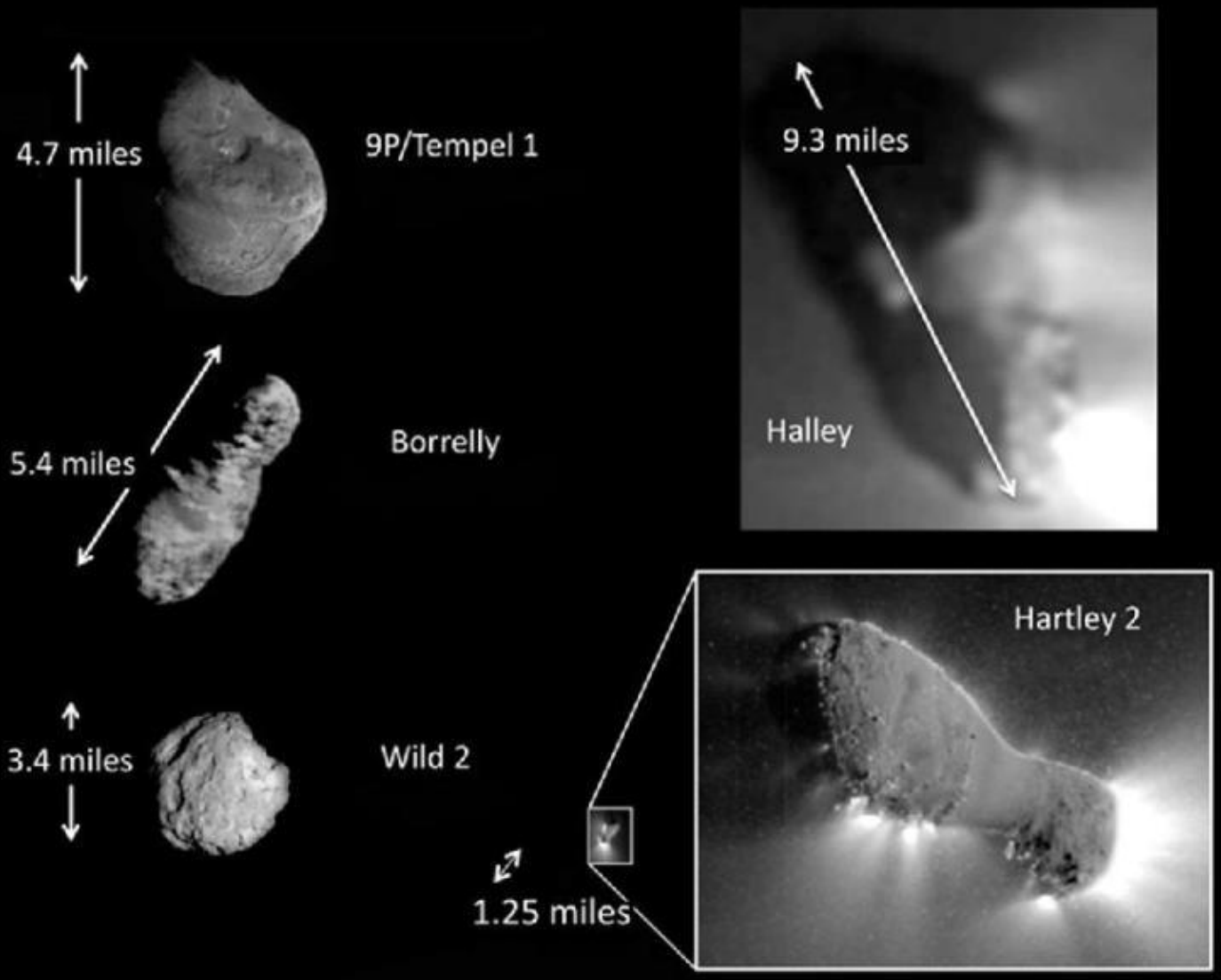
Comets

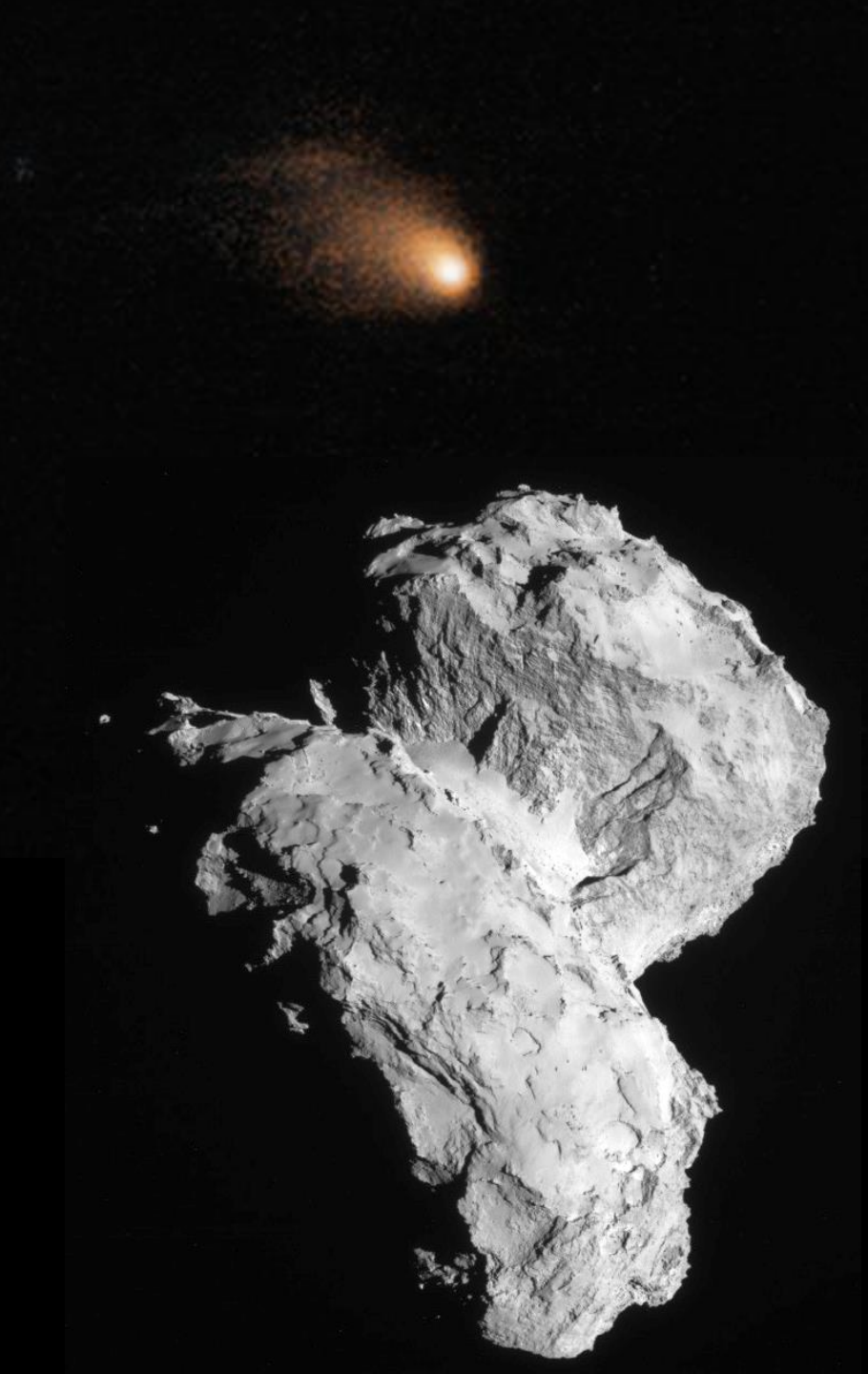
Dirty snowballs or snowy dirtballs…




Rotation axis
Crust
Gas jets
Ices and
rocky core
Sunlight

Previous close views of comets

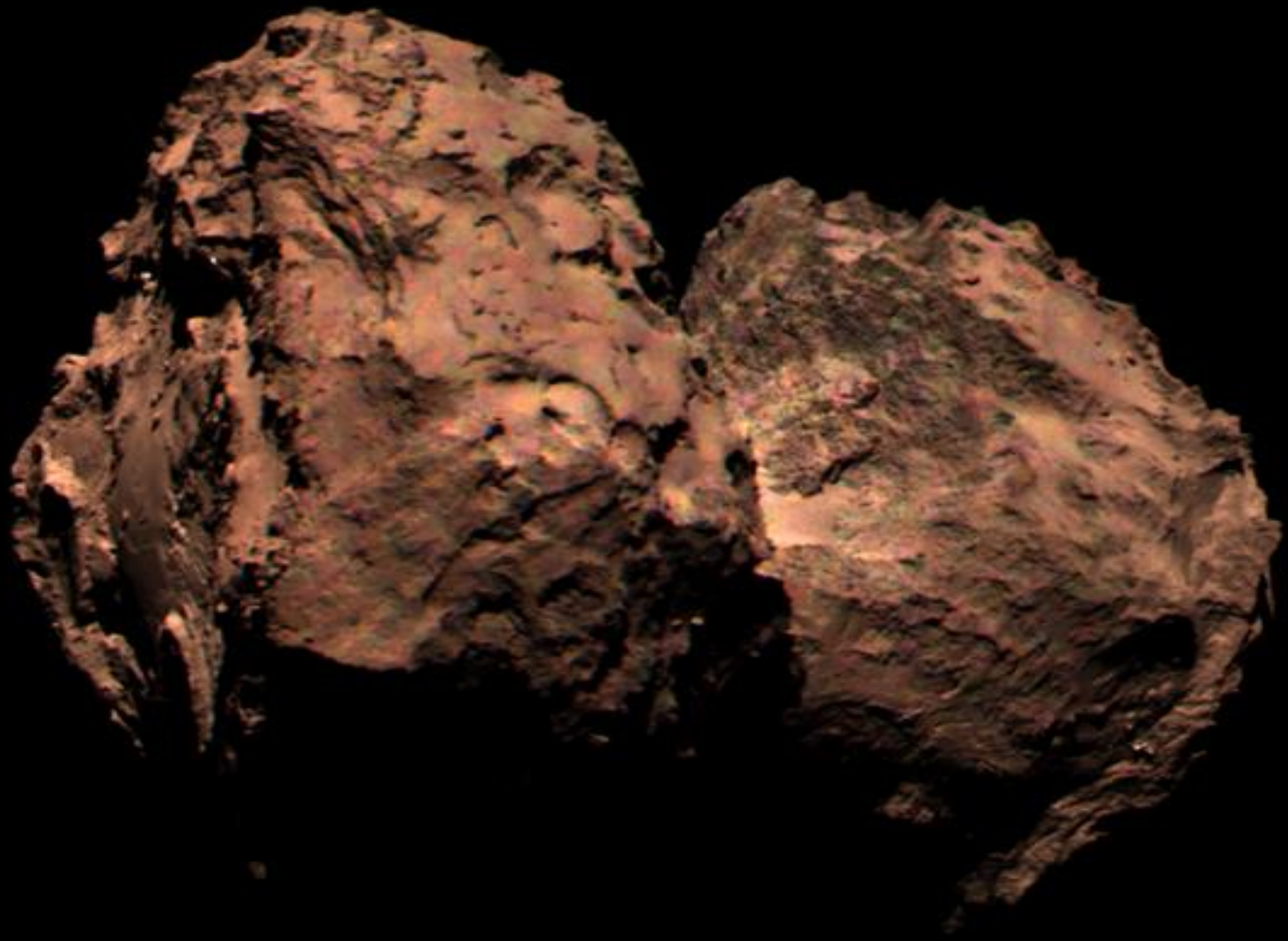




Best ground-based image (VLT, Aug. 11th 2014)

Rosetta image (NAVCAM, Aug. 22nd 2014)

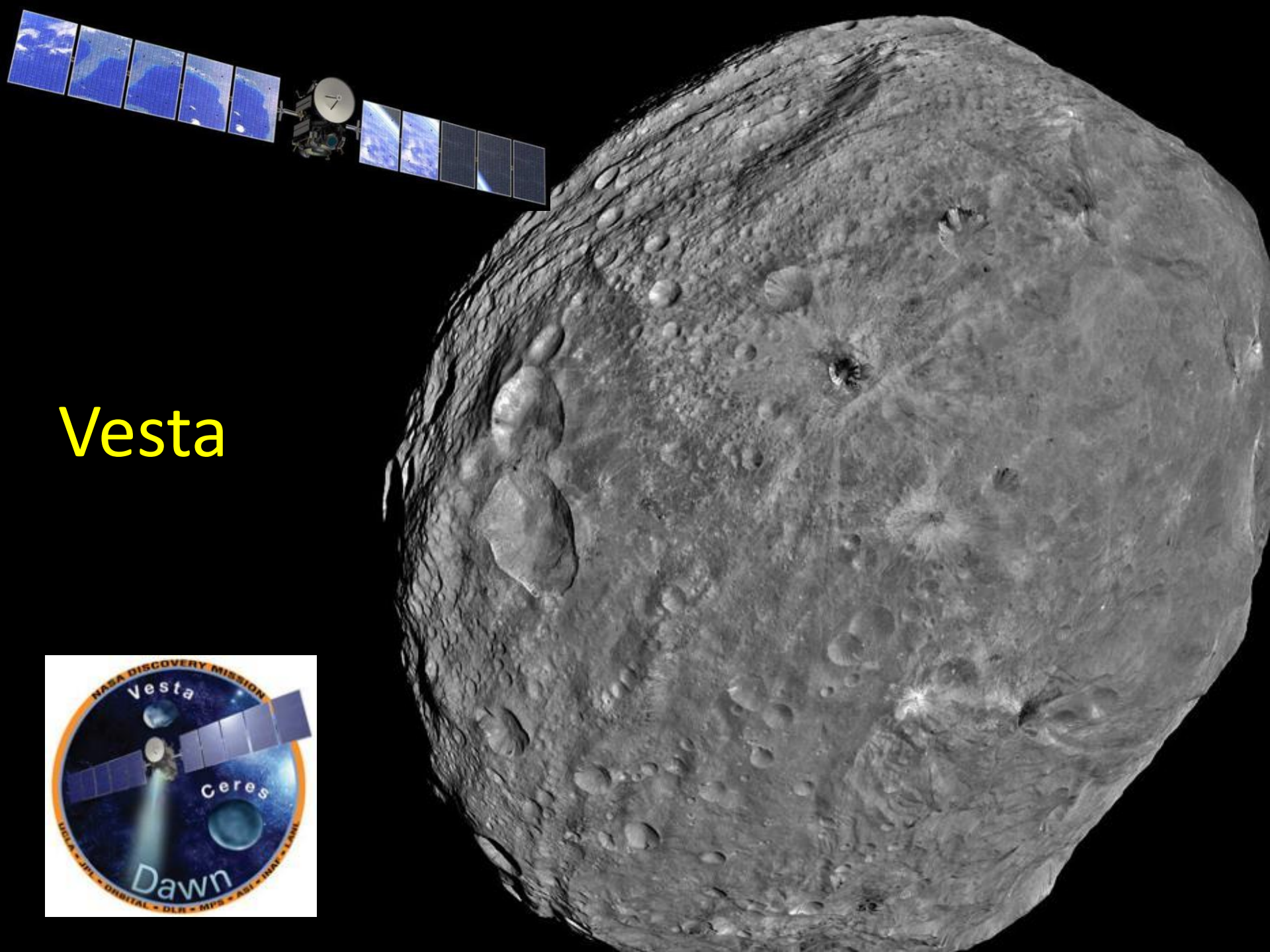
Rosetta’s true colours?



