



ASTEROID:

Jejak Sejarah Tata Surya, Dampak, & Potensinya bagi Bumi

Judhistira Aria Utama
Sekadar Seorang Penikmat Keindahan Langit

Disampaikan dalam ***Pengamatan Virtual Langit Malam***
Observatorium Bosscha Lembang
Sabtu, 17 Oktober 2020



**Observatorium
Bosscha**
Institut Teknologi Bandung

How did our solar system come to be?

National Aeronautics and
Space Administration



It all began about 4.6 billion years ago in a wispy cloud of gas and dust.

At some point, part of the cloud collapsed in on itself—possibly because the shockwave of a nearby supernova explosion caused it to compress.

The result: a flat spinning disk of dust and gas.

4.6 Billion
Years Ago

This cloud was a small part of a much bigger cloud.

Nuclear fusion occurs when hydrogen atoms fuse into helium.



When enough material collected at this disk's center, nuclear fusion began. Our sun was born. It gobbled up 99.8% of all the material.

These clumps became planets, dwarf planets, asteroids, comets, and moons.

The material left behind by the sun clumped together into bigger and bigger pieces.

Only rocky things could survive close to the sun, so gaseous and icy material collected further away. That's how our solar system came to be the place it is today!

Comets and asteroids are the left over remains of the solar system's formation.

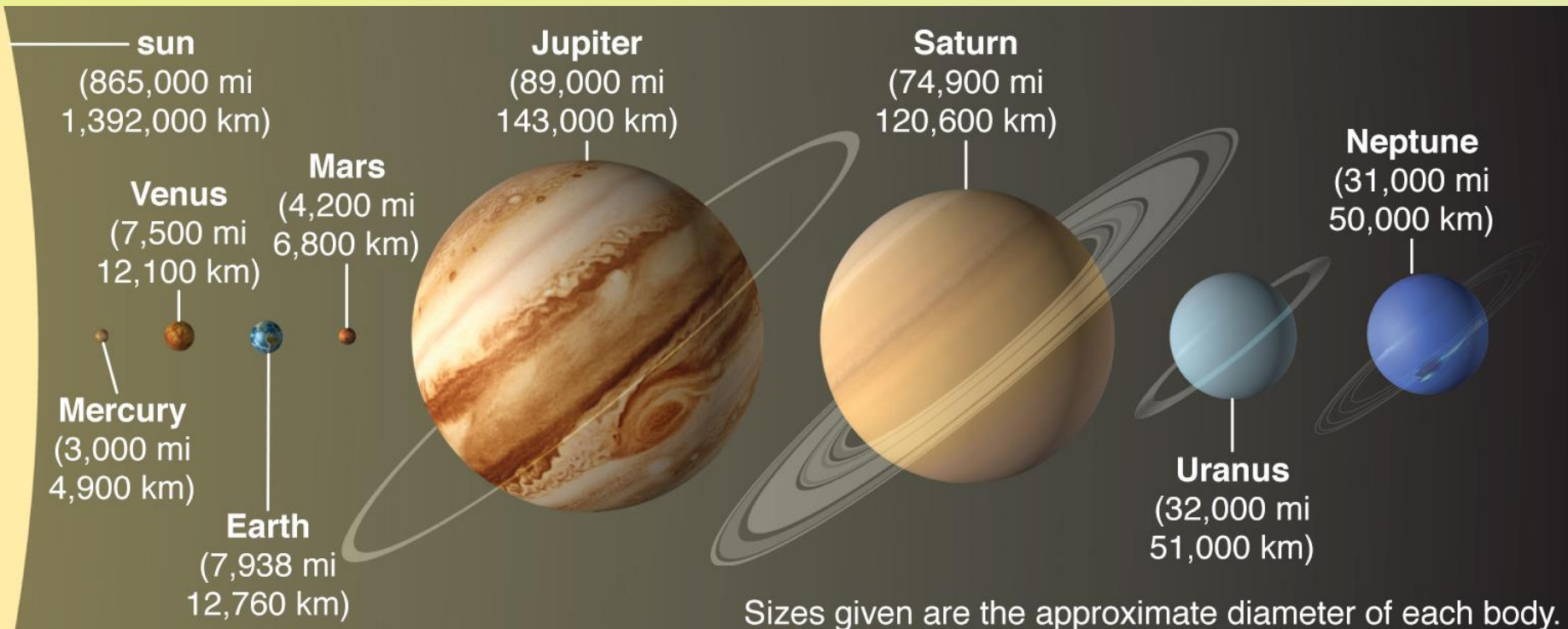
Present

Space Place
in a Snap!