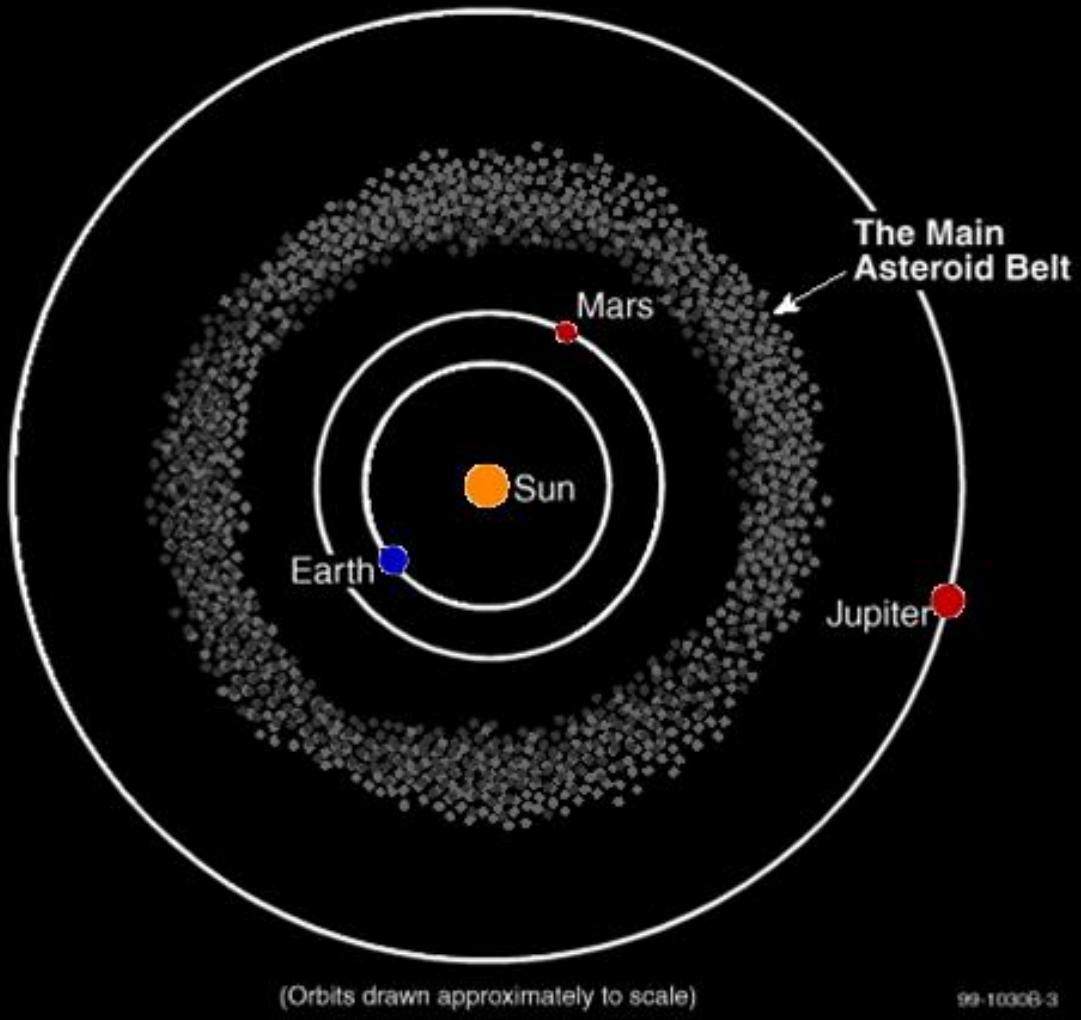
Asteroids

Rock, metal

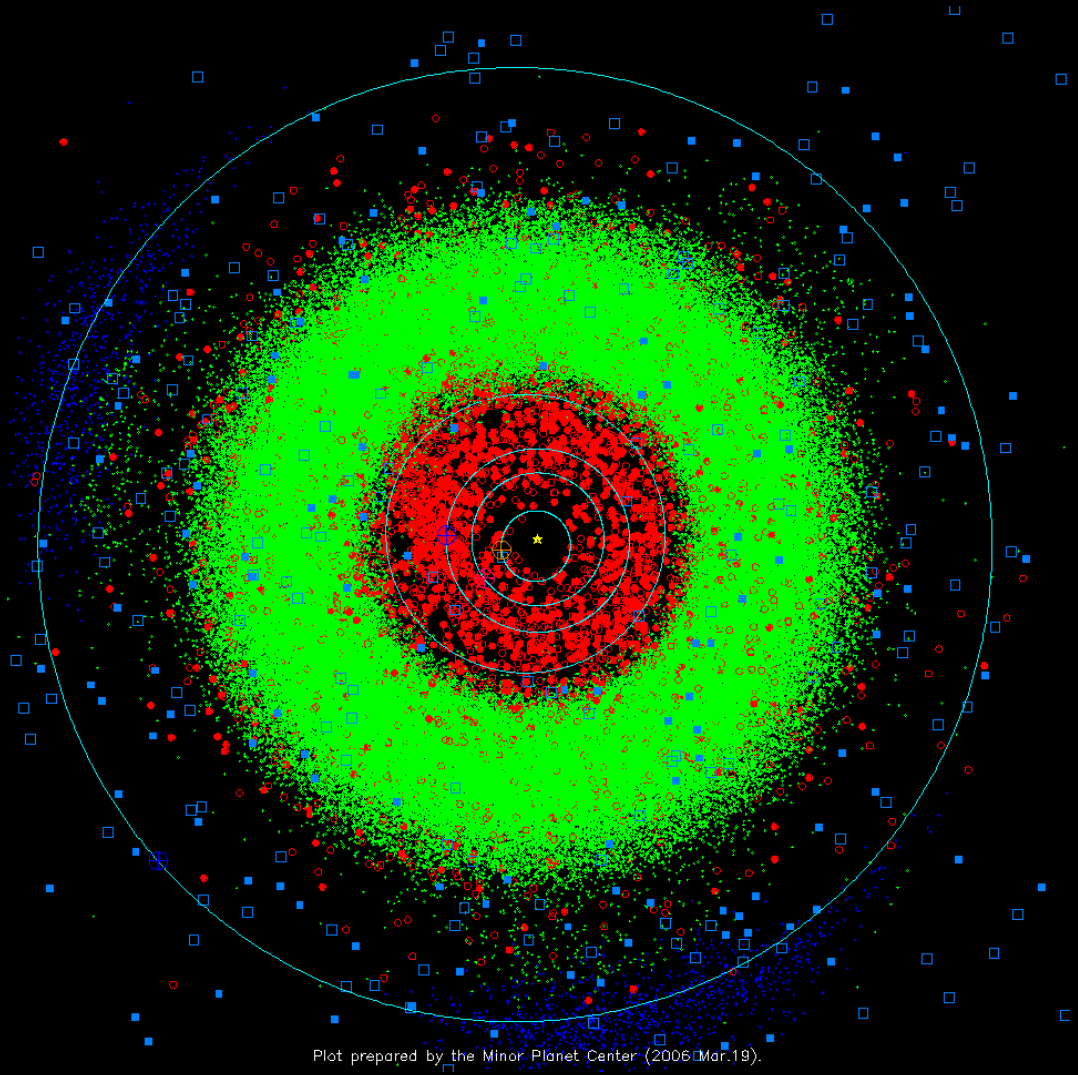
~95% live in Main Belt

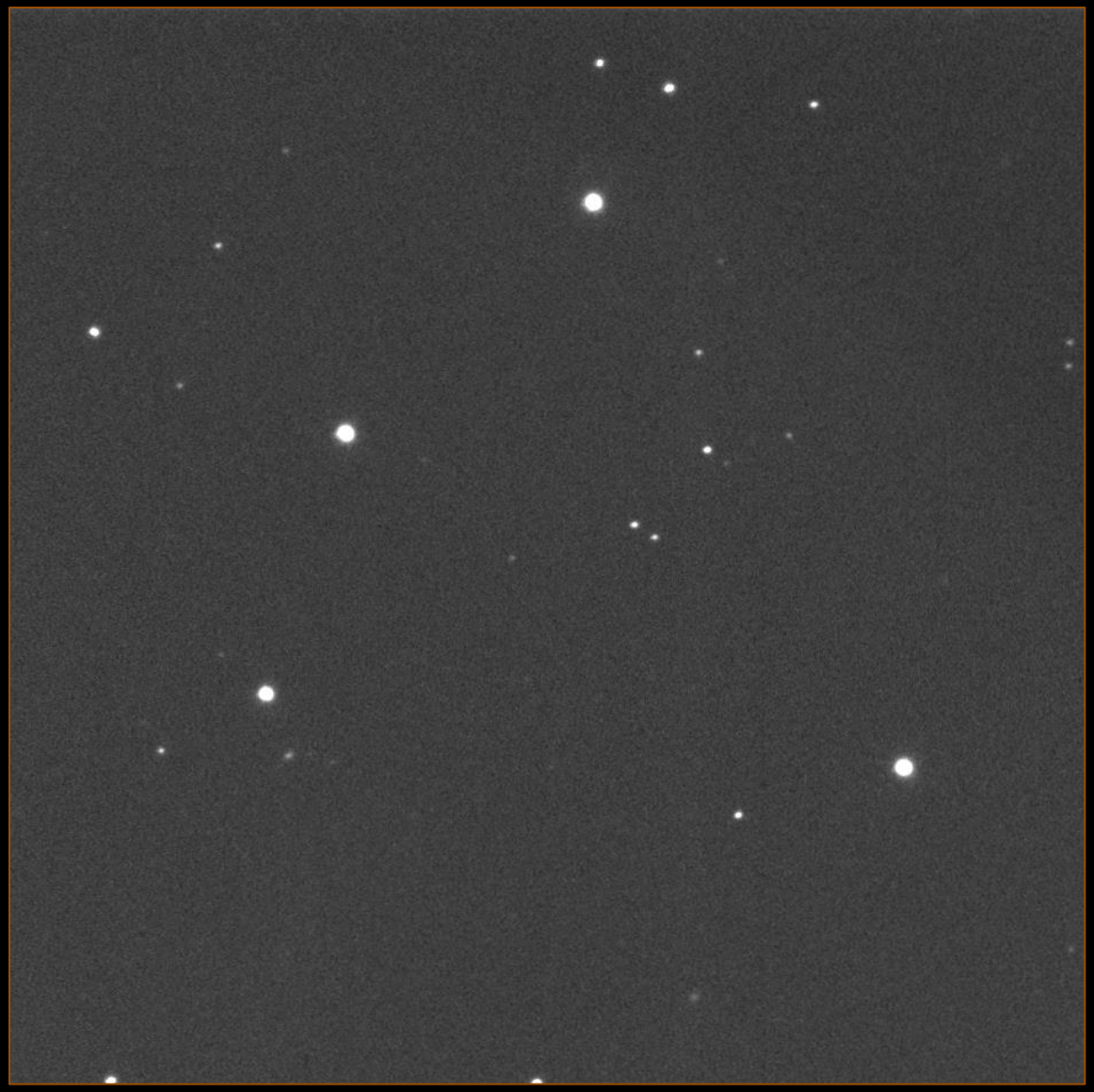

Vesta

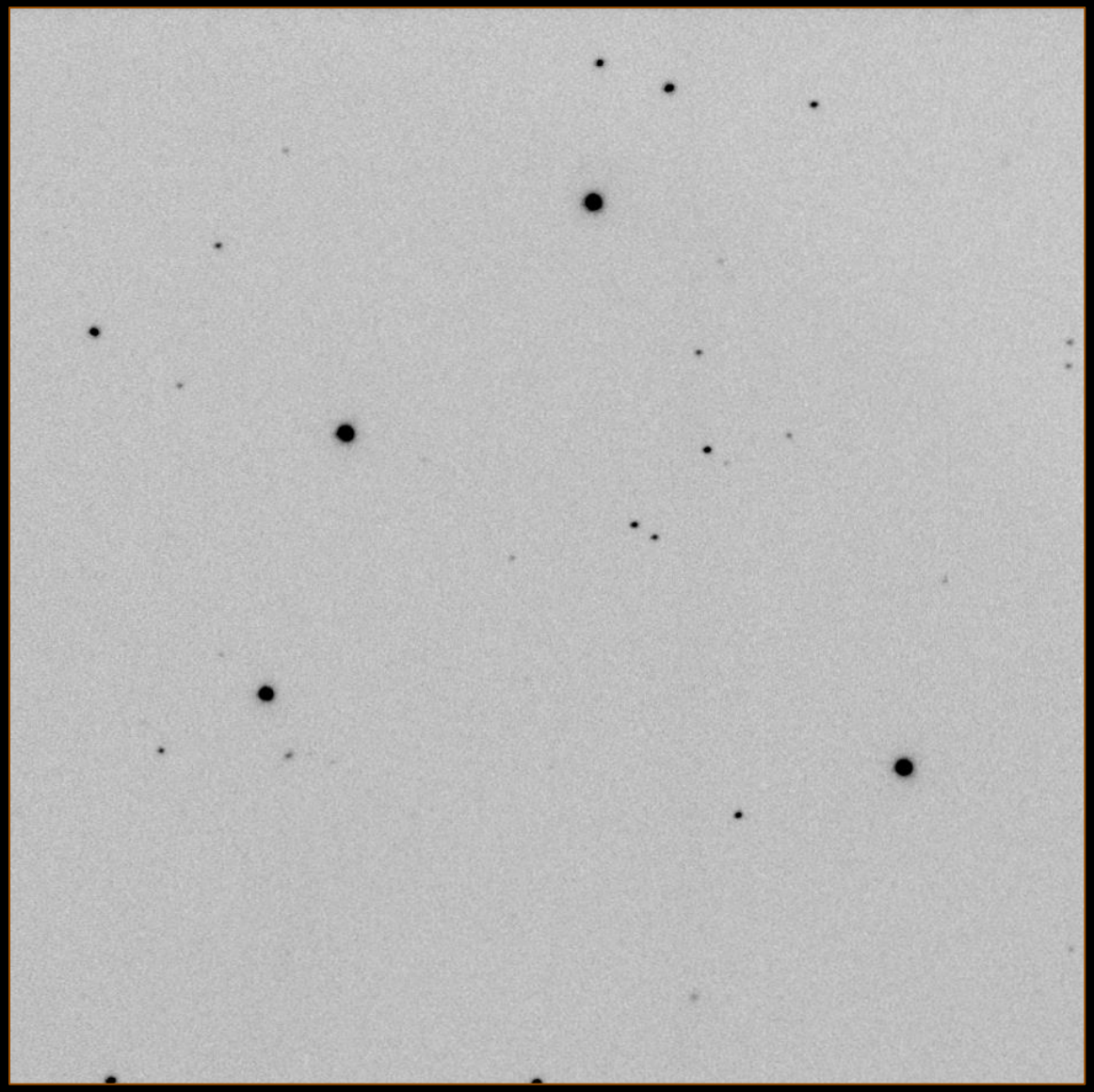
Where are the asteroids?

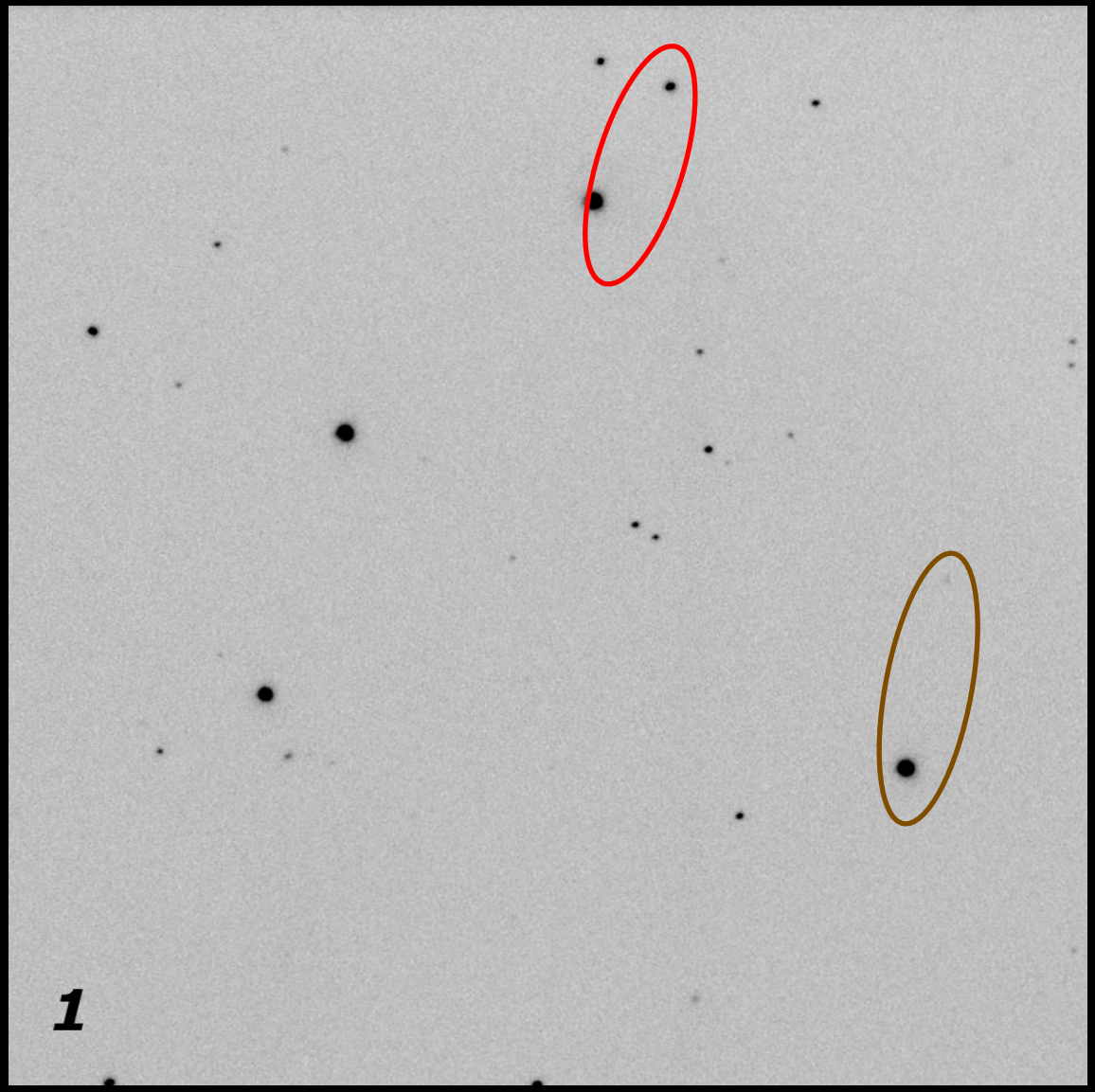


Where are the asteroids?





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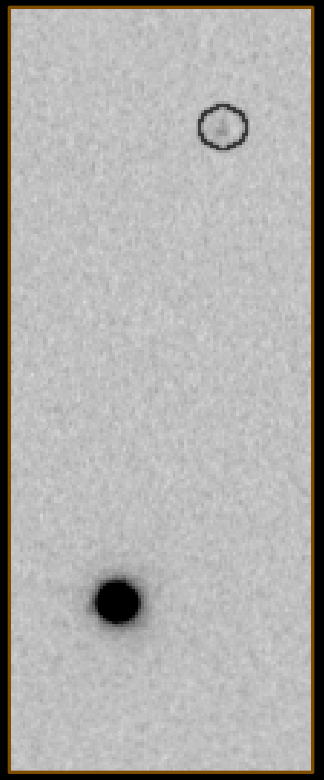
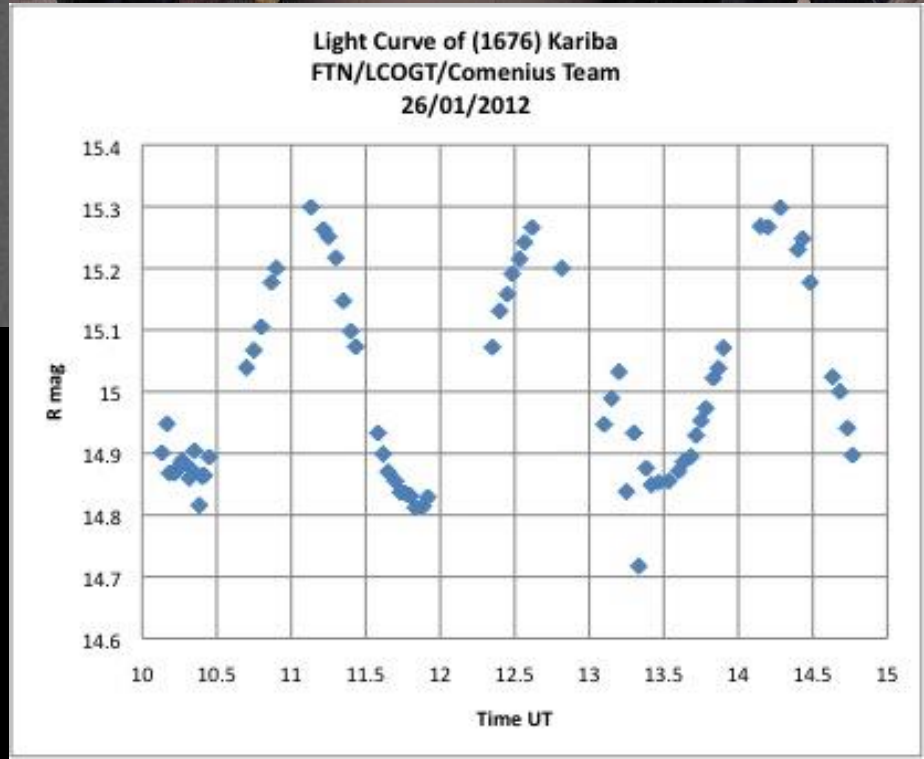
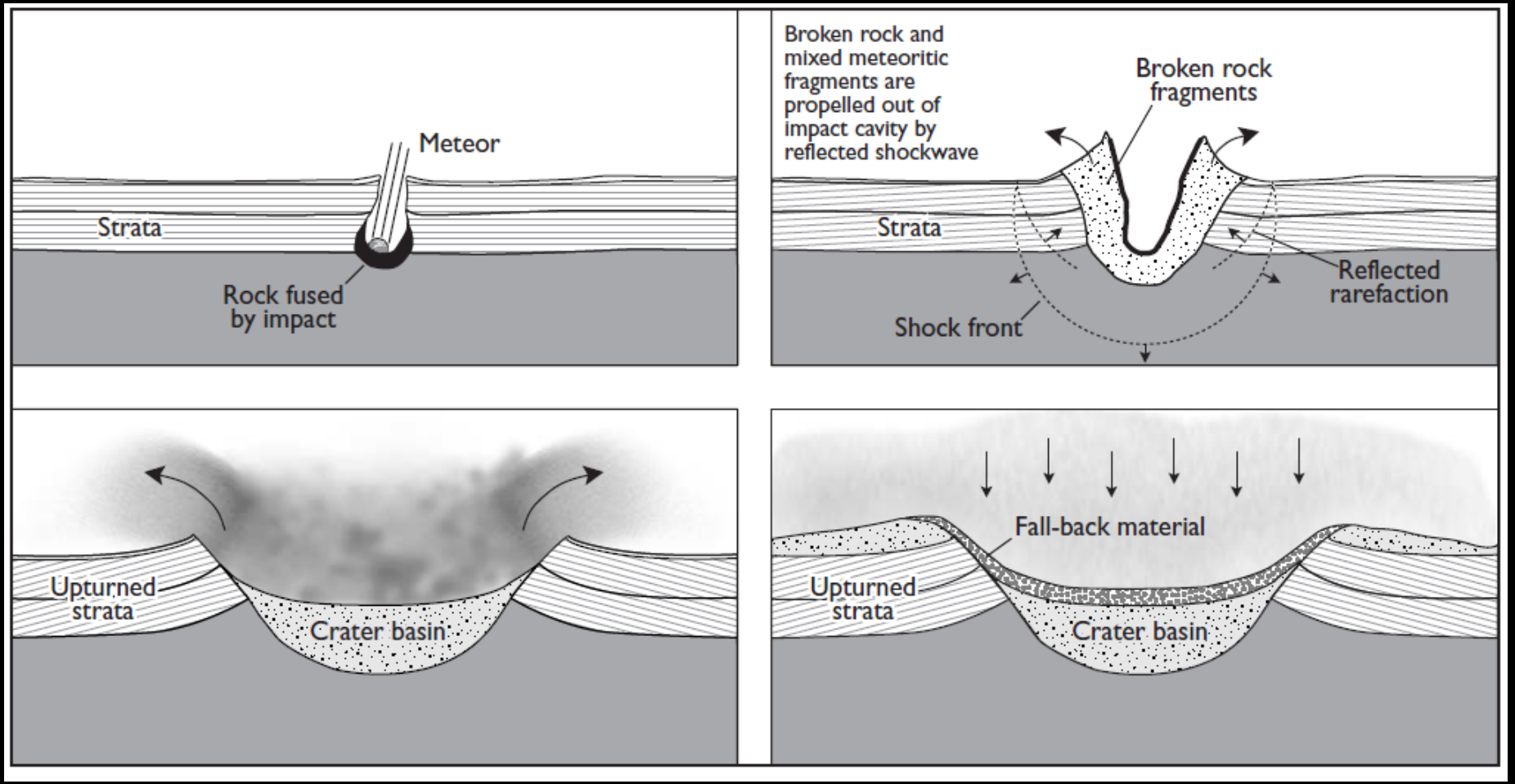