Bagaimana Tata Surya Terbentuk? (2)

Model yang tepat harus mampu menjelaskan fakta teramati:

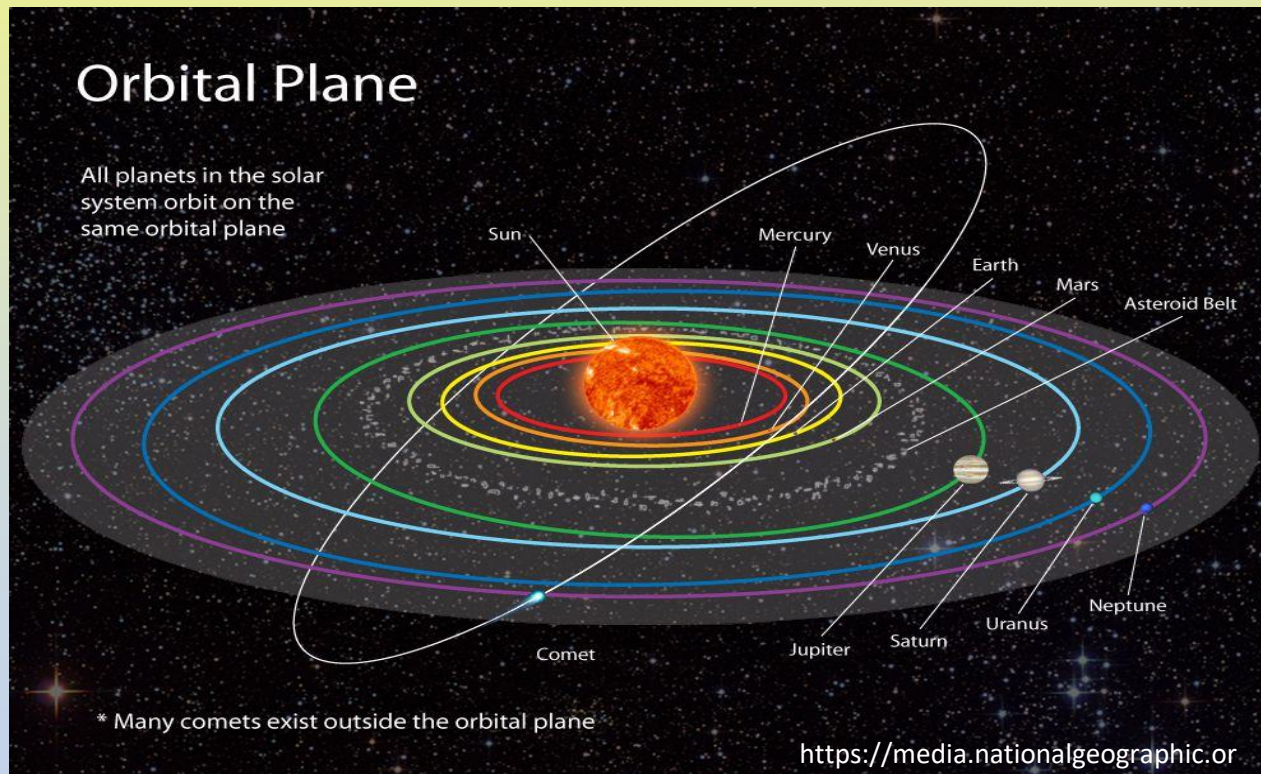
- Bintang induk **mendominasi massa** dalam sistem
→ Massa Matahari meliputi 99,9% massa Tata Surya