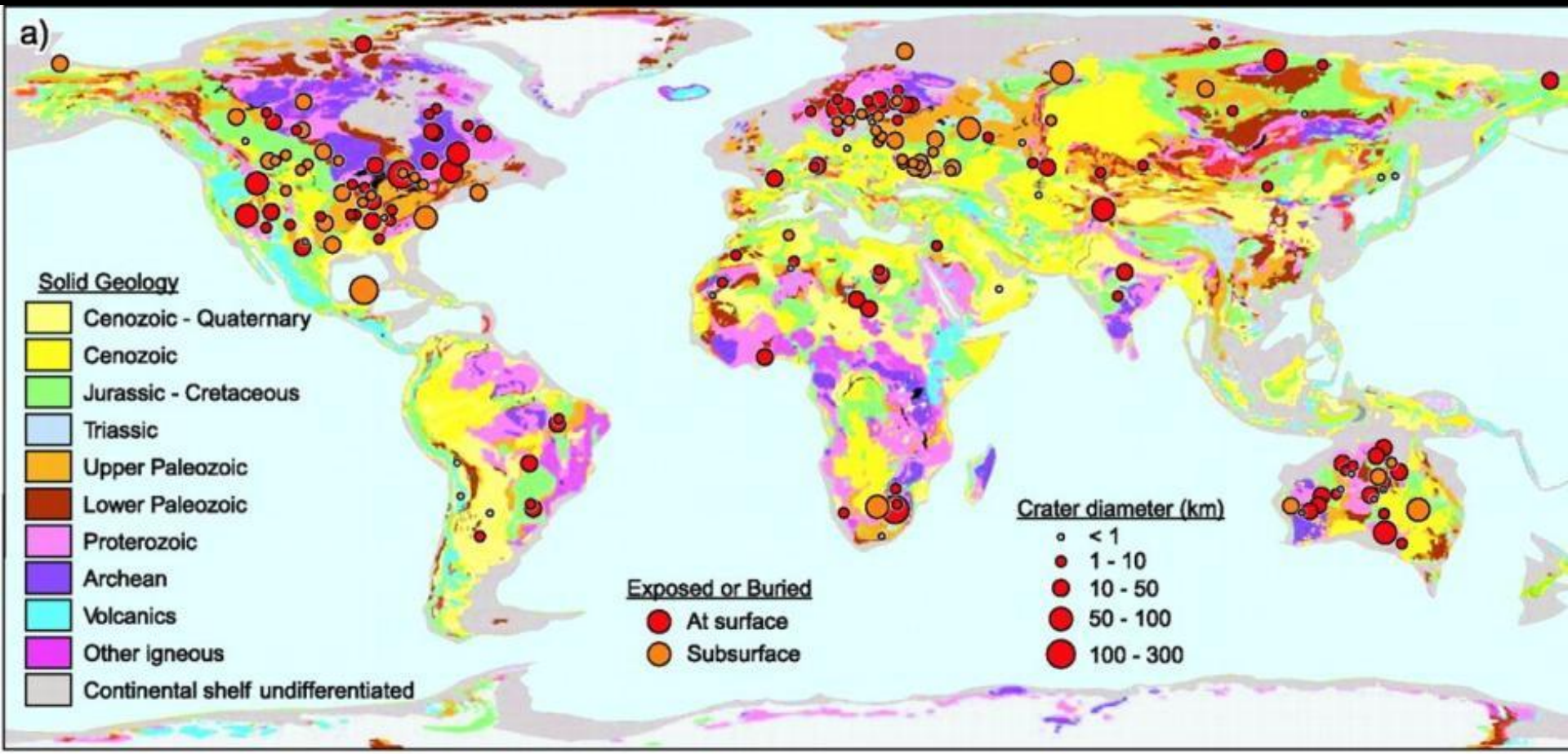
GTTP/EU-HOU teacher training



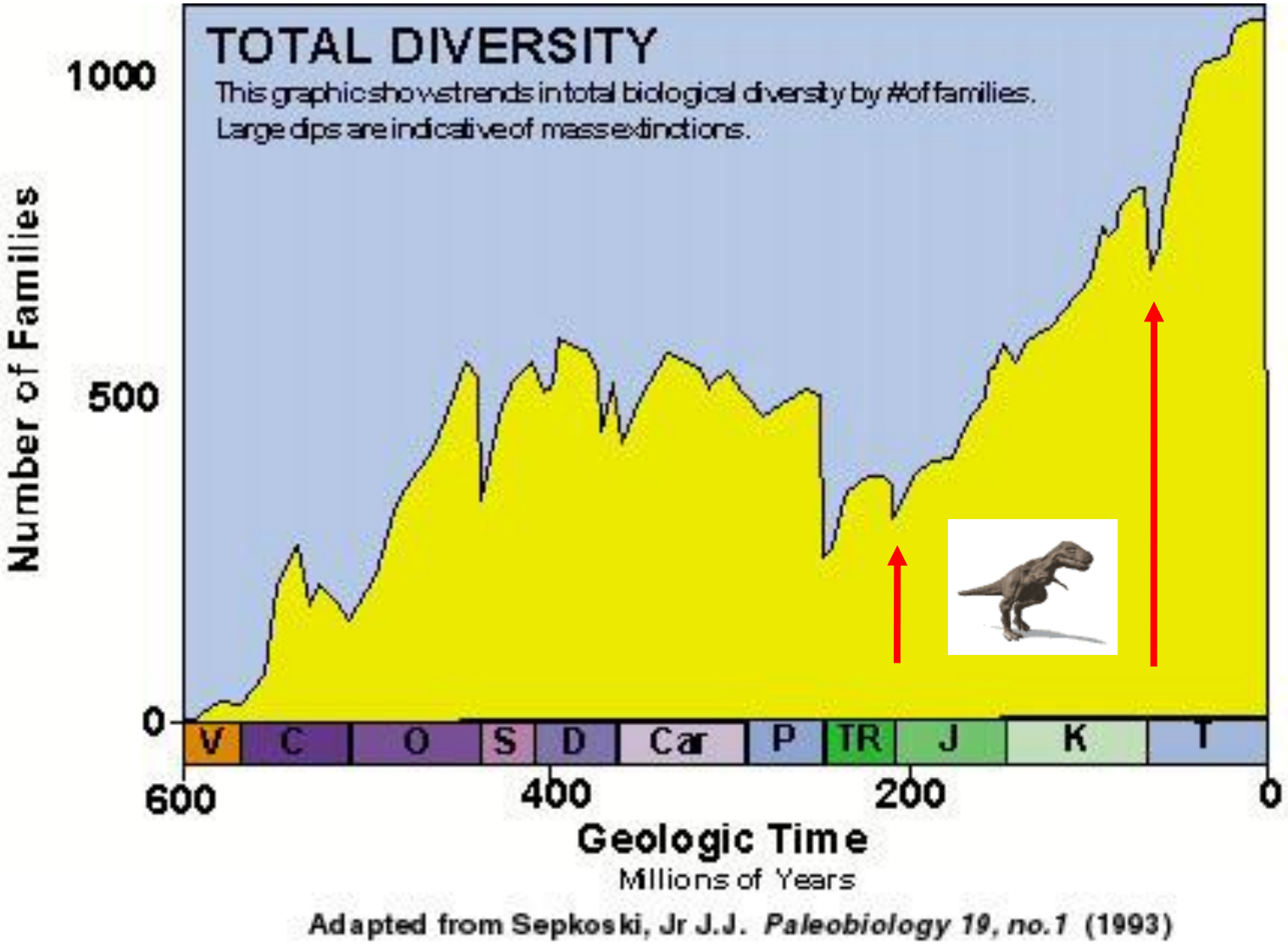
Crater Formation



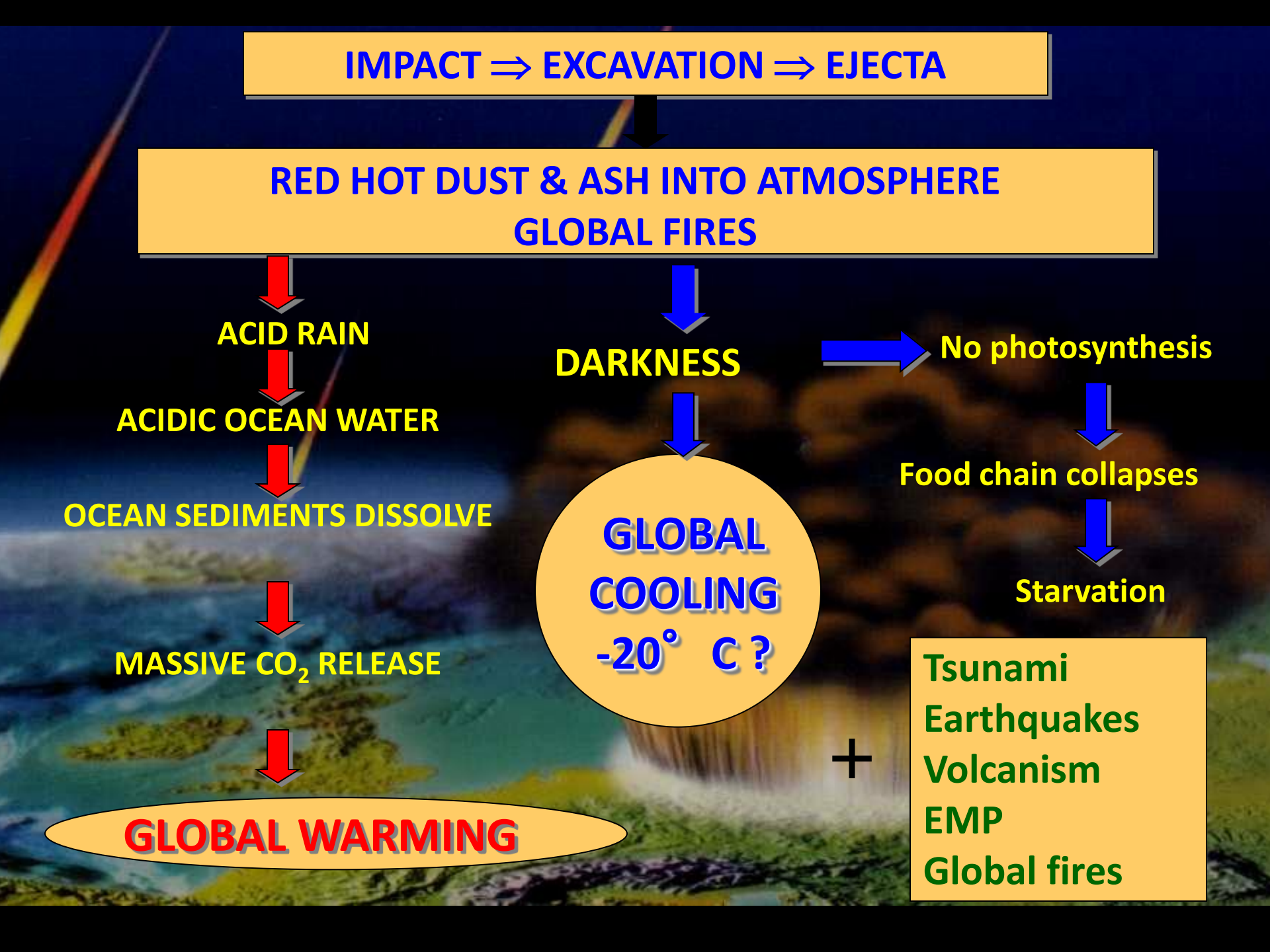
Craters on Earth



Mass Extinctions



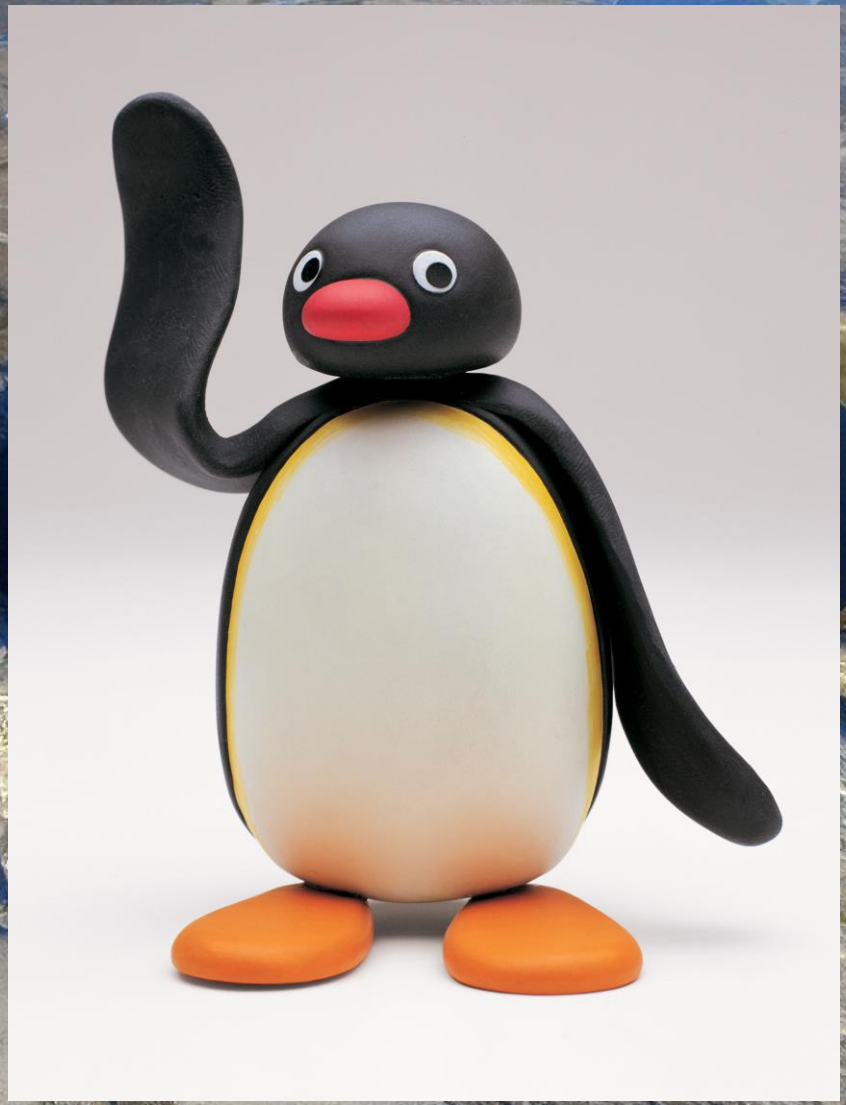
Adapted from Sepkoski, Jr J.J. *Paleobiology 19, no.1* (1993)


IMPACT ⇒ EXCAVATION ⇒ EJECTA
RED HOT DUST & ASH INTO ATMOSPHERE
GLOBAL FIRES
ACID RAIN
ACIDIC OCEAN WATER
OCEAN SEDIMENTS DISSOLVE
MASSIVE CO_2 RELEASE
GLOBAL WARMING
DARKNESS
GLOBAL COOLING -20° C ?
No photosynthesis
Food chain collapses
Starvation
+
Tsunami
Earthquakes
Volcanism
EMP
Global fires


Meteor Crater

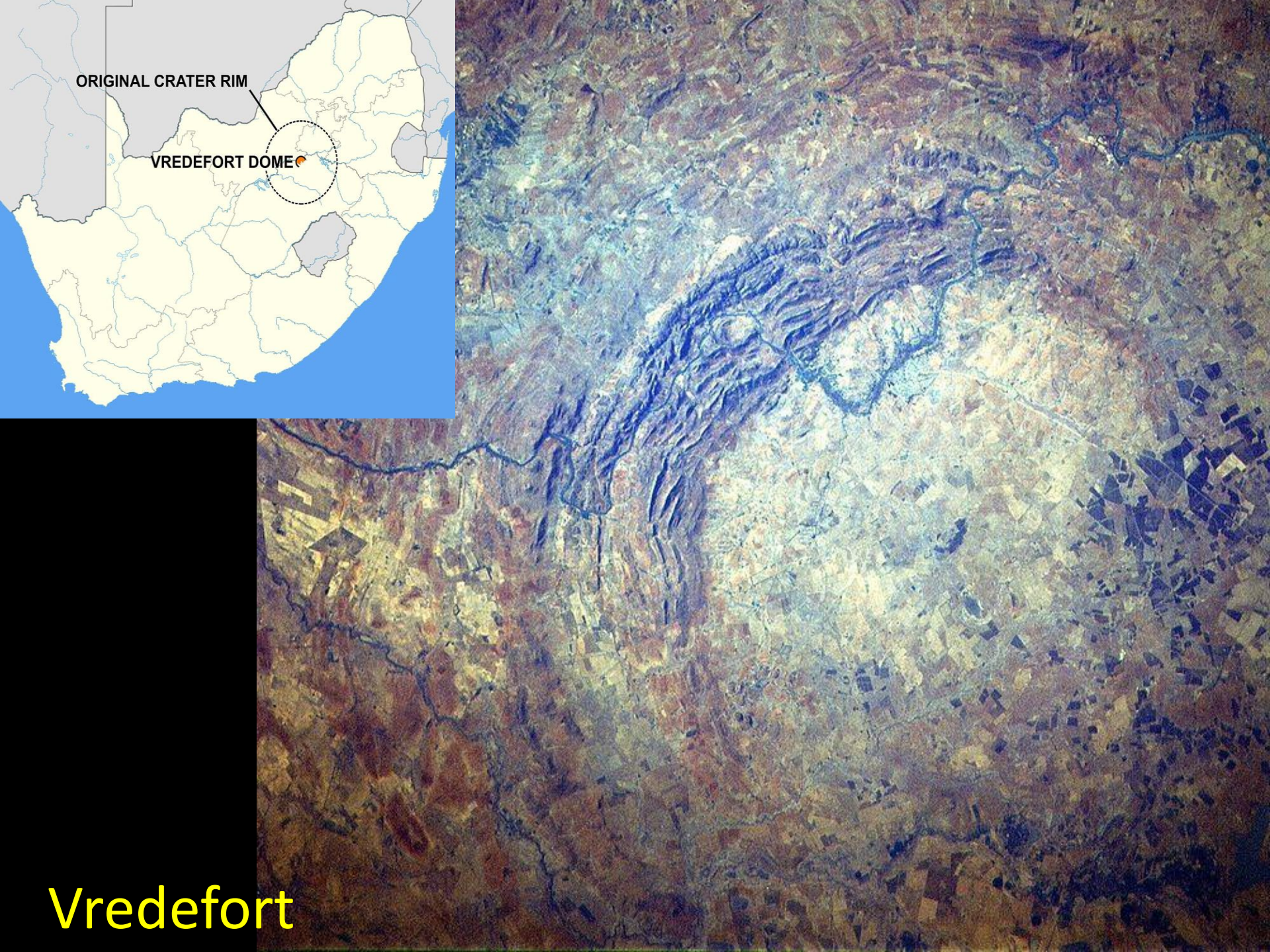
IR reveals **asymmetric** ejecta blanket at Meteor Crater


Pingualuit



Pingu

Manicouagan



Vredefort

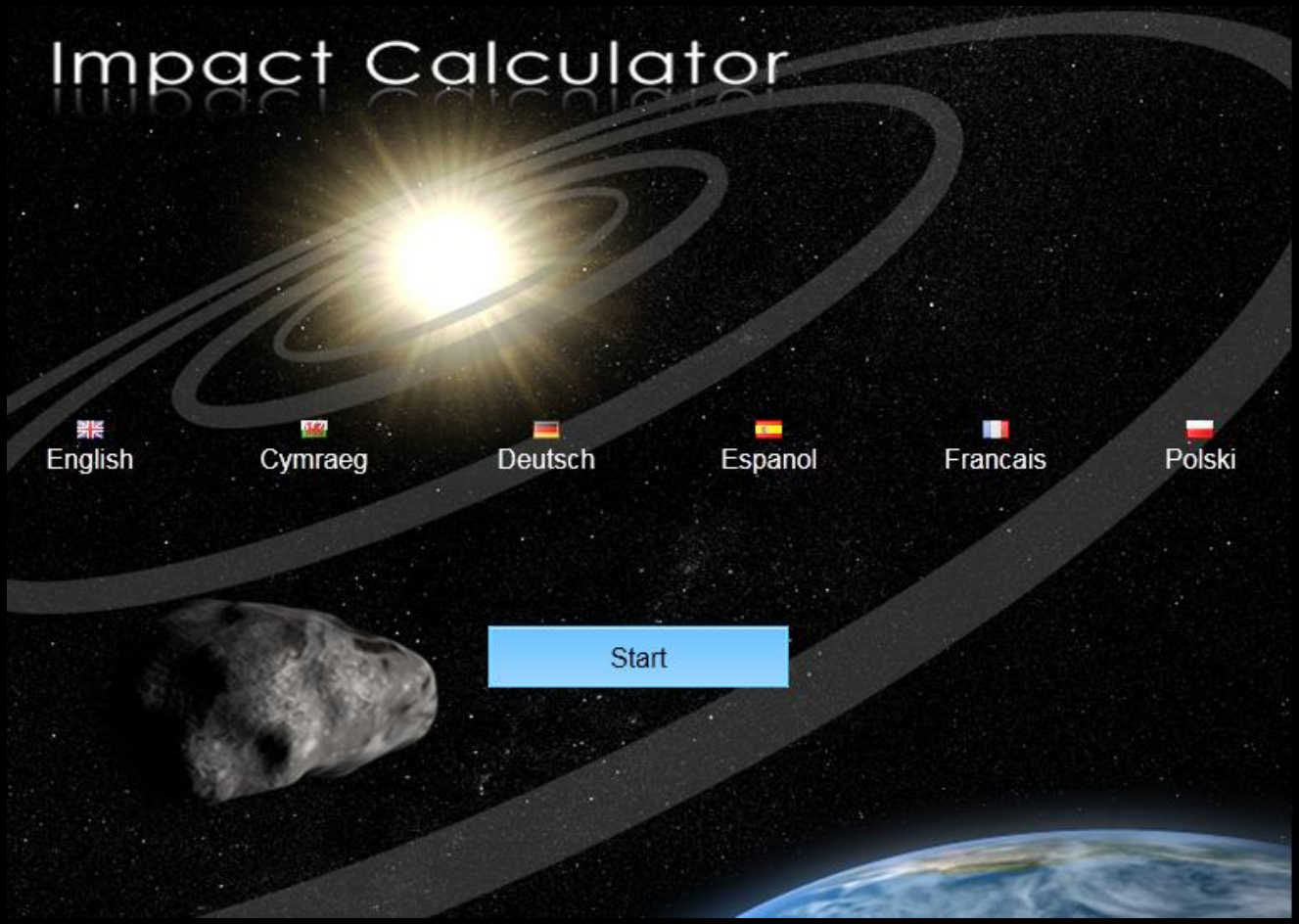
Simulating asteroid and comet impacts

Deep Impact…

- Use the science of impacts to help teach STEM subjects, e.g.
  - Kinetic energy, gravity, orbits
  - Impacts, crater formation
  - Mass extinctions, life (death!) on Earth
  - Planetary formation

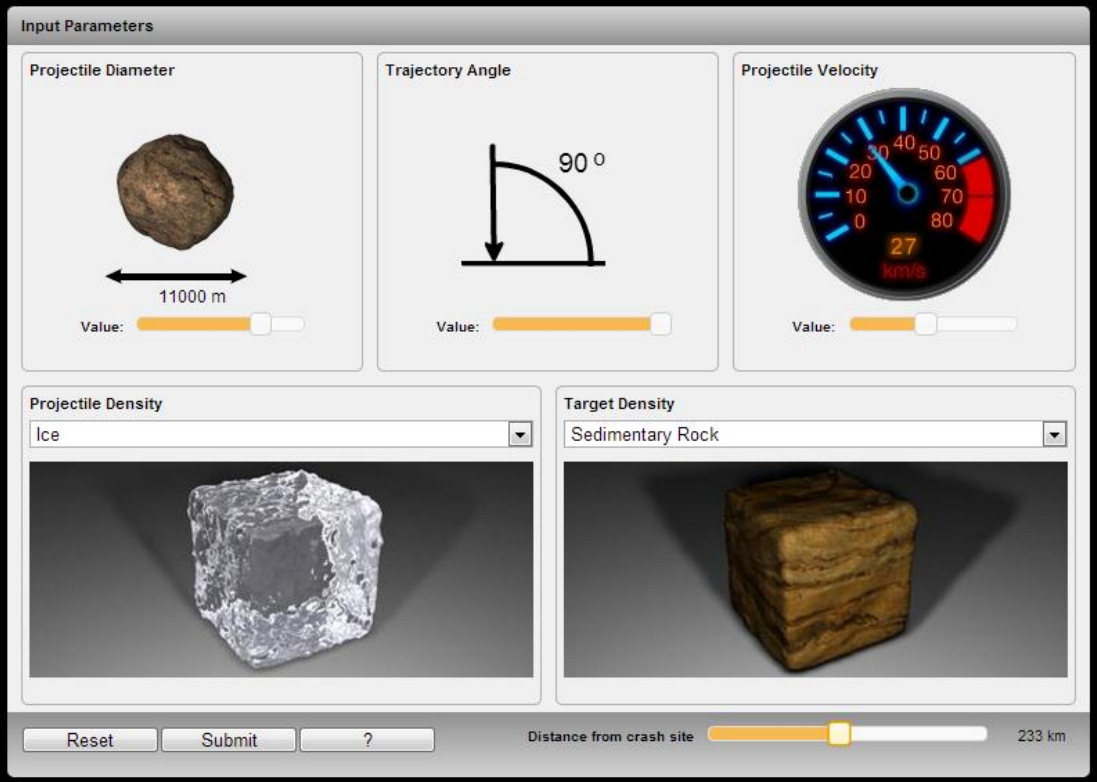
- **Ages 9** to **undergrad**, **adult education**
- **Funding for:**
  - Website development
  - Teacher training
  - Loan box production
  - Booklet
  - Talks, demos, outreach

Soon: Portuguese, Greek, Romanian



http://education.down2earth.eu

- Research code by Gareth Collins (Imperial) & Jay Melosh (Purdue)
- Graphical user interface – student-friendly, multi-lingual
- Real physics



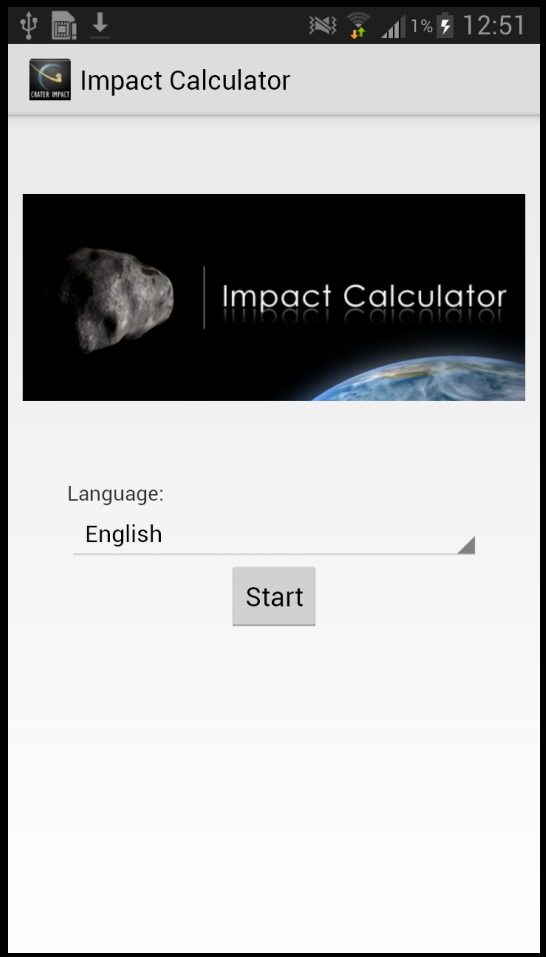
Let's blow things up…!

- Log on to the "new" Impact Calculator
- Play with the simulator, then try some of the worksheet activities

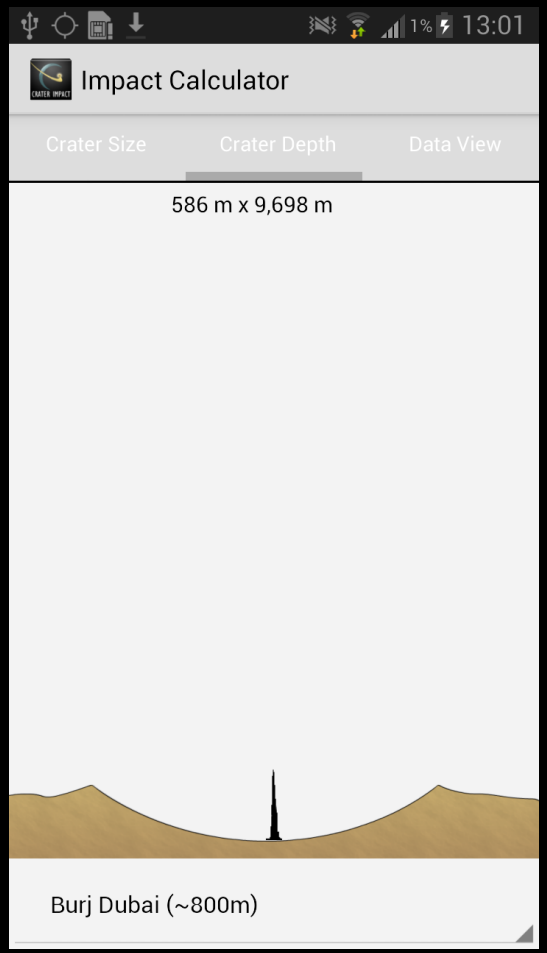
Note: you will need IE 9, Chrome, Firefox, Opera or Safari as new version runs html5

http://education.down2earth.eu

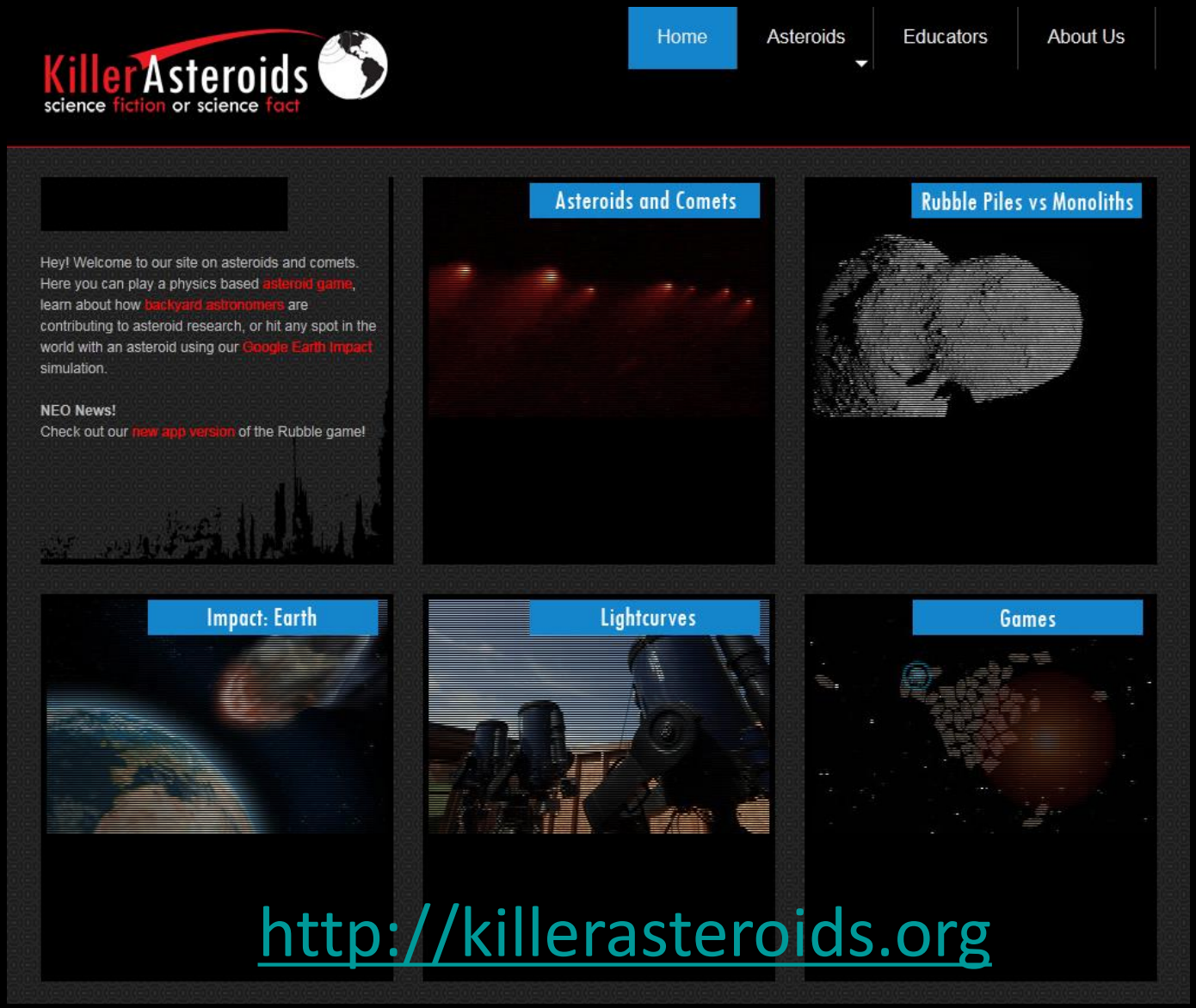
Android app


12:51
Impact Calculator
Impact Calculator
Language:
English
Start

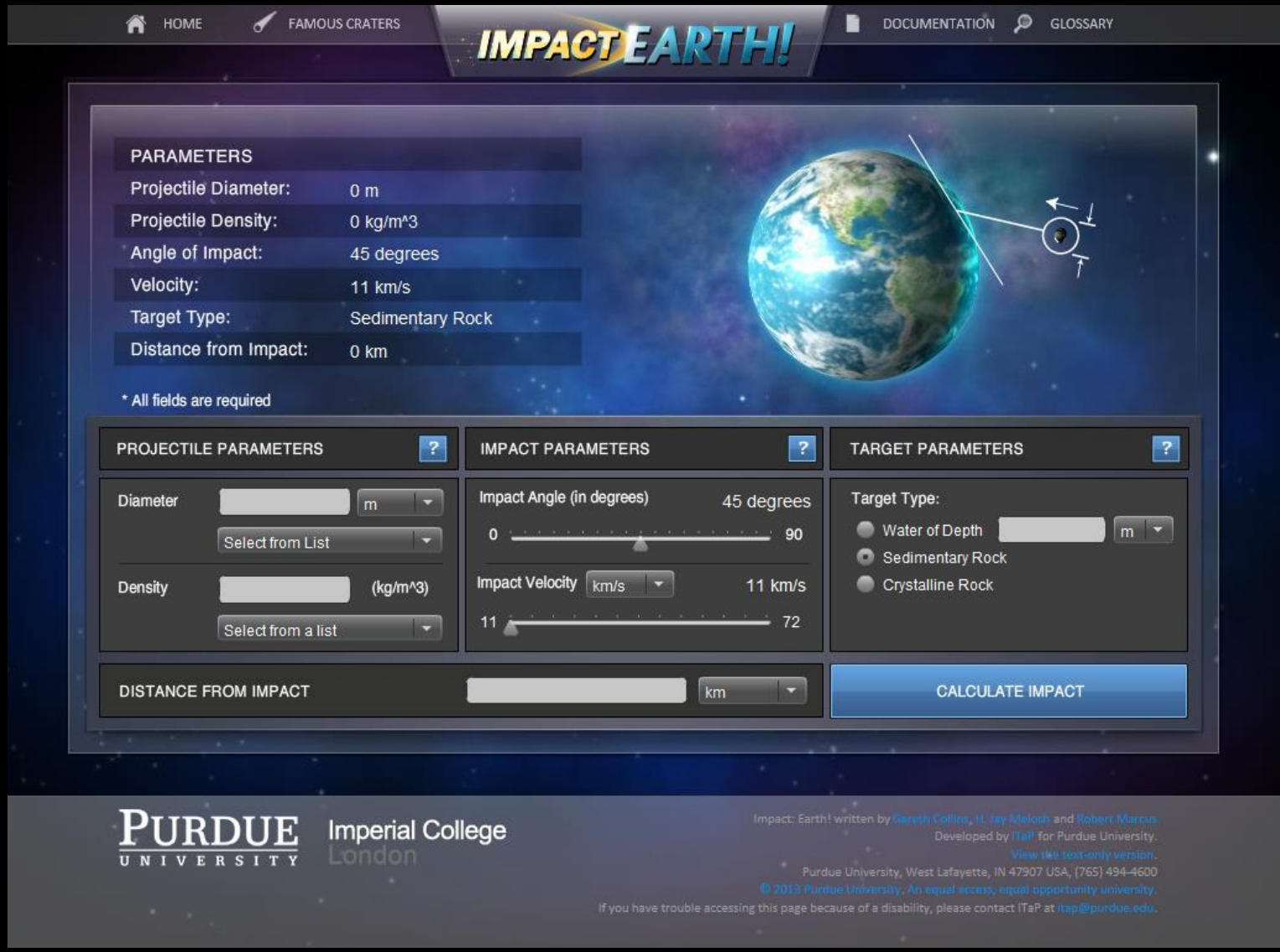

12:51
Asteroid Diameter
15000m
Submit


13:01
Impact Calculator
Crater Size
Crater Depth
Data View
586 m x 9,698 m
Burj Dubai (~800m)

Other impact websites



http://killerasteroids.org



http://www.purdue.edu/impactearth

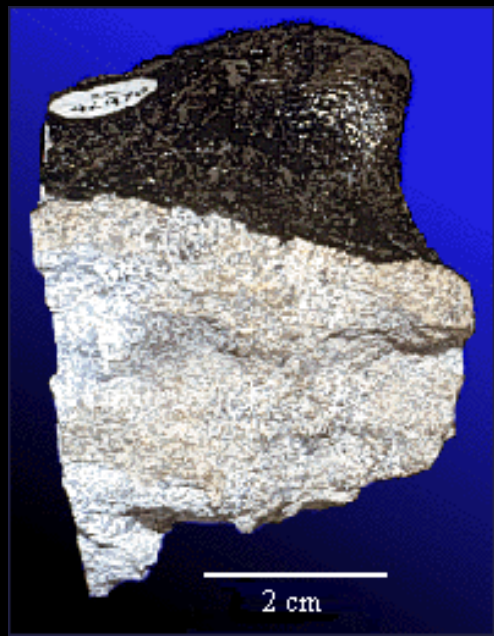
Meteorites in the classroom

Excellent “wow” factor!

UK: free loans to schools

Different types of box containing meteorites, terrestrial rocks, dinosaur fossils & resources

Meteorites



Main types of meteorites

Stones

Chondrules

“Chondrites”

Main types of meteorites

Irons

Mix of **Iron** and **Nickel**

Main types of meteorites

Stony-Irons

Mix of **Iron** and **Olivine** crystals

Cosmic comics

Comic strip cartoon about teenagers interested in astronomy and space

Asteroid hunting with the Faulkes Telescopes…

http://www.planet-science.com/categories/extras/cosmic-comics/

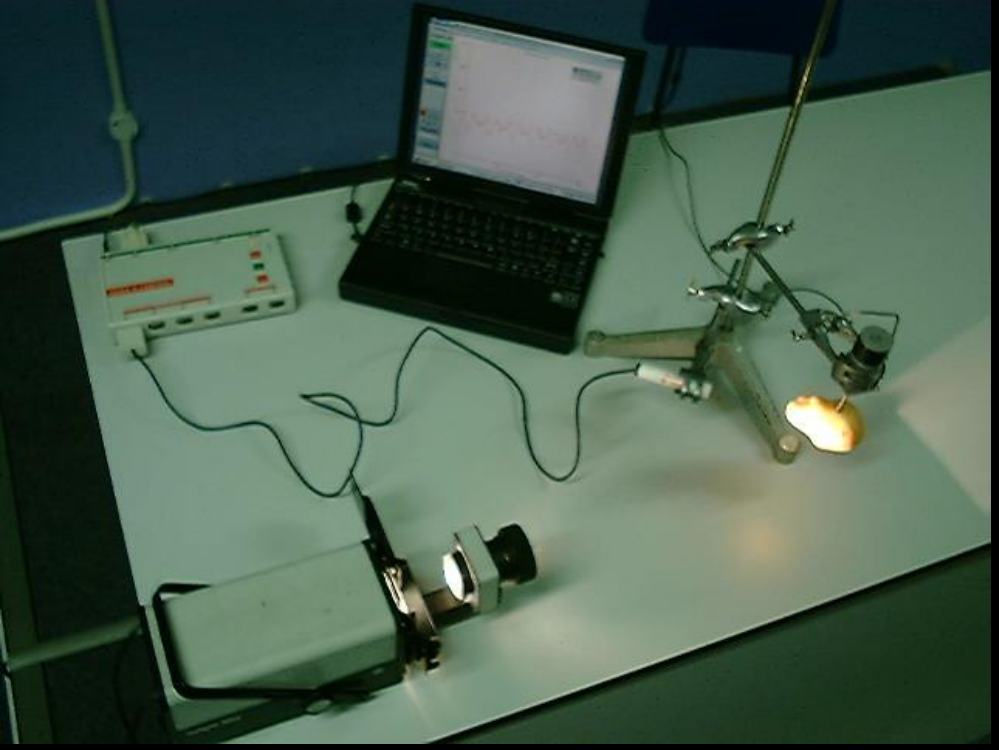
Maths: what is an asteroid worth?

Near Earth Asteroid **1986DA**

2km Iron-Nickel (~8% Ni)

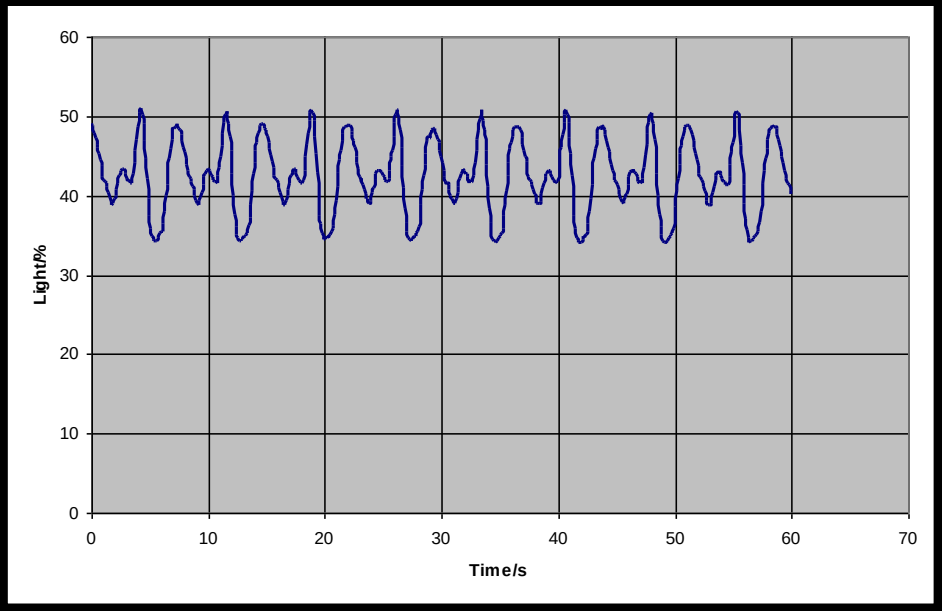
Assume spherical

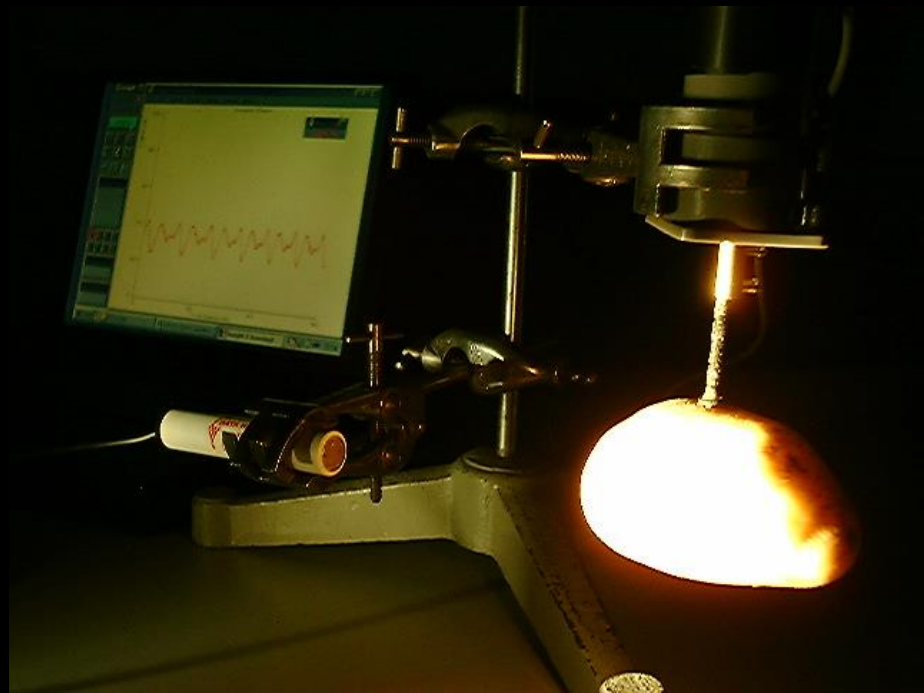
Metal:	Quantity:	Value (01/10):
Gold	10^7 kg	$0.4 trillion
Iron	10^{13} kg	$2.2 trillion
Platinum	10^8 kg	$5.5 trillion
Nickel	10^{12} kg	$17.6 trillion
Total		**$25.7 trillion**



“The Rotato”

Classroom simulation of asteroid rotation





Other subjects?

- Effects of impacts on life on Earth – mass extinctions
- Global climate change – massive effects on ocean and atmospheric chemistry

Coming (very!) soon

- Extension of impact simulator to Moon and Mars

- Compare effects of different **g**, different **atmospheric compositions**

education.down2earth.eu

paul.roche@faulkes-telescope.com


“Real time, real science, real scientists”

Practical session 12

Faulkes Telescope Project

Prof. Paul Roche
Sophie Bartlett
Univ. of South Wales

Overview

Deep space - FT observations

Deep impact - Down2Earth

- Faulkes Telescope Project
- Professional & Amateur astronomers
- STEM educators – EU collaborations
- European Space Agency

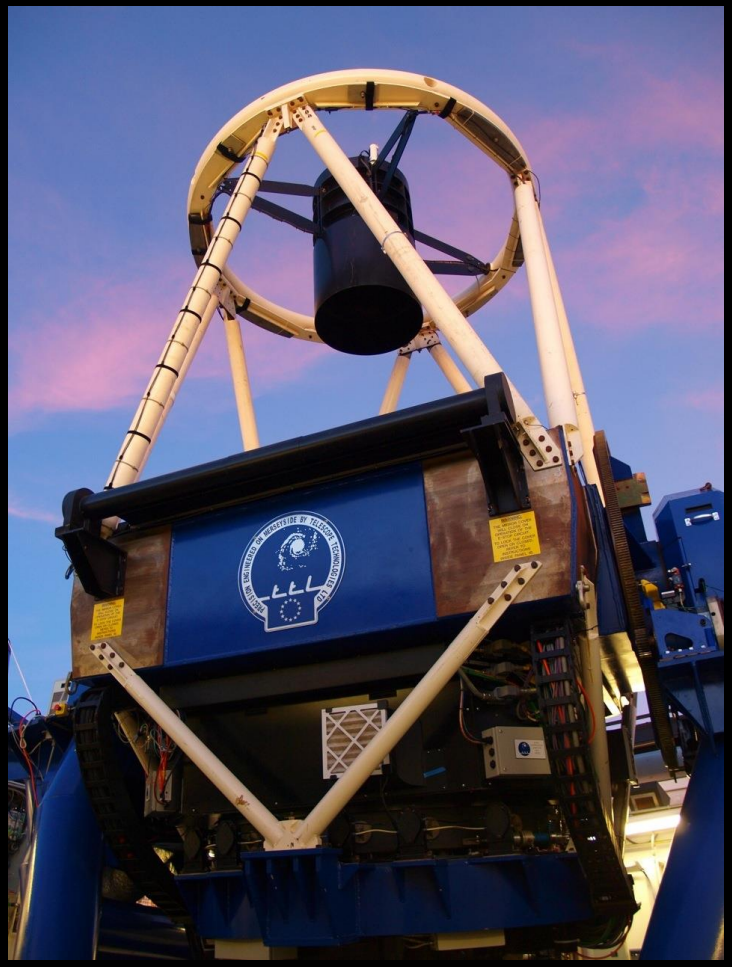
Faulkes Telescope Project

Observing the Universe from the classroom

Faulkes Telescope Project

- Free access to **2m**, **1m** and **0.4m** telescopes around the world

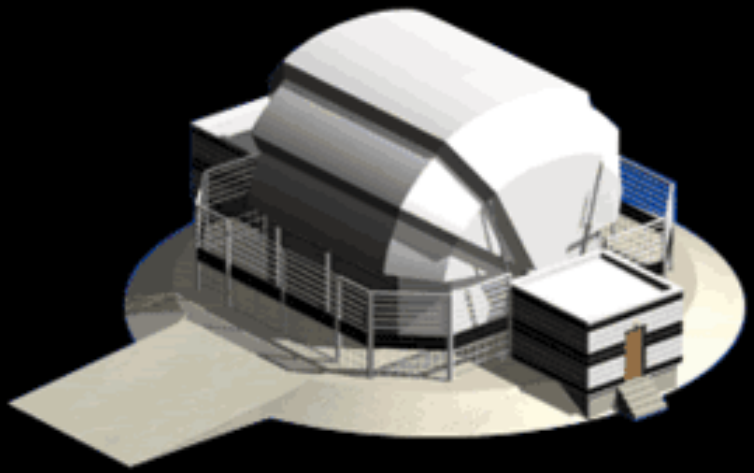
- Participate in real research projects

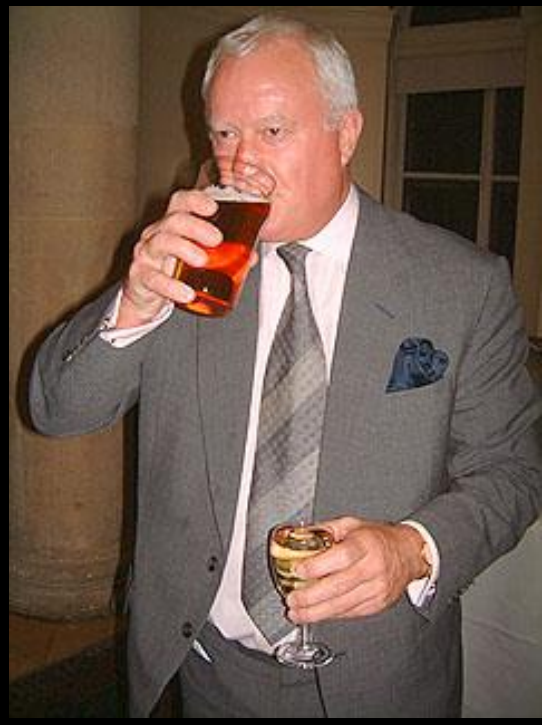


www.faulkes-telescope.com

Faulkes Telescopes

FTN started operations March 2004





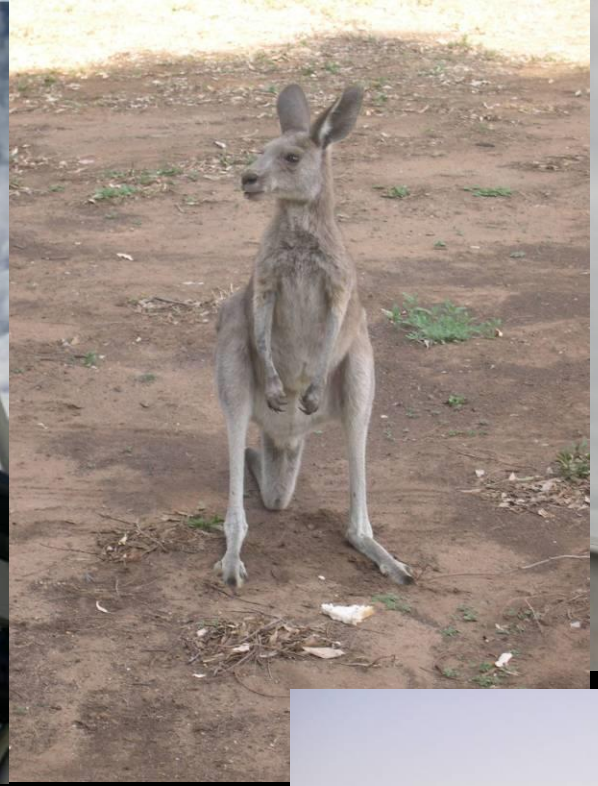
~£10M	Dill Faulkes Educational Trust
~£1M	STFC (UK Research Council)
~£0.6M	Government (Education)

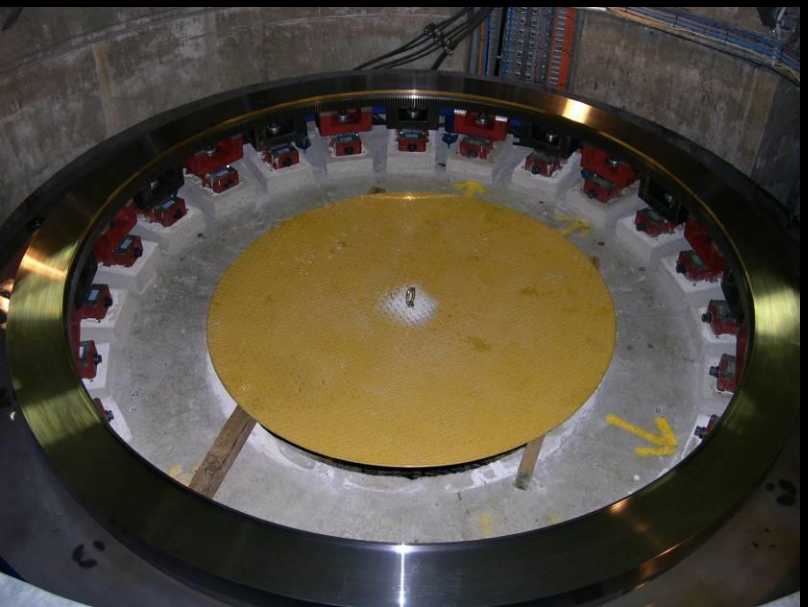
FAULKES TELESCOPE


FTN
The Faulkes Telescope
Haleakala, Maui

FTS

Siding Spring, Australia





Las Cumbres Observatory Global Telescope

FTN + FTS + additional telescopes:

Education - 6 clusters of **0.4m**

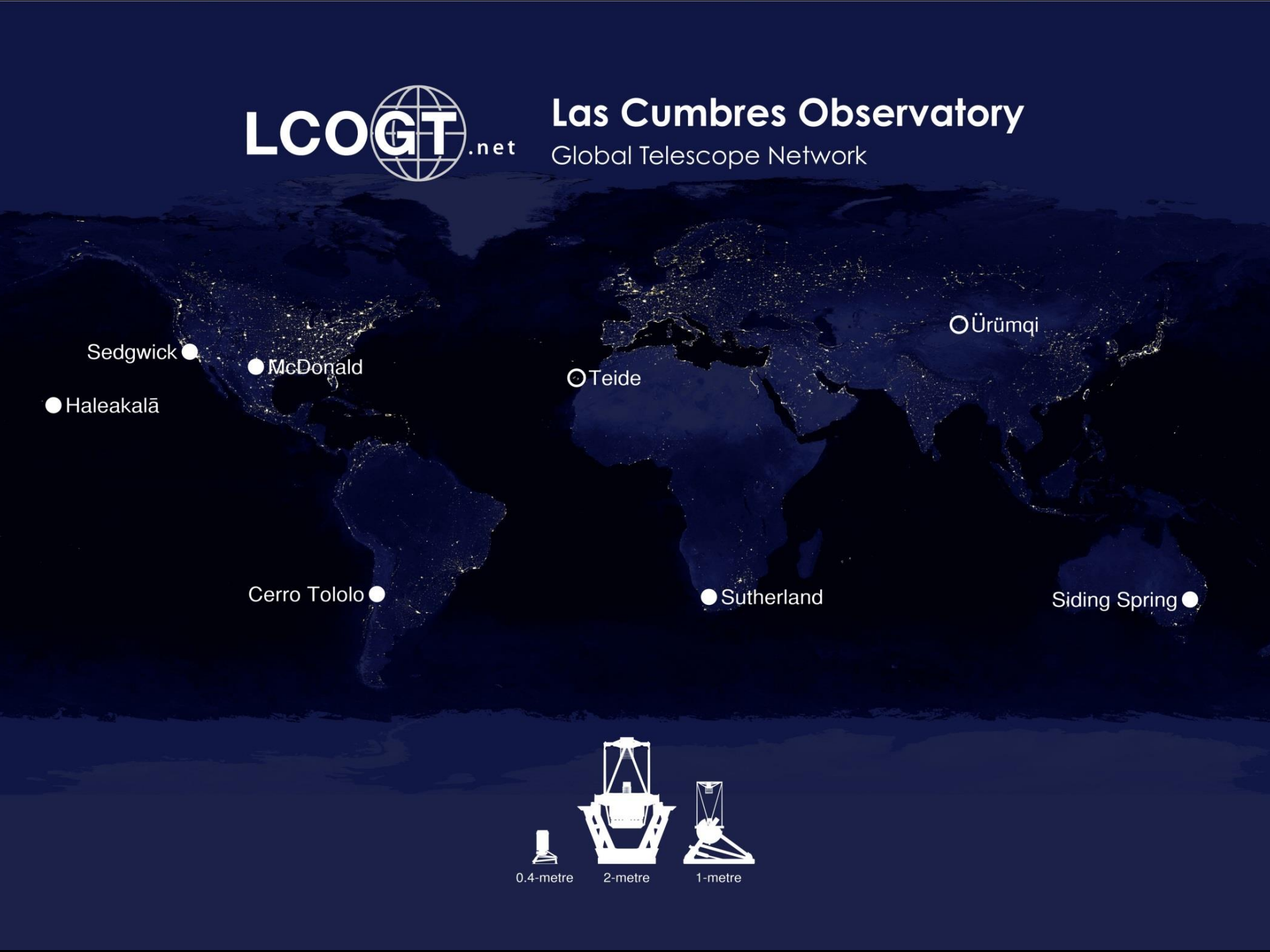
Research - 6 clusters of **1.0m**

~$100 million programme

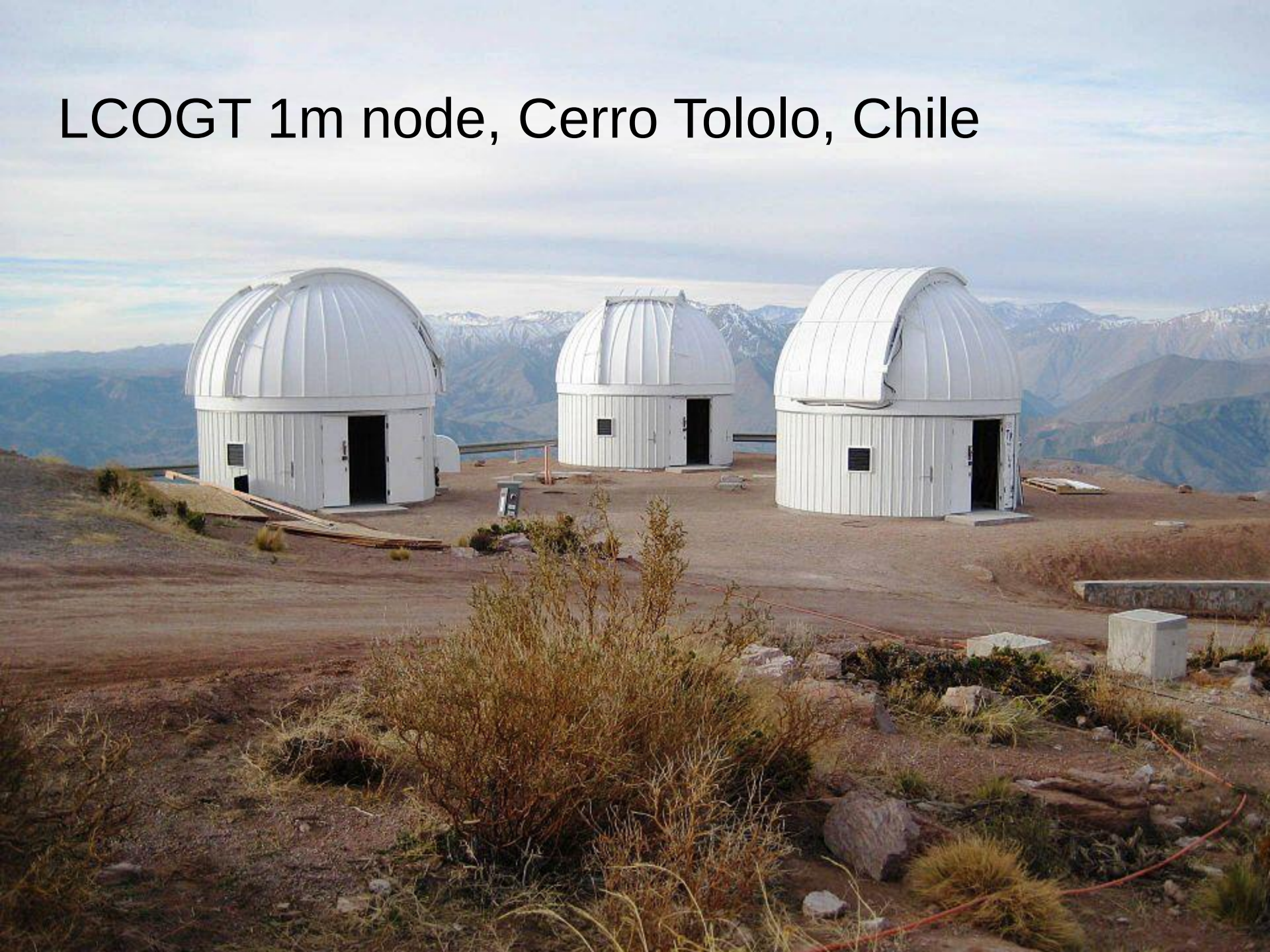
Wayne Rosing

LCOGT.net

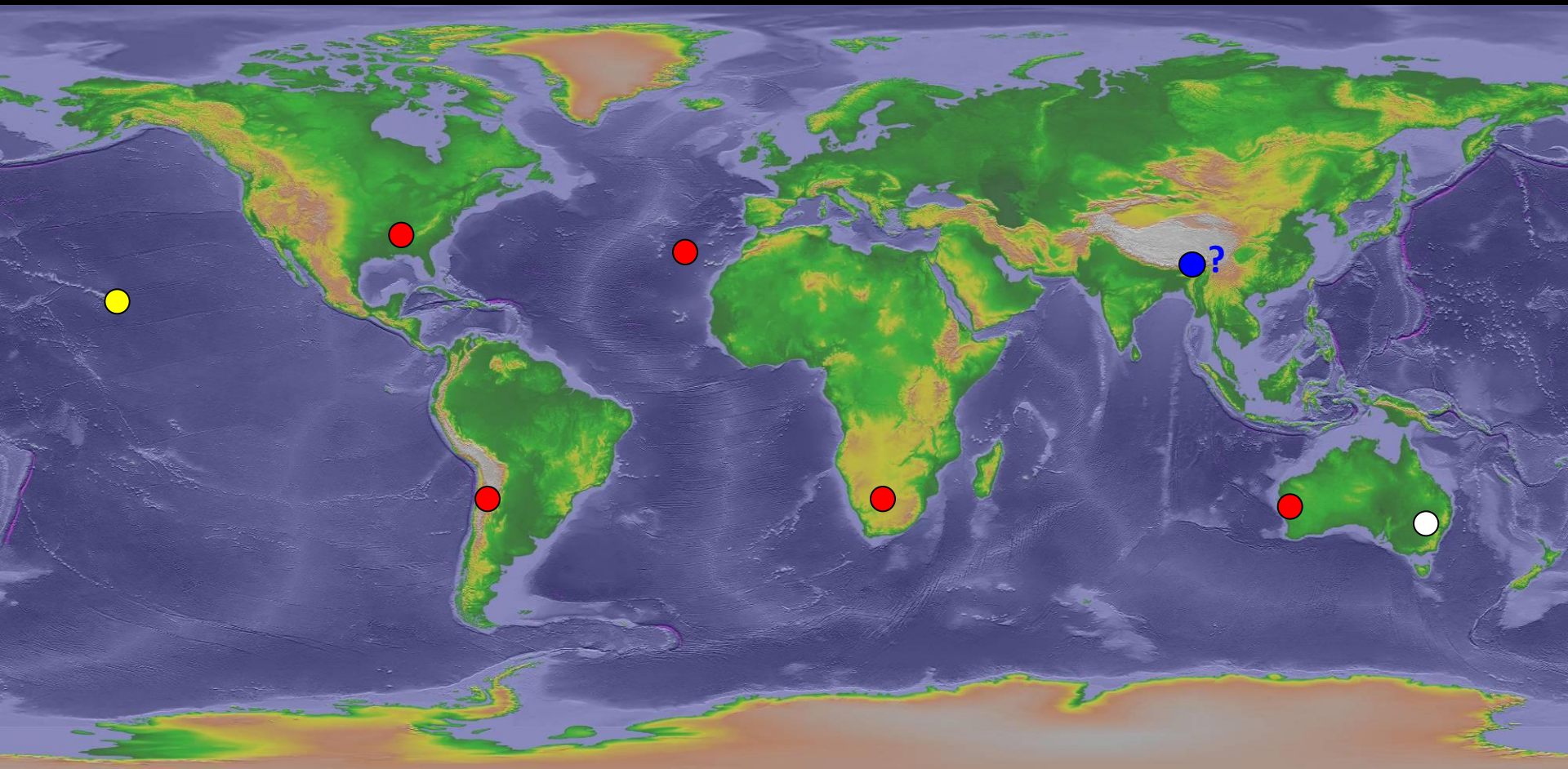
http://lcogt.net


LCOGT.net
Las Cumbres Observatory
Global Telescope Network
Sedgwick
McDonald
Haleakalā
Teide
Ürümqi
Cerro Tololo
Sutherland
Siding Spring
0.4-metre
2-metre
1-metre

LCOGT 1m node, Cerro Tololo, Chile



- Request observations via website
- View live (“real-time”) or download data later (“offline”)



Screenshot of Saturn with Starry Night Pro at 13:25 UTC

Image taken with FT at approximately 13:25 UTC

Transient targets

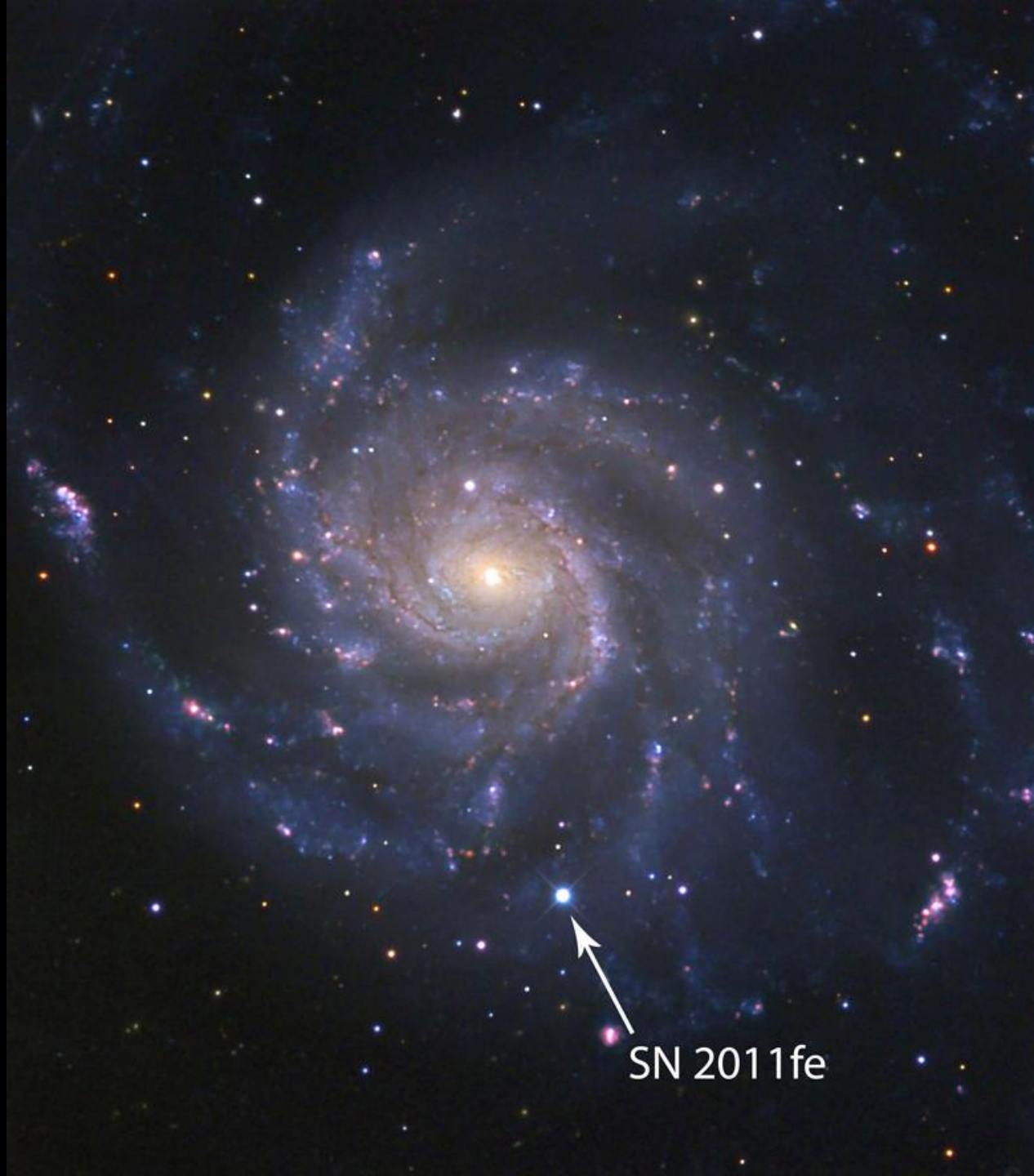
Supernova
2011dh

Whirlpool
Galaxy (M51)

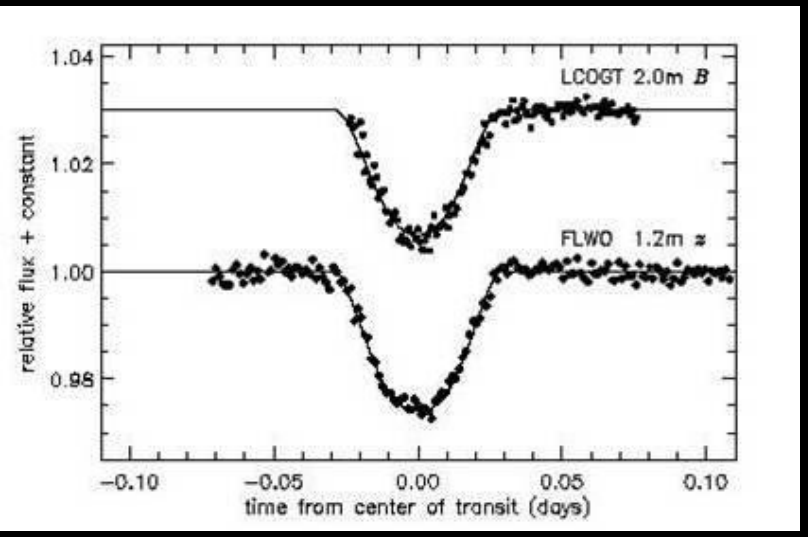
07/06/11

SN 2011fe in M101 at maximum brightness

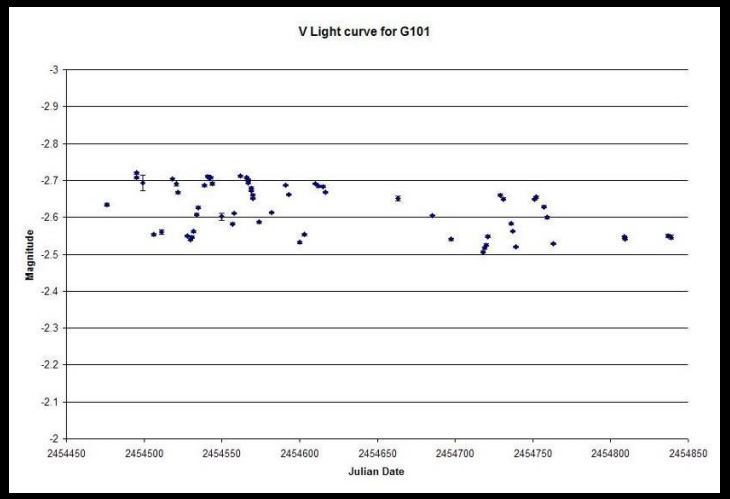
Optical data from LCOGT 0.8m

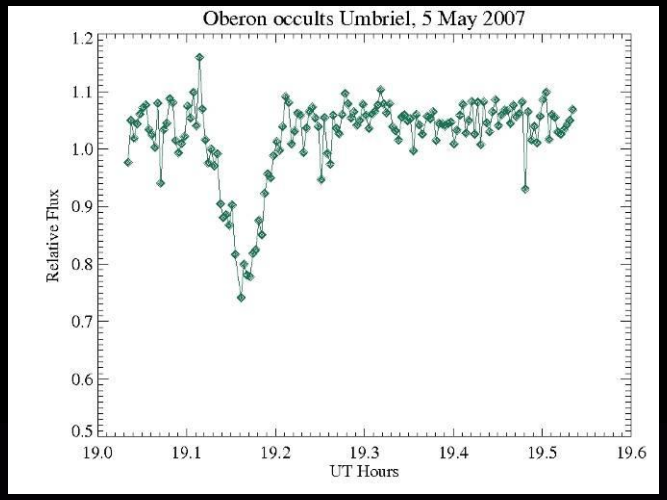


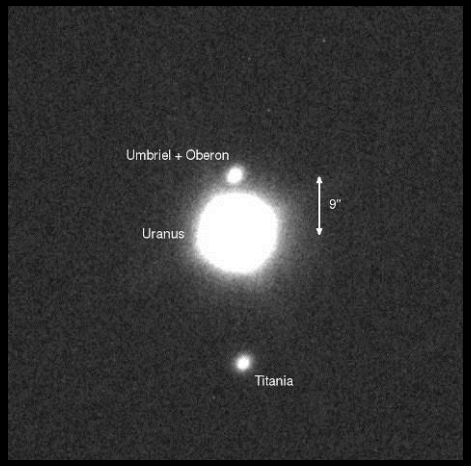
Inquiry-Based Science Education



ESP occultation (TrES 3)







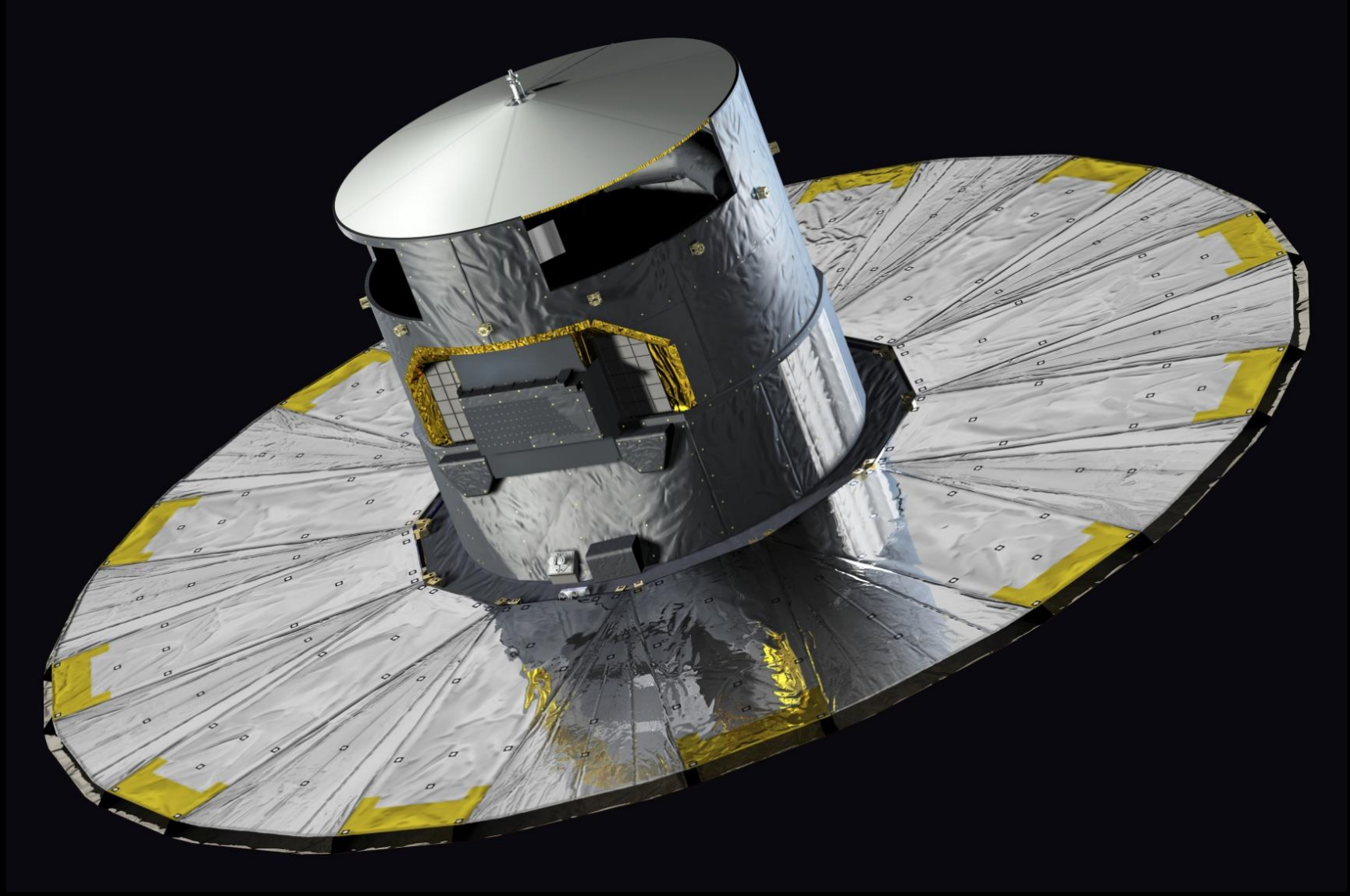
Uranian moon occultations

Educational resources

http://resources.faulkes-telescope.com

GO-LAB

.uk esero



esa

Gaia

Gaia

- Map **1,000,000,000** stars in Milky Way using **1,000,000,000** pixel camera at cost of **€1,000,000,000** over 5-6 years