Bagaimana Tata Surya Terbentuk? (3)

Model yang tepat harus mampu menjelaskan fakta teramati:

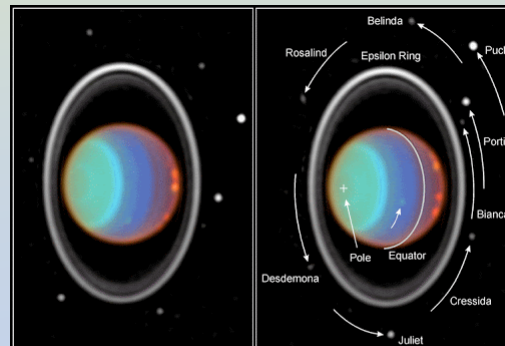
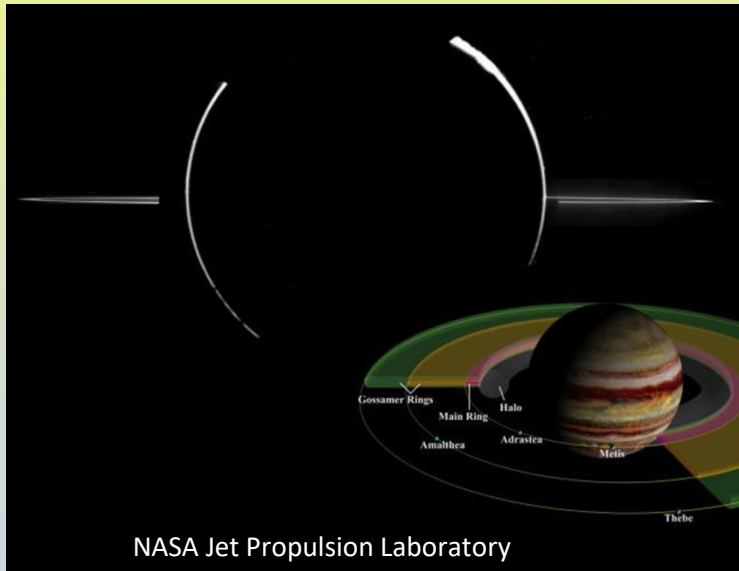
- Mayoritas planet mengorbit di bidang datar dengan gerak yang teratur dan **memiliki satelit alami** → Merkurius & Venus sebagai pengecualian



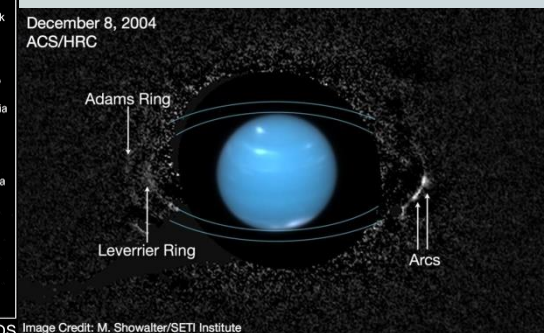
Bagaimana Tata Surya Terbentuk? (4)

Model yang tepat harus mampu menjelaskan fakta teramati:

- Terdapat **2 jenis planet** → Batuan (berukuran kecil dengan sedikit bulan dan gas (berukuran besar dengan banyak bulan dan sistem cincin))



Uranus • July 28, 1997
PRC97-36a • November 20, 1997 • ST ScI OPO
E. Karkoschka (University of Arizona Lunar & Planetary Lab) and NASA