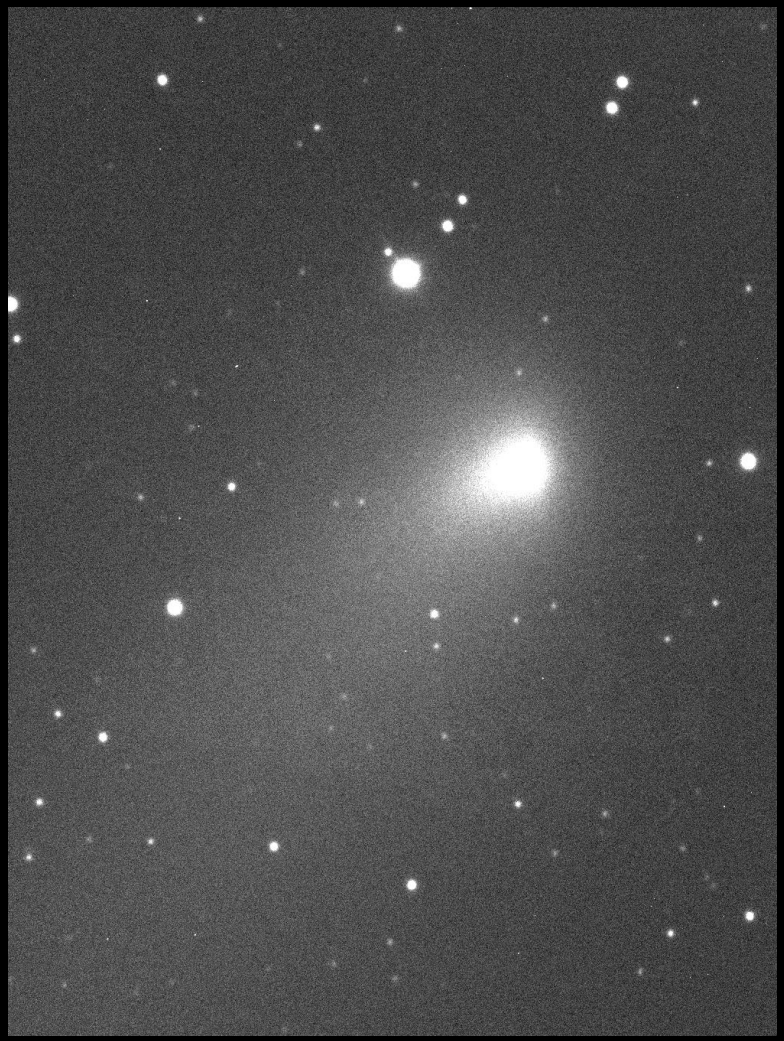
Gaia

- It will “accidentally” discover ~3 new supernovae every day, plus numerous variable, transient and moving objects

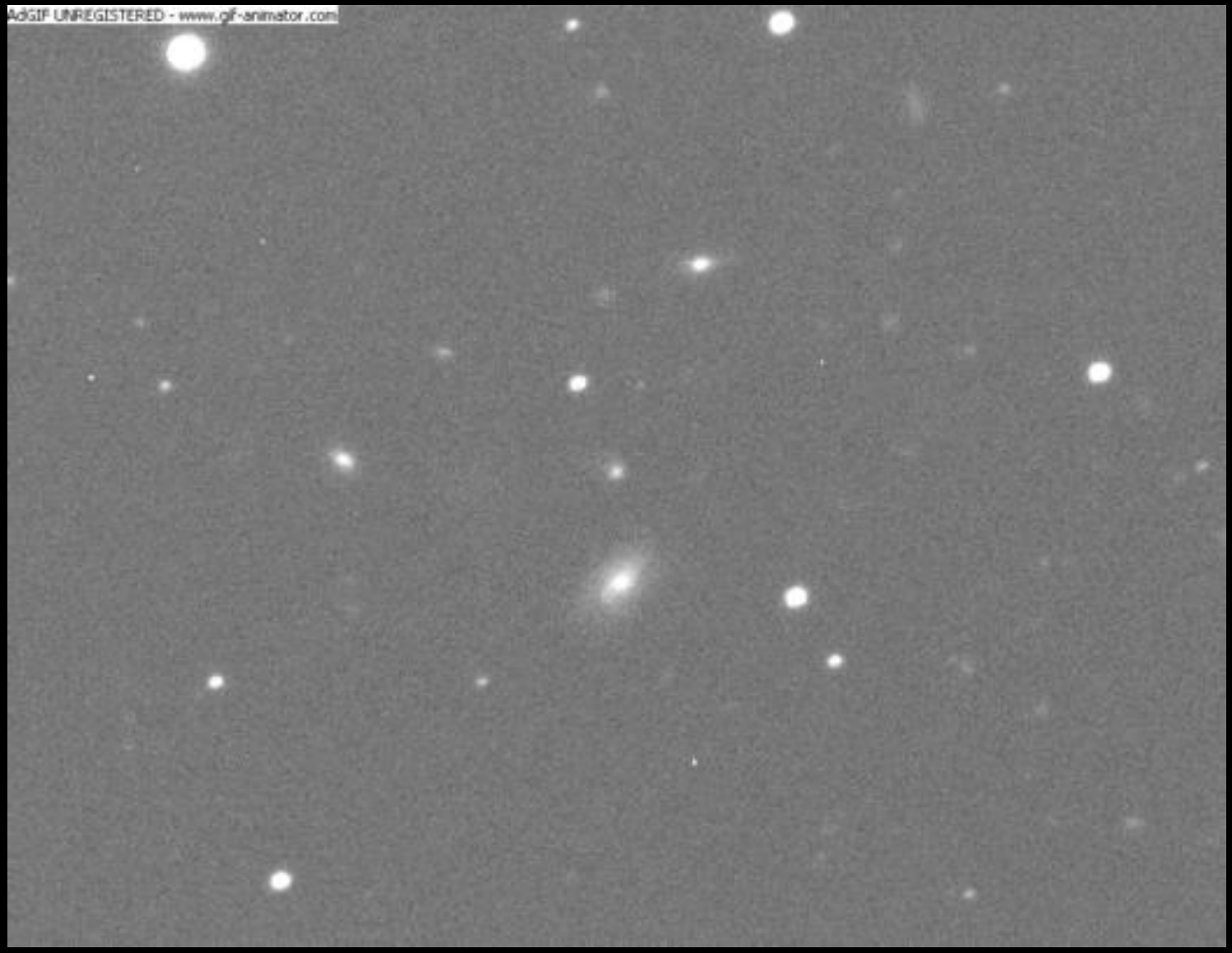
Gaia

- FT users will provide ground-based observations to help confirm Gaia transients – real discovery science!

Observing comets



C/2012 K5 (LINEAR) FTS 07 January 2013



C/2013 A1 FTS 07 March 2013 by E. Guido, N. Howes & Horbury Academy

Aug. 2011

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30 August 2011 Last updated at 19:31

Asteroid spotter Hannah hopes for her name in the stars

Student Hannah Blyth was on a month-long work placement

A sixth-former who went on work experience to study astronomy and discovered two new asteroids is hoping to have one named after her.

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the telegraph .com.au

WEATHER Today Tomorrow

min 11°C - max 24°C

SPORT

Bennett's secret Ne

TWO days before the Drag match of the season, Wa

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Weather: Sydney 11°C - 24°C . Sunny

Breaking News

Asteroid Hannahblyth named after British teen who spotted it during internship

From: NewsCore August 31, 2011 9:04AM

Recommend | Send | 2 people recommend this

A BRITISH teenager spoke of her deli discovered during a northern summe

Hannah Blyth, 18, was working alongside ast Wales when she spotted the chunk of rock th million miles (480 million km) from Earth.

She had been given the task of painstakingly Faulkes Telescope on the Hawaiian island of and Jupiter and are difficult to spot against th

Her discovery was confirmed by experts from

DiscoveryNews. ... saw a dust devil spin on Mars.

EARTH | SPACE | TECH & GADGETS | ANIMALS | HISTORY | ADVENTURE | HUMAN | AUTOS

Discovery News > Space News > 18 Year-Old Student Discovers Comet Break-Up

18-YEAR-OLD STUDENT DISCOVERS COMET BREAK-UP

During a summer internship, the British student also helped with the discovery of over 20 asteroids.

By Ian O'Neill
Sat Sep 3, 2011 07:47 PM ET
(3) Comments | Leave a Comment

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Like | Nick Howes and 402 others like this. | Share 149 | Tweet 296

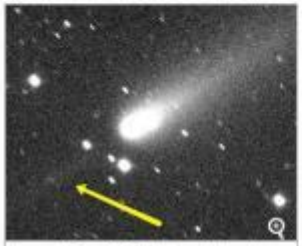

Image of Comet 213P Van Ness taken by Hannah Blyth, processed by N. Howes, F

THE GIST

- Analyzing photographs of a comet taken by student Hannah Blyth, astronomers had broken apart.
- During her summer placem Faulkes Telescope Project previously unknown aster

It's an event that any profes consider to be a once- in-a- 18-year-old British student, of a comet she was studyin summer work experience p pound (dollar) Faulkes Tele Cumbres Observatory Glob

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Student's asteroid find the equivalent of seeing a dark grey building in black space 482 million km away

August 31, 2011 10:58AM

of a large building hurtling through space 482 million kilometres d after the Welsh student who spotted it during her summer

g a month's work experience with astronomers at the University of when she spotted the asteroid that now bears her name.

ik of painstakingly examining images recorded by the university's two n the Hawaiian island of Maui. Thousands of asteroids orbit between ifficult to spot against the inky blackness of outer space.

d by experts from Harvard University, who decided to name the our of its finder.

that Miss Blyth, from St John's Sixth Form College in Cardiff, spotted - more than many astronomers discover in a career.

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'There's a rock out there with my name on it': Astronomy student on work experience discovers asteroid that will be named after her

By CHRIS SLACK

Last updated at 9:39 PM on 30th August 2011

Comments (7) | Add to My Stories | Share | Like 51

A schoolgirl who discovered 22 new asteroids during work experience at an astronomy project has discovered one of them will be named after her.

Hannah Blyth, 18, was using a a remote controlled telescope at the University of Glamorgan's Faulkes Telescope Project when she spotted the new asteroids more than 300 million miles away.

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Tags > finds 22 new asteroids

US teen Hannah Blyth finds 22 new asteroids, hopes to have one named after her

Student Hannah Blyth was on a month-long work placement. Image showing Hannah Blyth's asteroid discoveries. A sixth-former who went on work experience to study astronomy and discovered two new asteroids is hoping to have one named after her. Hannah Blyth was using a remote-controlled telescope to stare into the night sky when she helped spot 22 new asteroids between Mars and Jupiter. Fellow stargazers hope one will be named 'Hannahblyth' after

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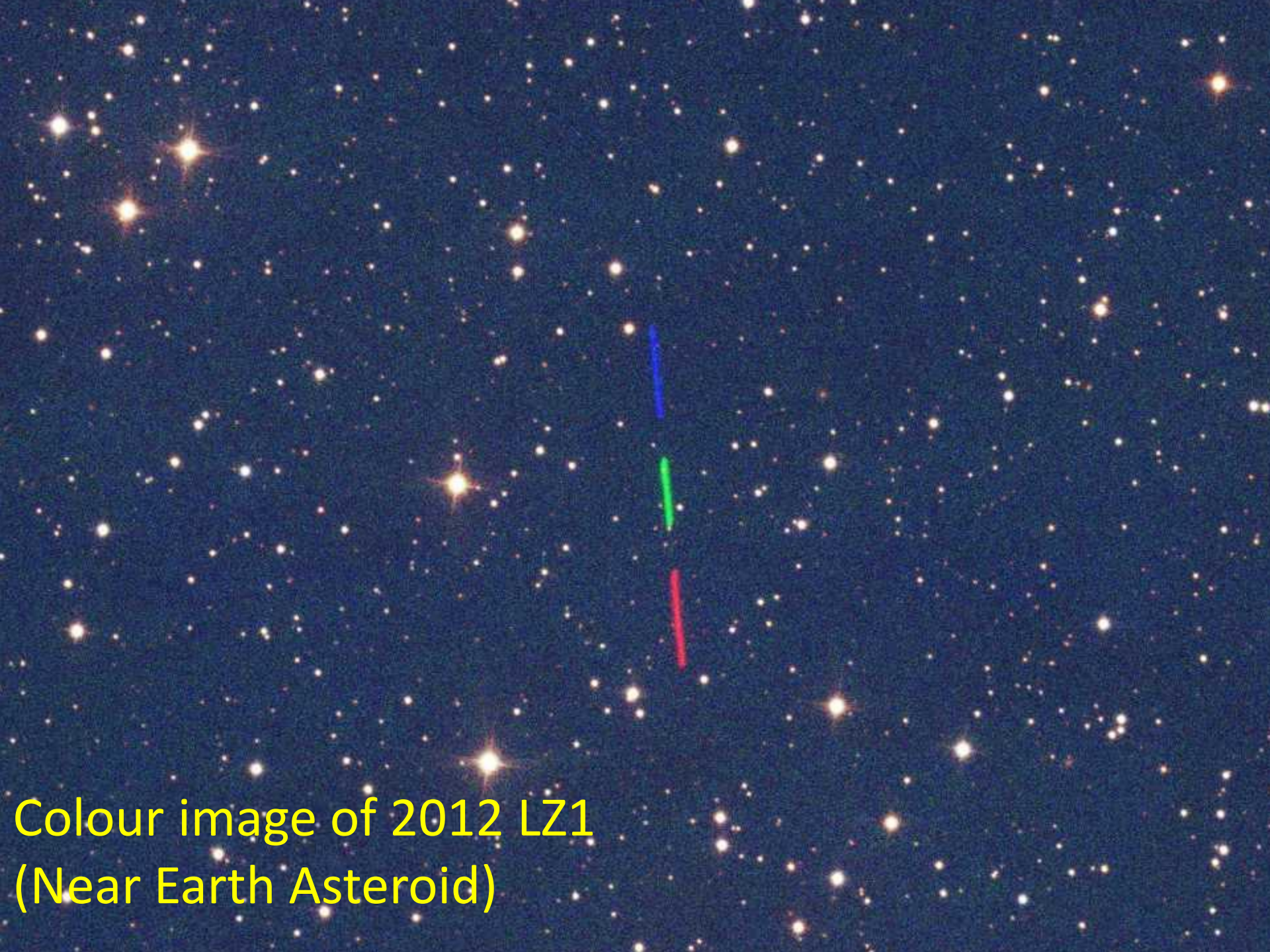
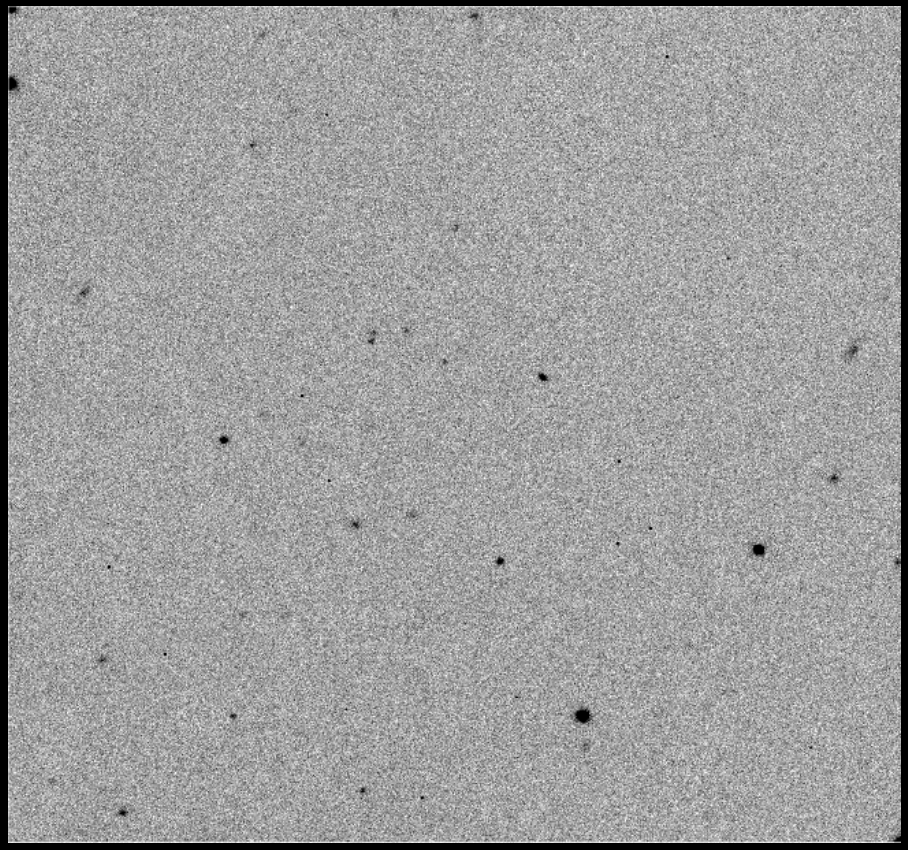
The Smurf themed park

cry in the world


Colour image of 2012 LZ1
(Near Earth Asteroid)

International Asteroid Search Campaign



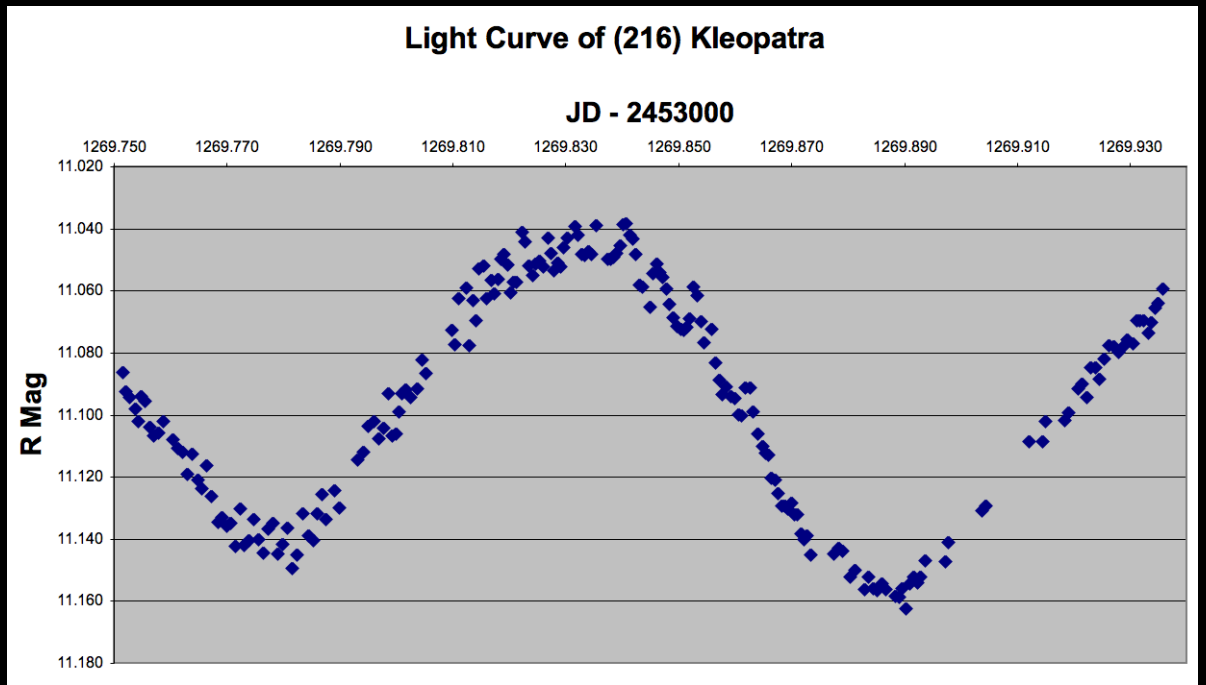
Discovery of 2012 BW23

IASC using FTs for follow-up of students MBA discoveries and confirmation of new NEOs and comets from several surveys

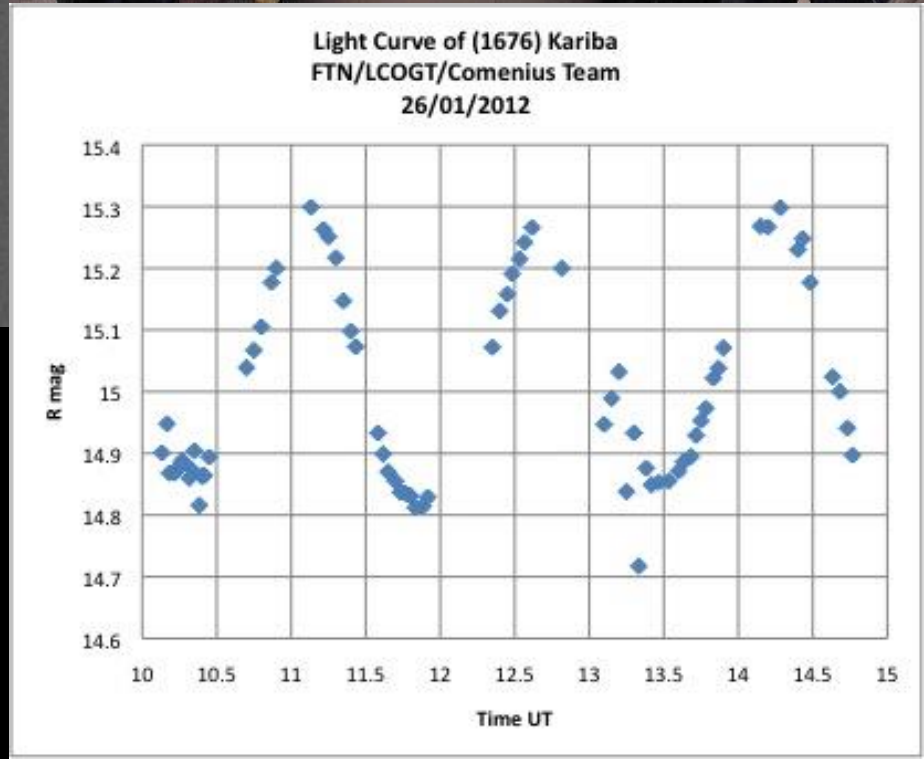
http://iasc.hsutx.edu/

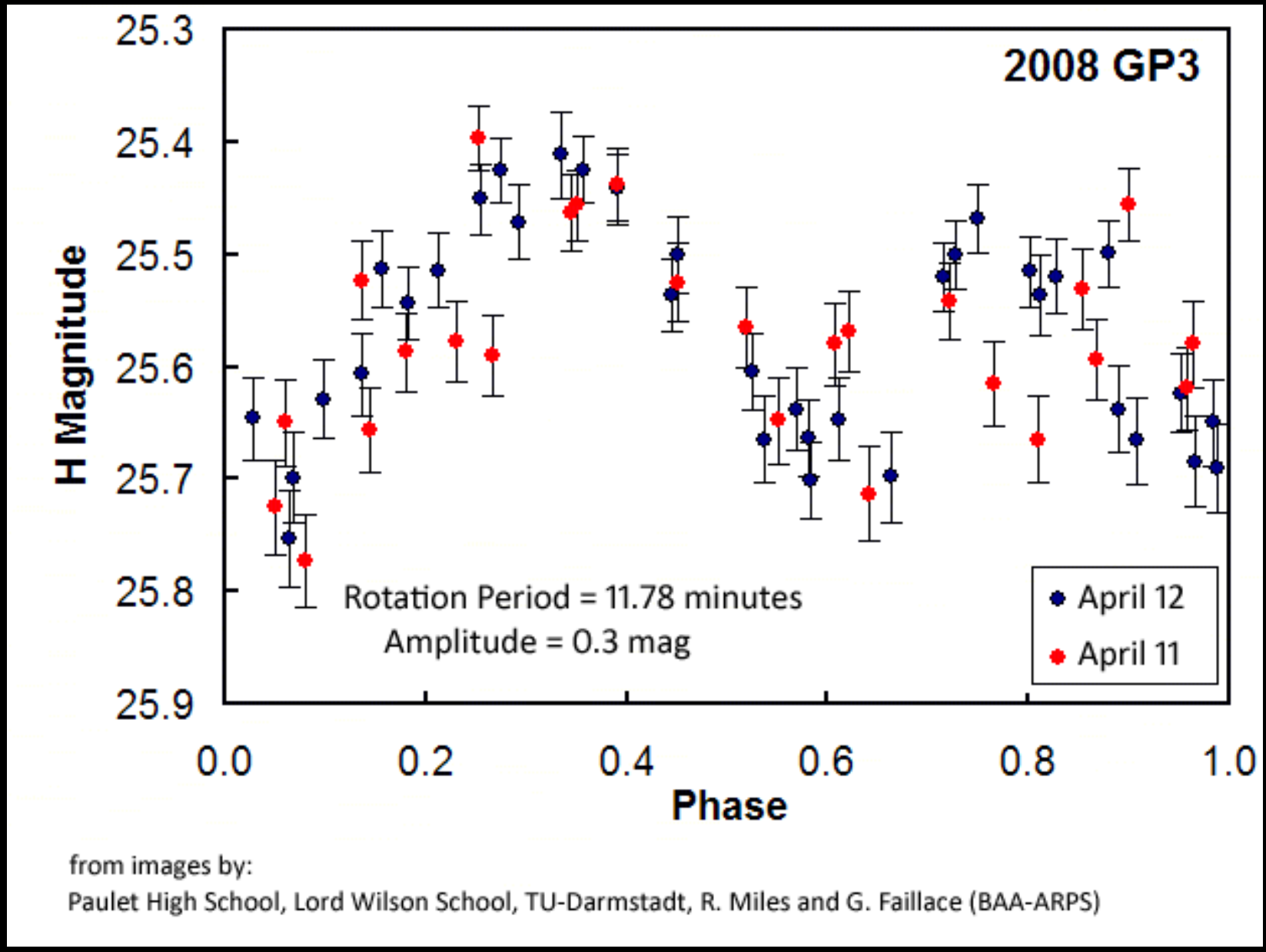
Asteroid Rotation

- Pro-Am-School collaborations
- Asteroid identified (Astrometrica), brightness measured (SalsaJ), light curves produced



GTTP/EU-HOU teacher training



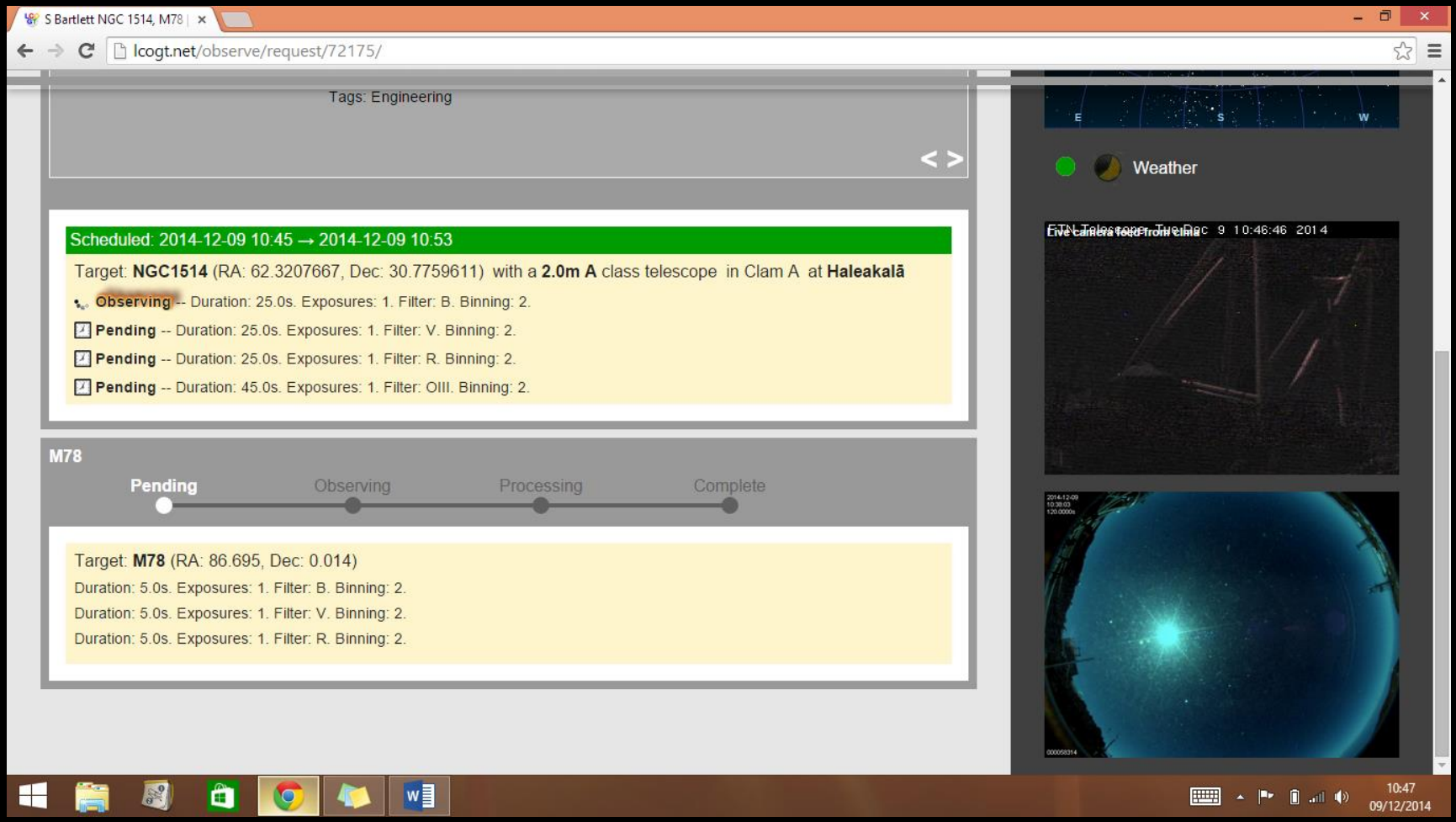


from images by:
Paulet High School, Lord Wilson School, TU-Darmstadt, R. Miles and G. Faillace (BAA-ARPS)

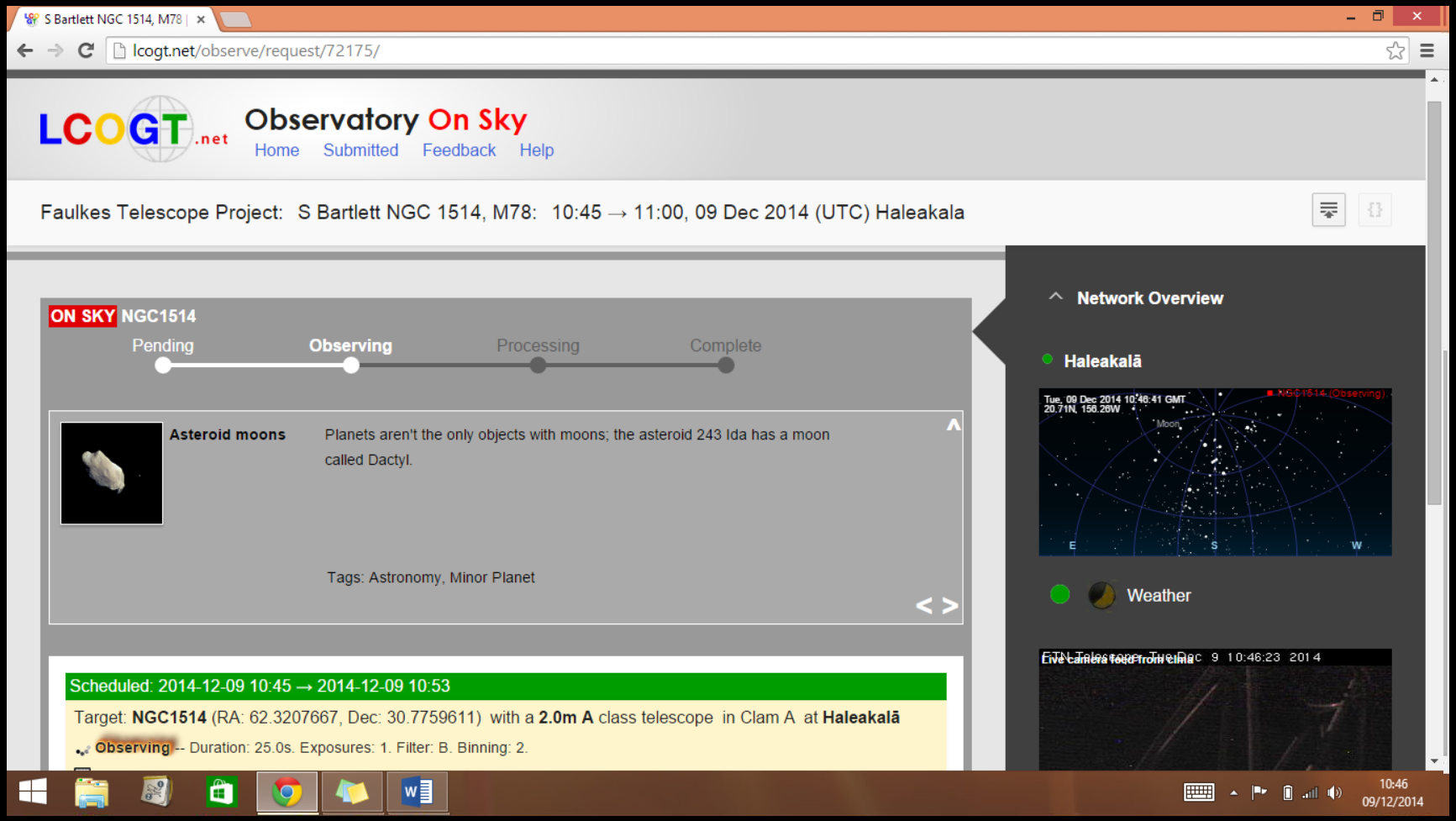
Observing with FT

- Free access for GTTP/ESA schools
- Register direct with FT (via Paul)
- Currently **2m** and **1m** telescopes, later **0.4m**

Observing with FT

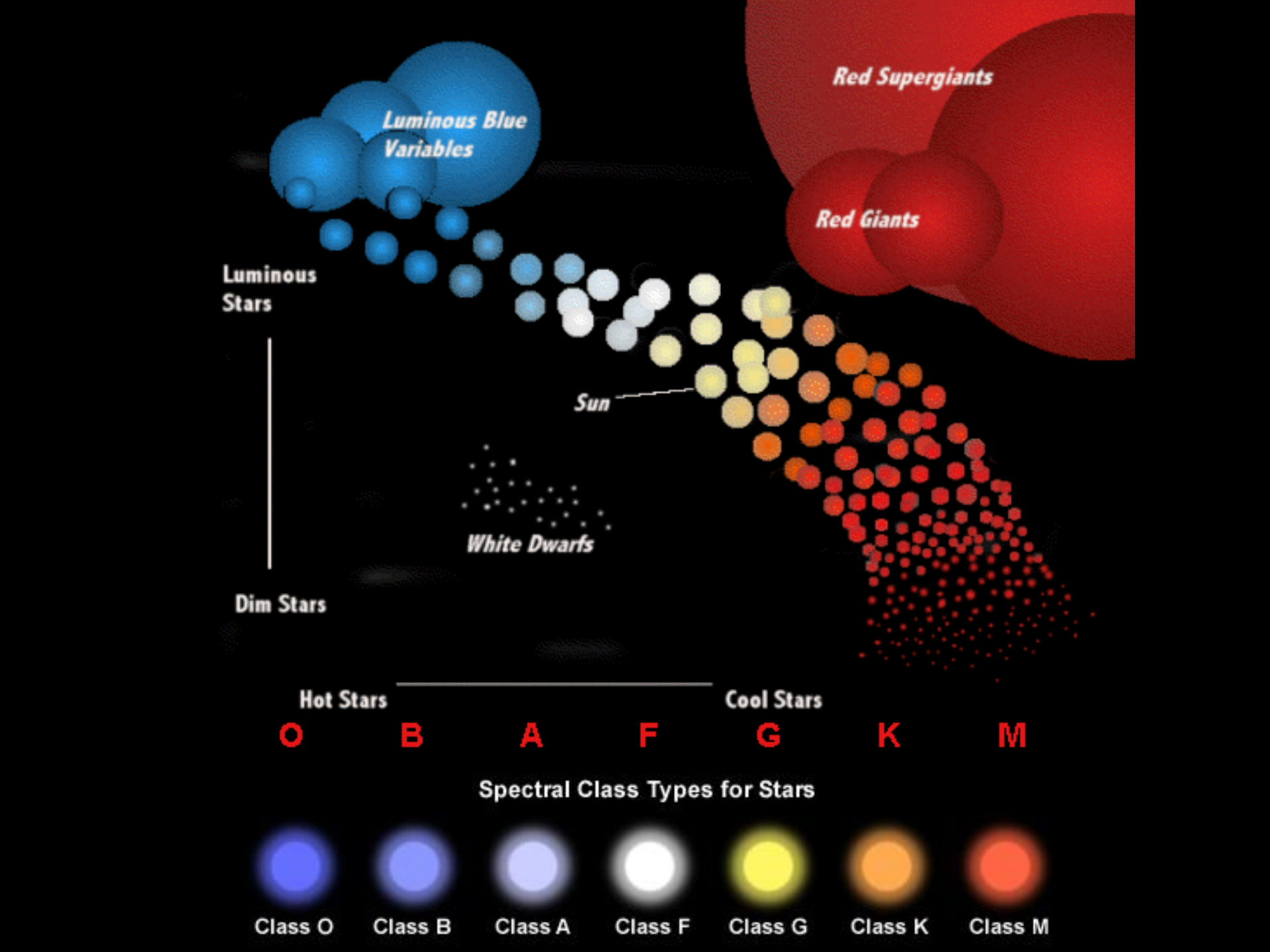


Observing with FT

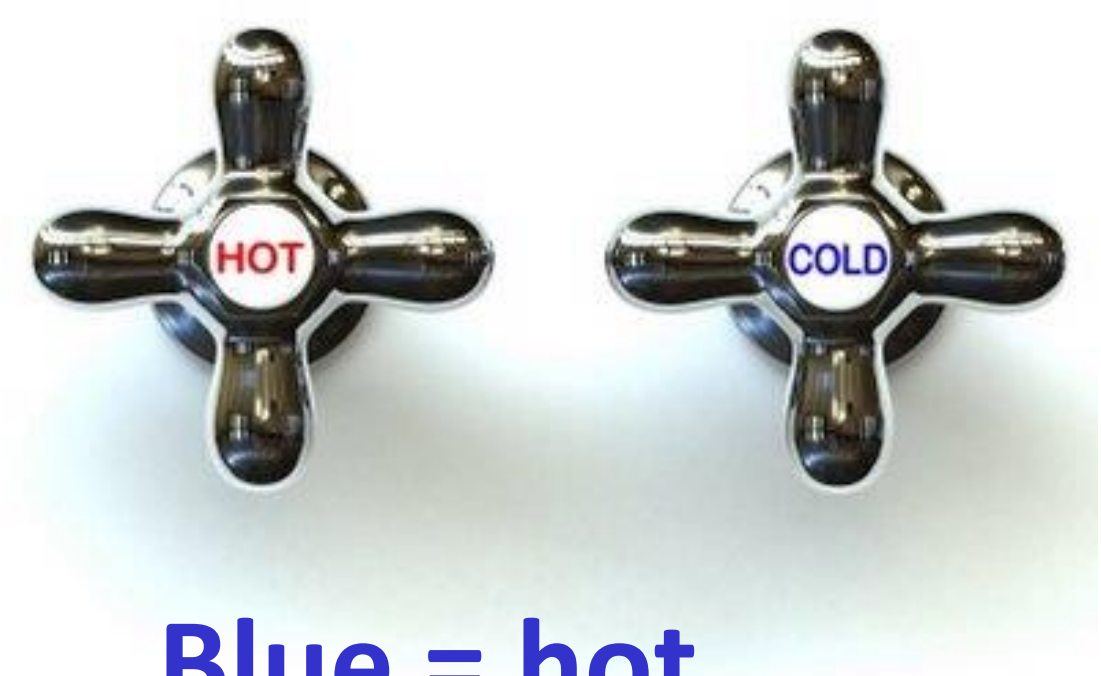


Open Clusters

- Colour images
- Produce Hertzsprung-Russel (colour-magnitude) diagrams (BV images)
- Identify “unusual” stars (BVR Ha images)
- Variable star searches (hours-days-years)
- Link with Project CLEA software (age, distance, chemistry)


Red Supergiants
Luminous Blue Variables
Red Giants
Luminous Stars
Sun
White Dwarfs
Dim Stars
Hot Stars
Cool Stars
O
B
A
F
G
K
M
Spectral Class Types for Stars
Class O
Class B
Class A
Class F
Class G
Class K
Class M

Stars are not like taps…



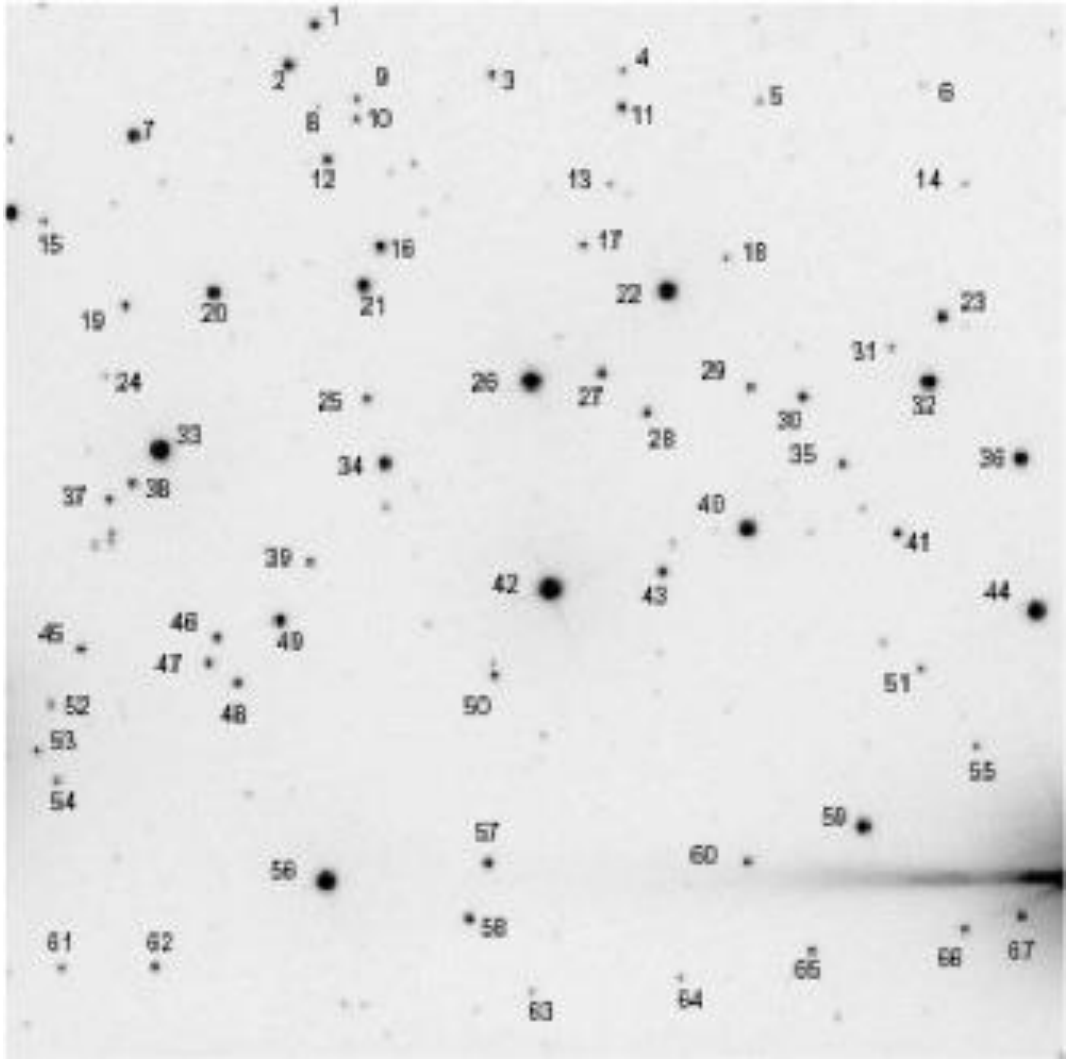
Blue = hot

Red = cold

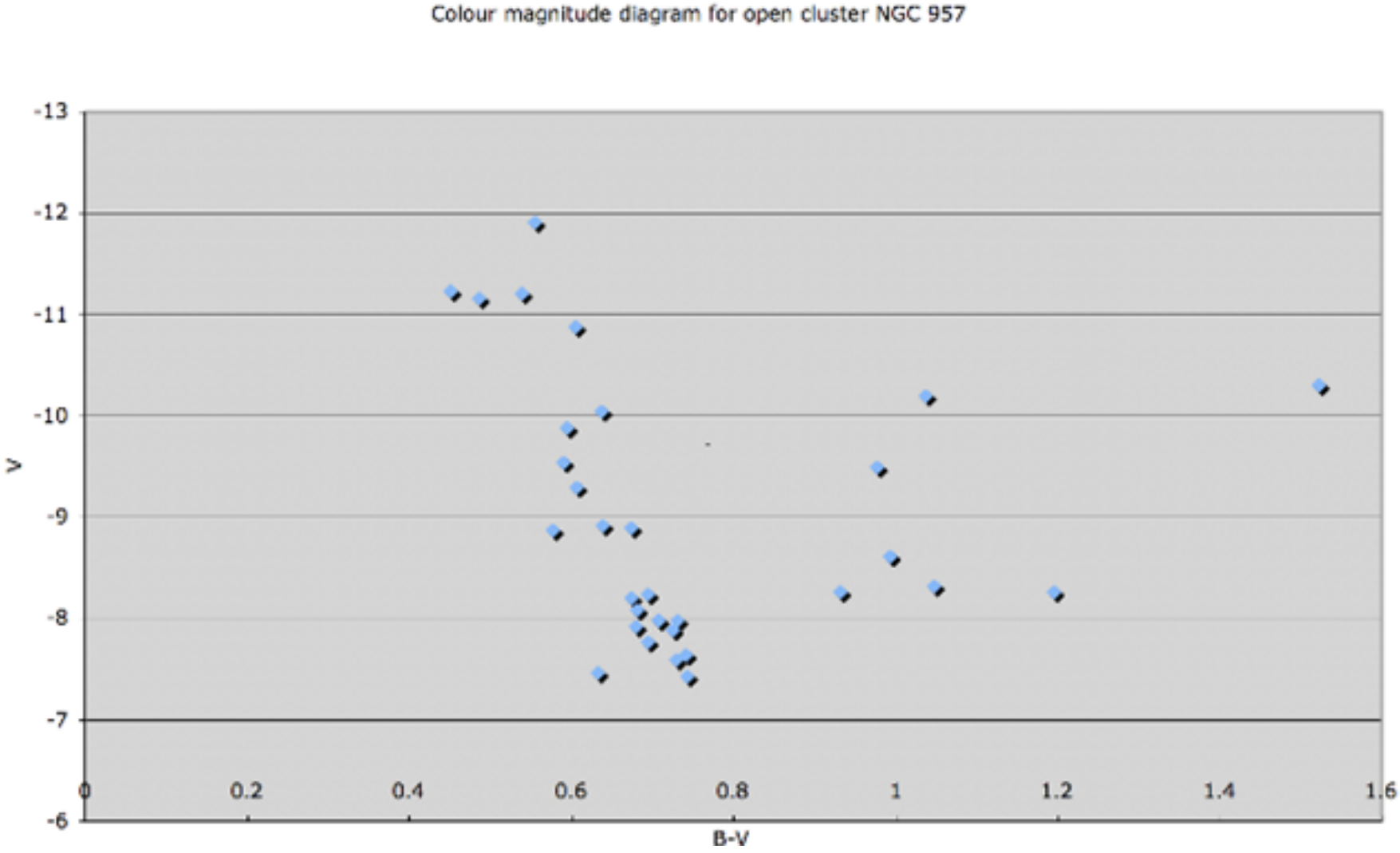
Making a HR diagram

- Use SalsaJ to measure the brighter stars in the NGC 957 open cluster
- Images are in Blue (**B**) and Visible (**V**) filters
- Use spreadsheet to convert counts to magnitudes