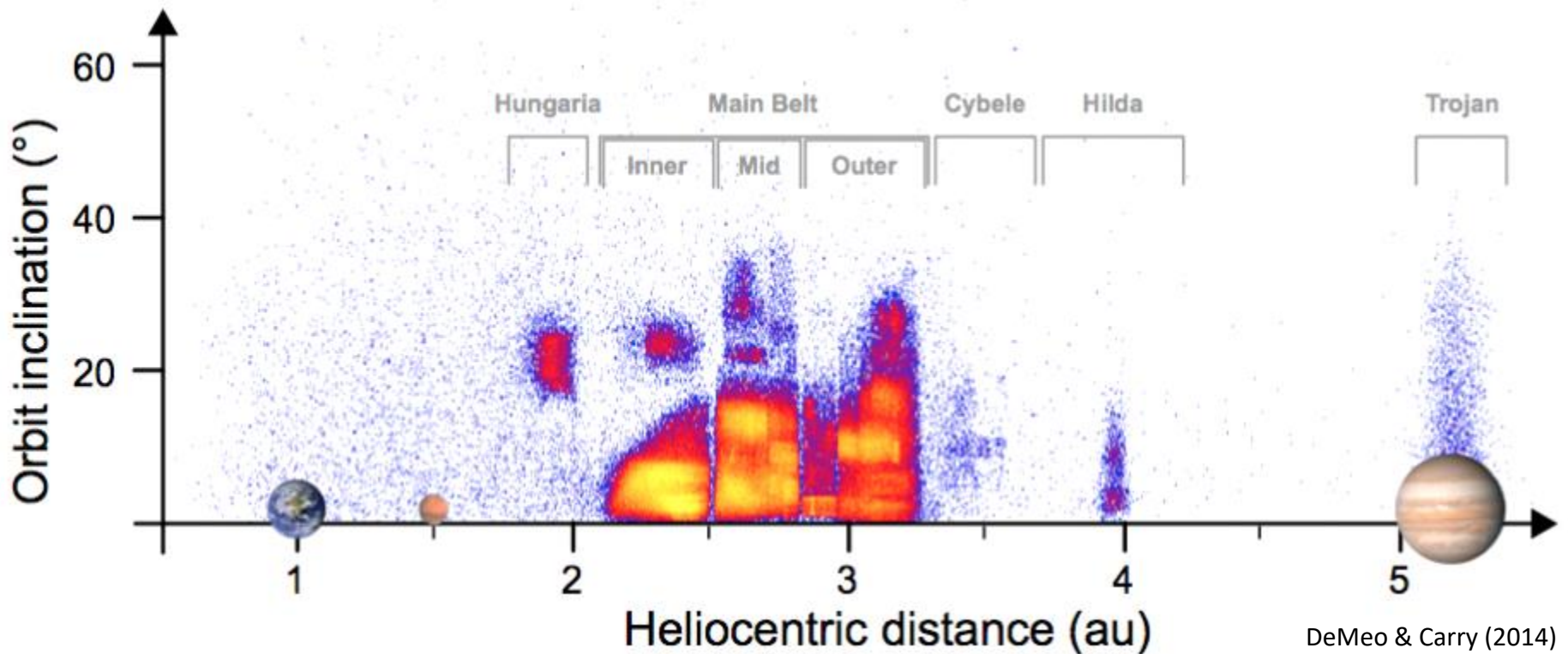


HST • NICMOS Image Credit: M. Showalter/SETI Institute

Bagaimana Tata Surya Terbentuk? (5-1)

Model yang tepat harus mampu menjelaskan fakta teramati:

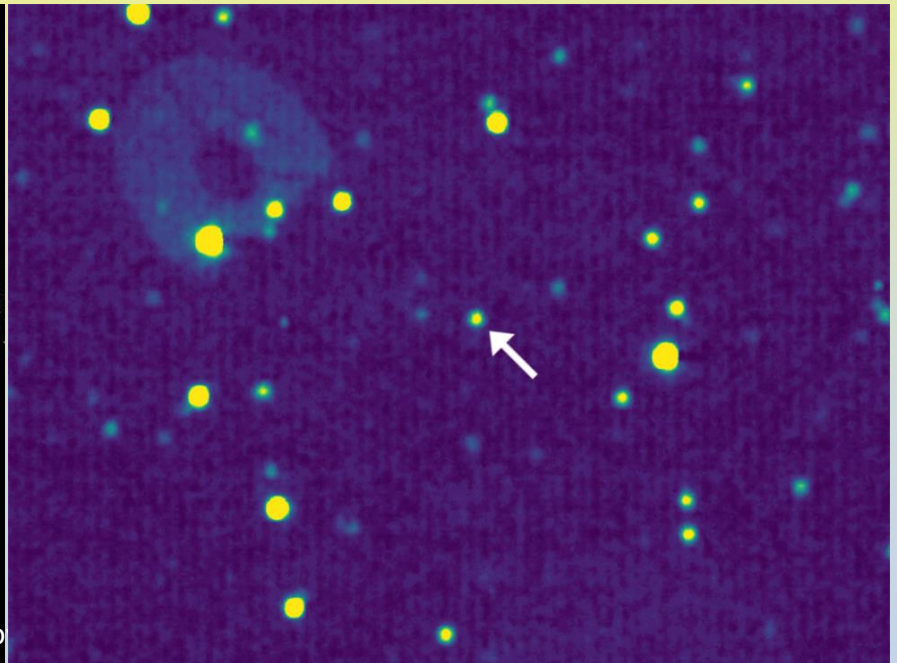
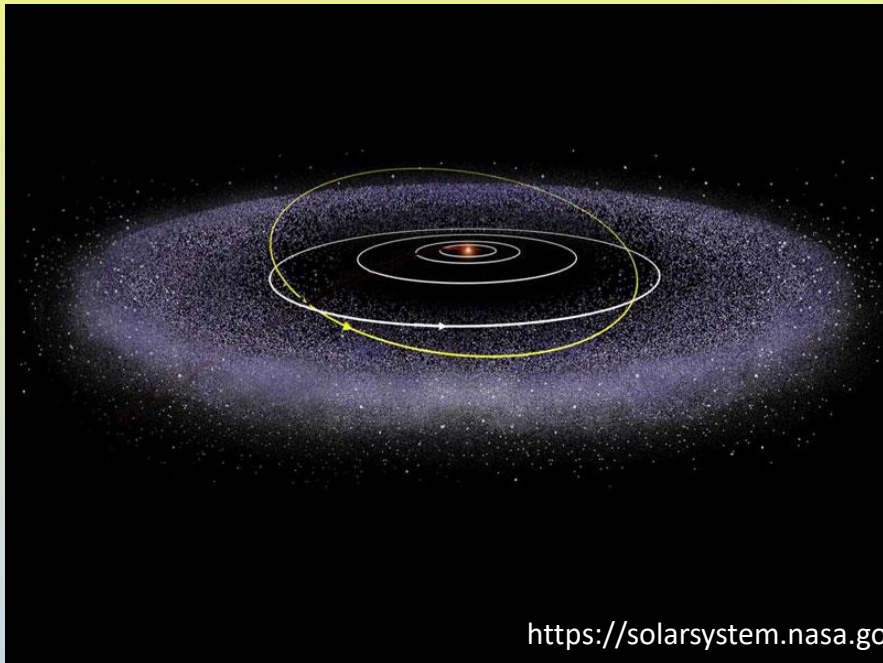
- **Benda-benda kecil** hadir di kawasan tertentu →
- Asteroid dan komet



Bagaimana Tata Surya Terbentuk? (5-2)

Model yang tepat harus mampu menjelaskan fakta teramati:

- **Benda-benda kecil** hadir di kawasan tertentu →
- Asteroid dan komet



Bagaimana Tata Surya Terbentuk? (5-3)

Model yang tepat harus mampu menjelaskan fakta teramati:

- **Benda-benda kecil** hadir di kawasan tertentu →
- Asteroid dan komet

Pluto: 0,187x
radius Bumi

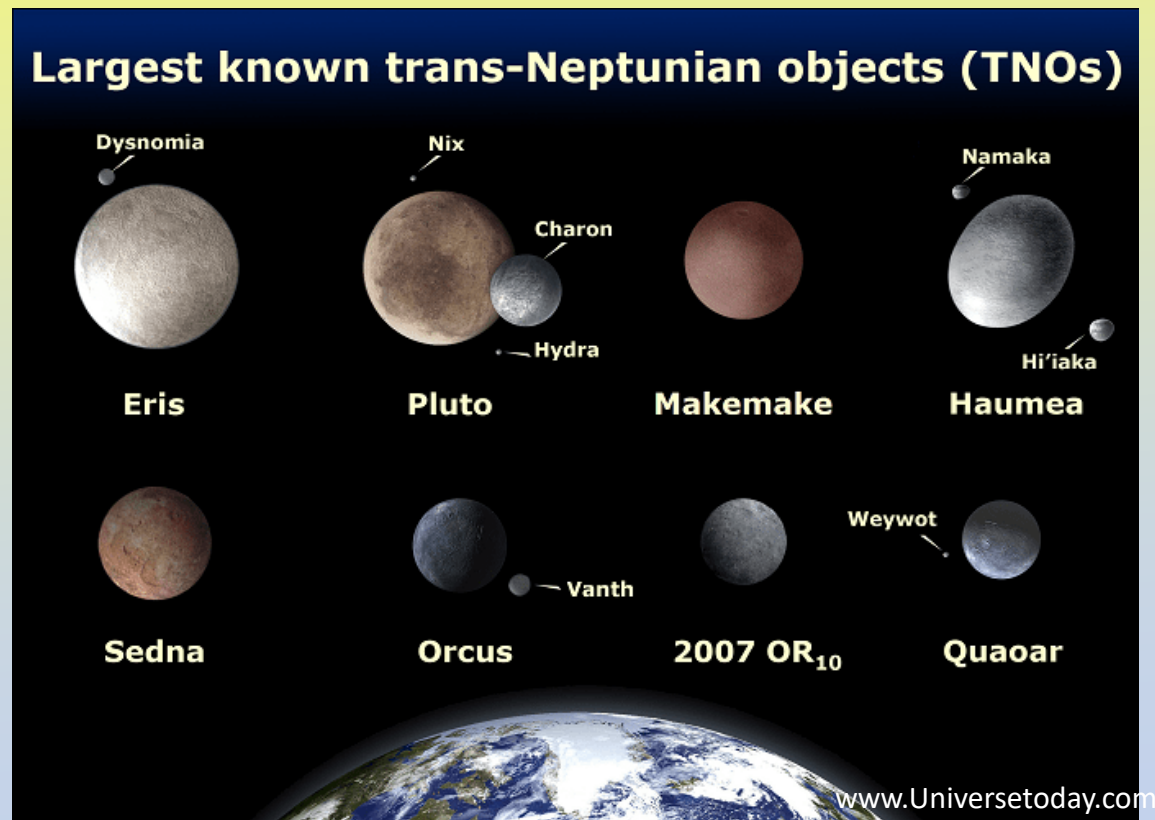
Eris: 0,183x
radius Bumi

Haumea: 0,12x
radius Bumi