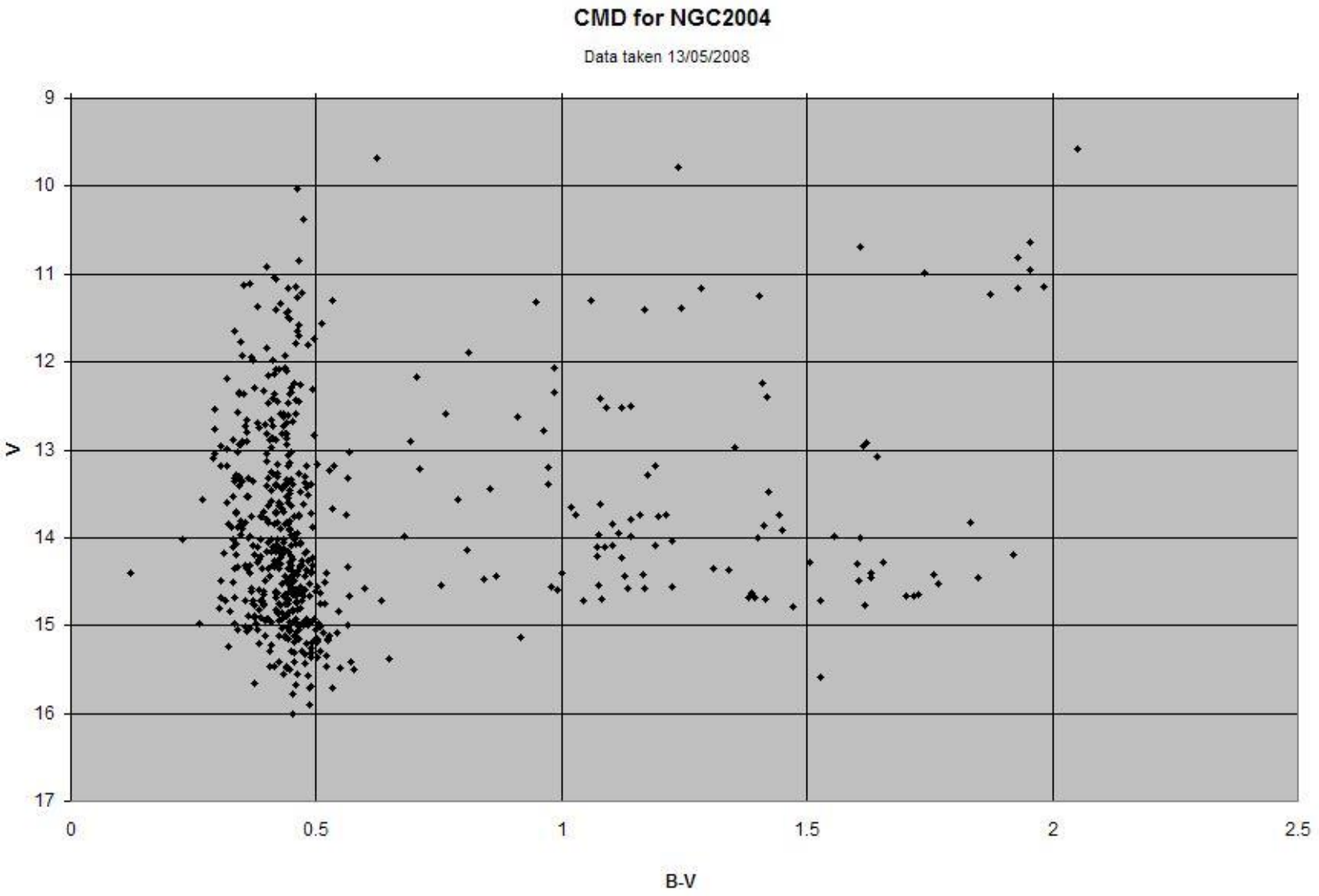
Open Cluster NGC 957

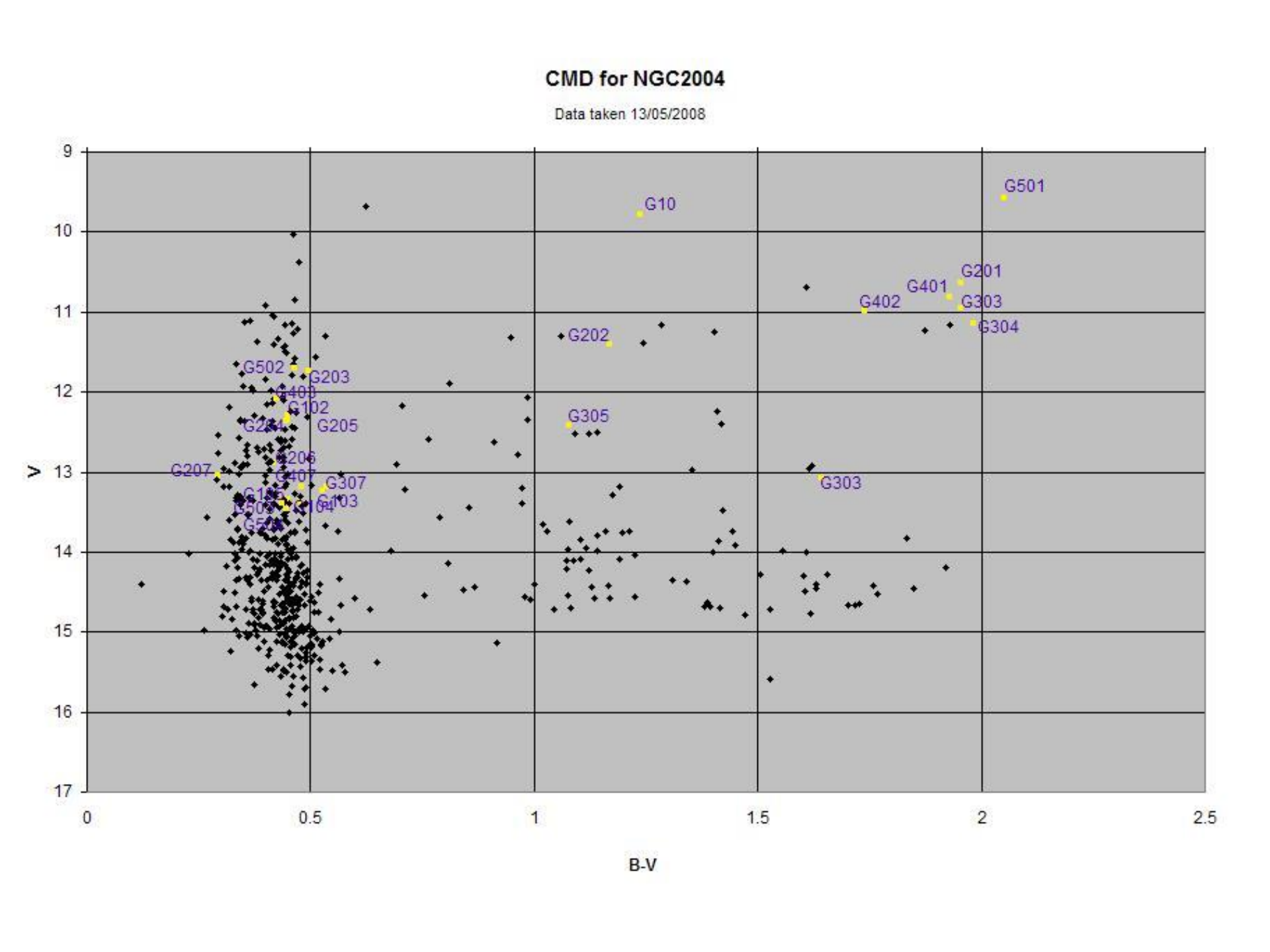


Finder chart, 4.6’ x 4.6’ (Old FTN field of view)

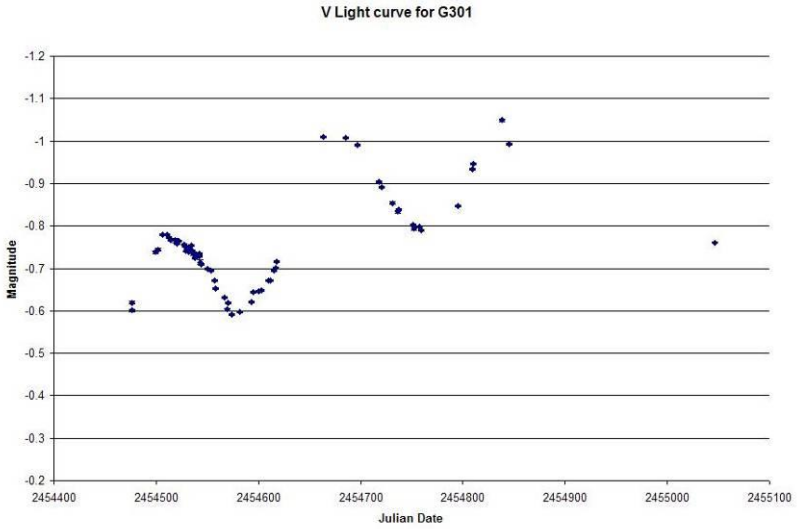

Colour magnitude diagram for open cluster NGC 957
-13
-12
-11
-10
-9
-8
-7
-6
V
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
B-V

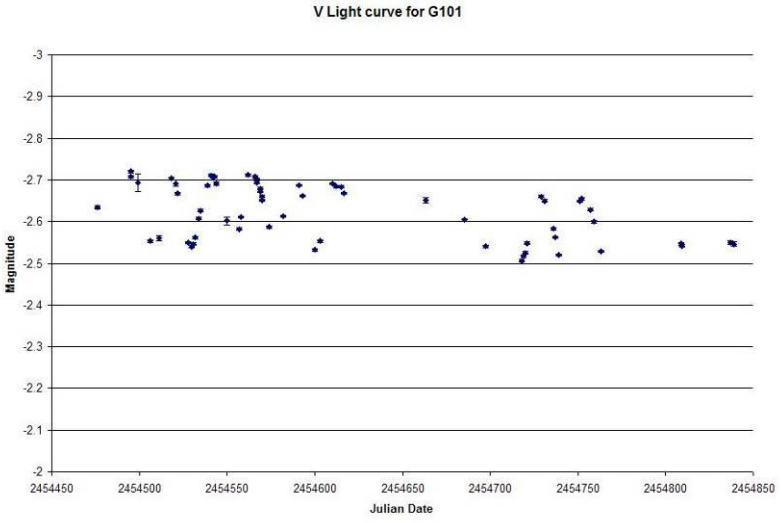
Case study: NGC 2004

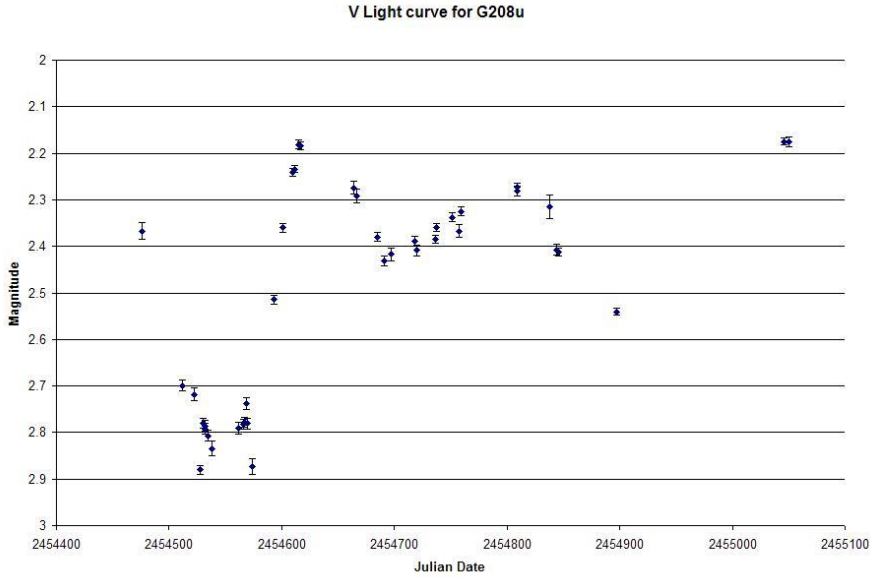


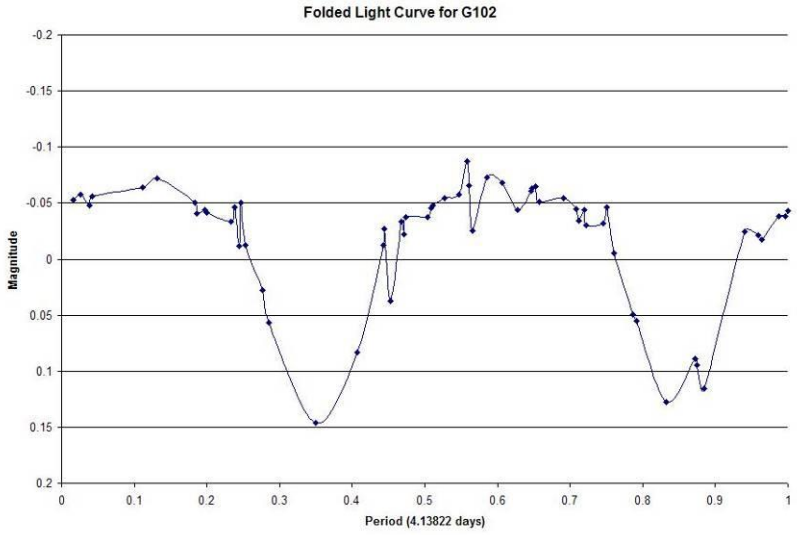

CMD for NGC2004
Data taken 13/05/2008
V
B-V
9
10
11
12
13
14
15
16
17
0
0.5
1
1.5
2
2.5
G501
G10
G201
G401
G402
G303
G304
G202
G502
G203
G403
G102
G205
G305
G206
G207
G407
G307
G103
G303

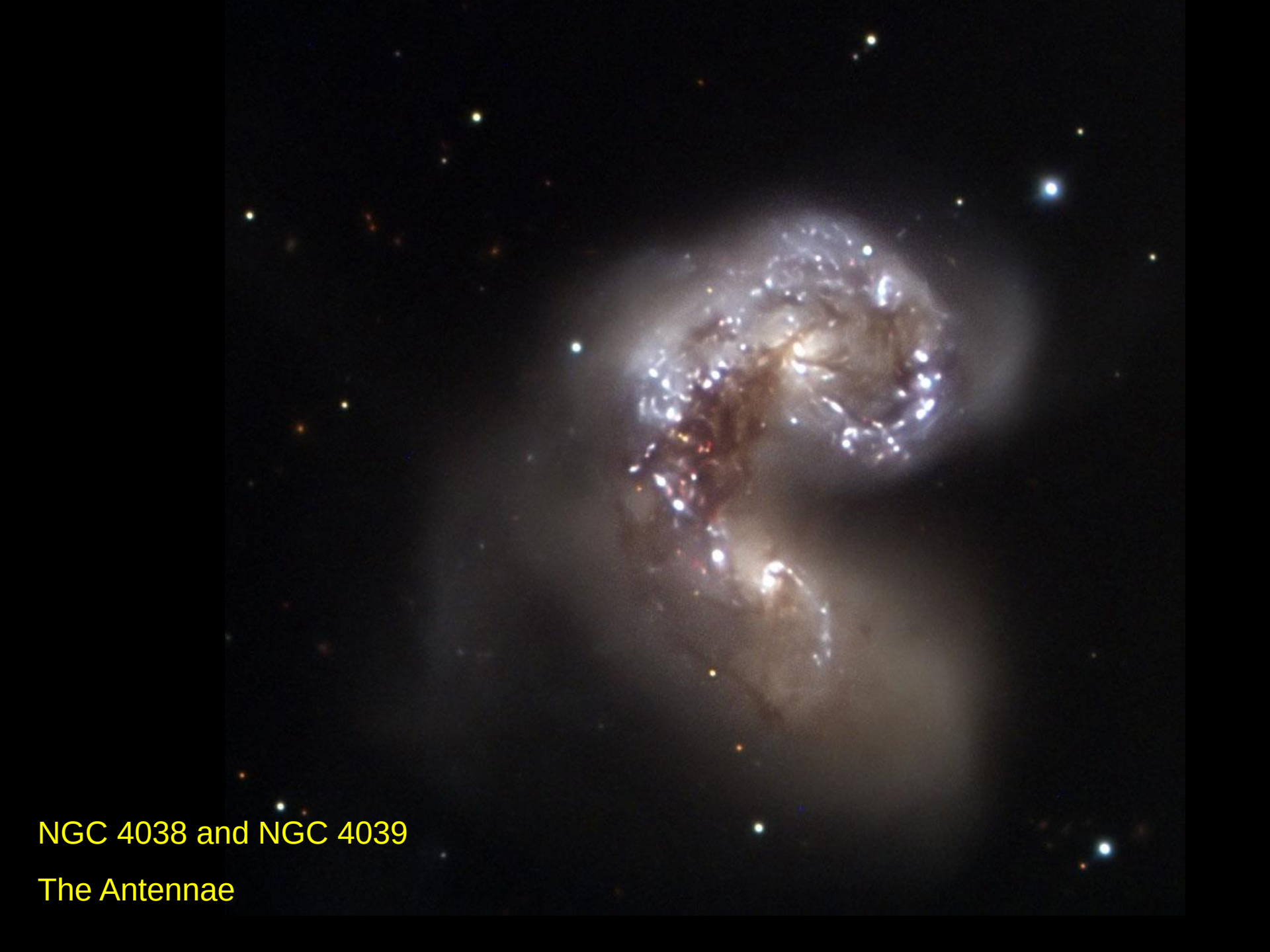
New variables











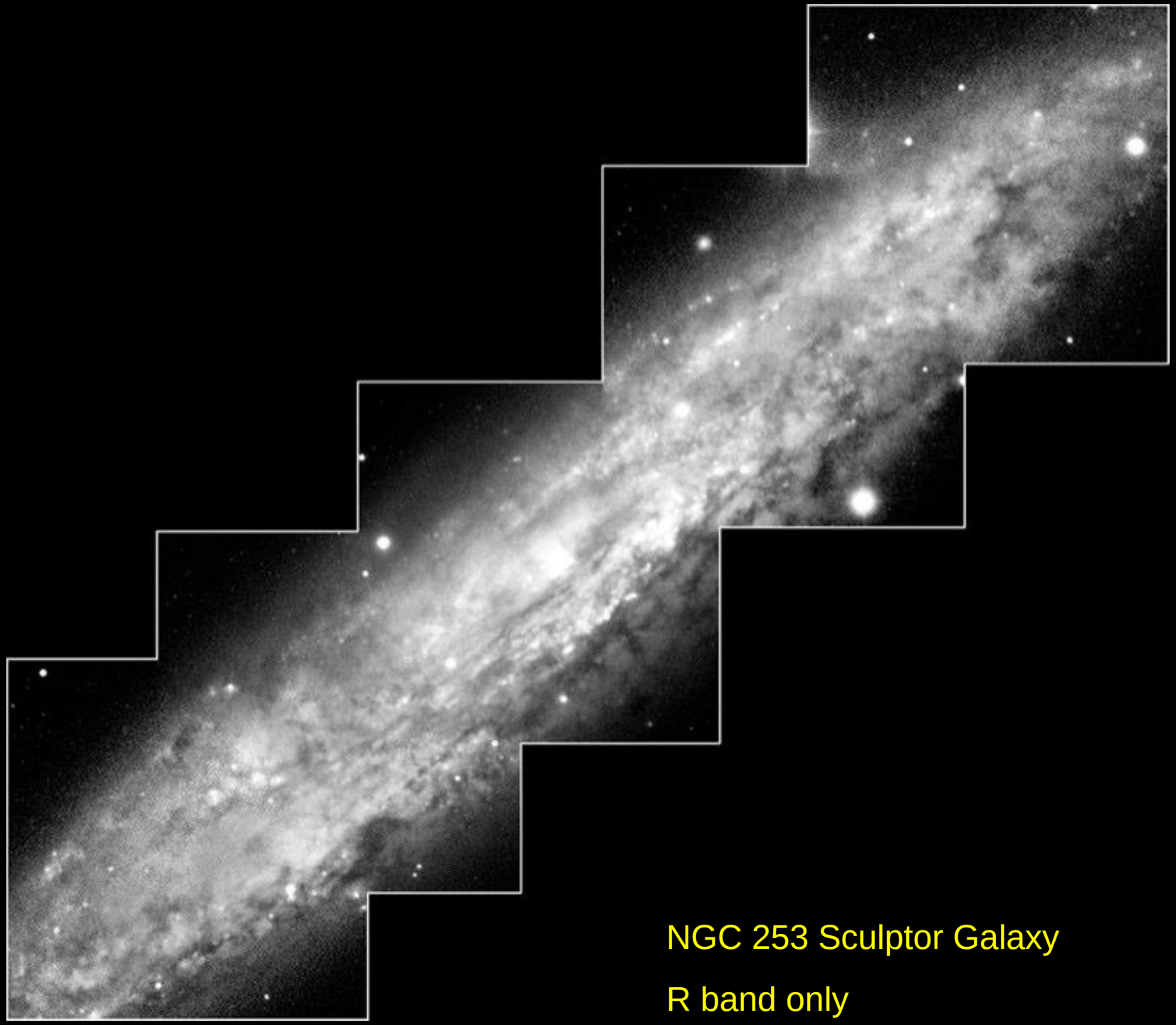
NGC 4038 and NGC 4039

The Antennae

M109


NGC 5195

NGC 1365



NGC 253 Sculptor Galaxy

R band only

Summary

- Talks, demos, teacher training, loan boxes
- Online resources and simulator(s)
- FT (in future, LCOGT network) observations of asteroids/comets
- Support for Pro-Am-Schools programmes
- Support for space missions (Gaia, Rosetta)

www.faulkes-telescope.com

paul.roche@faulkes-telescope.com

http://lcogt.net