Makemake: 0,11x
radius Bumi

Quaoar: 0,09x
radius Bumi

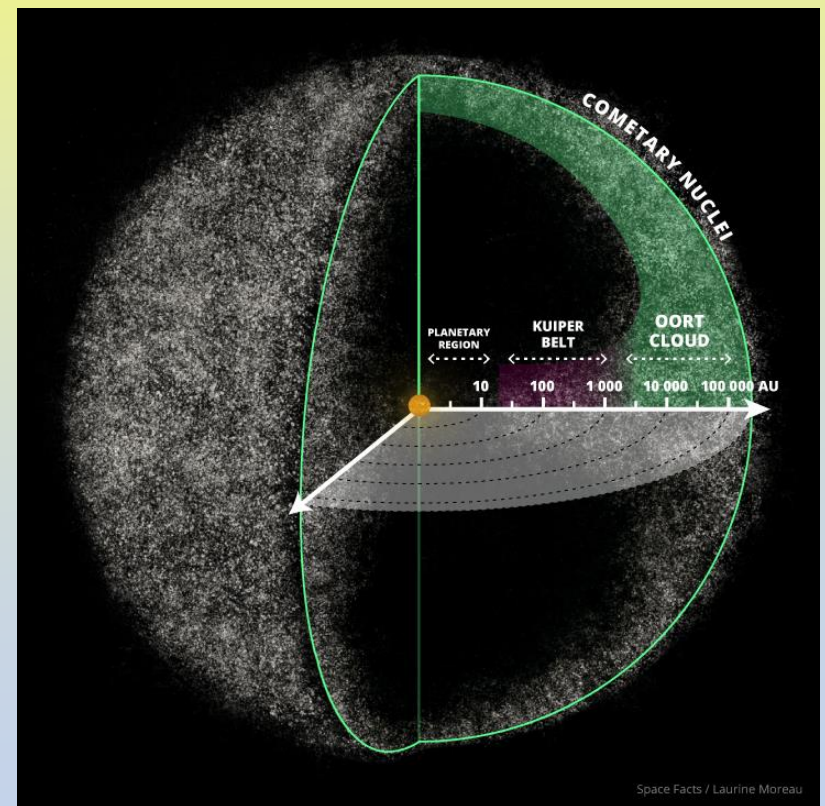
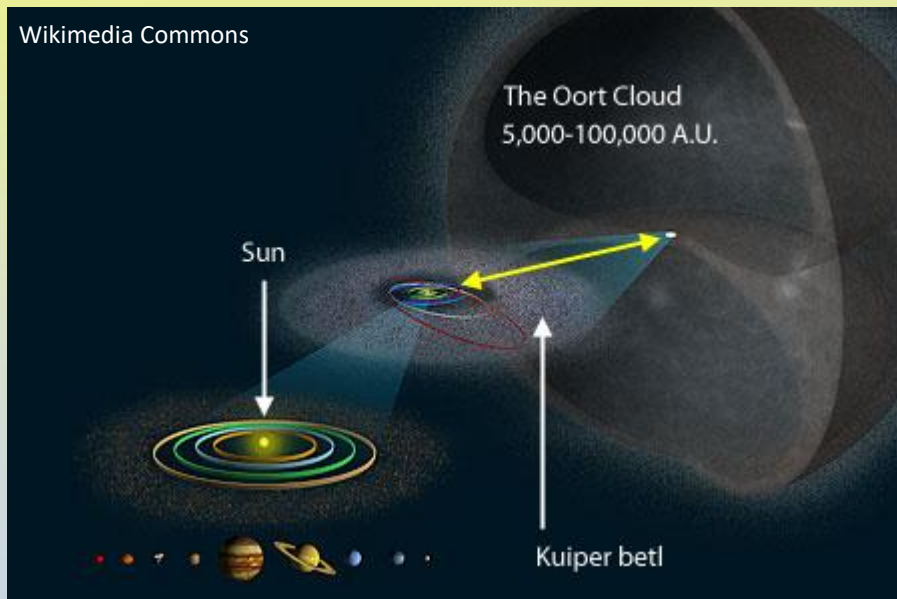
*Radius Bumi =
6370 km



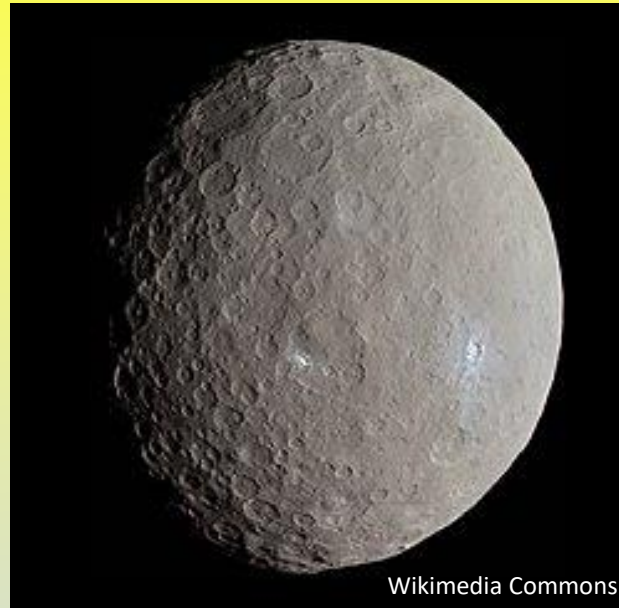
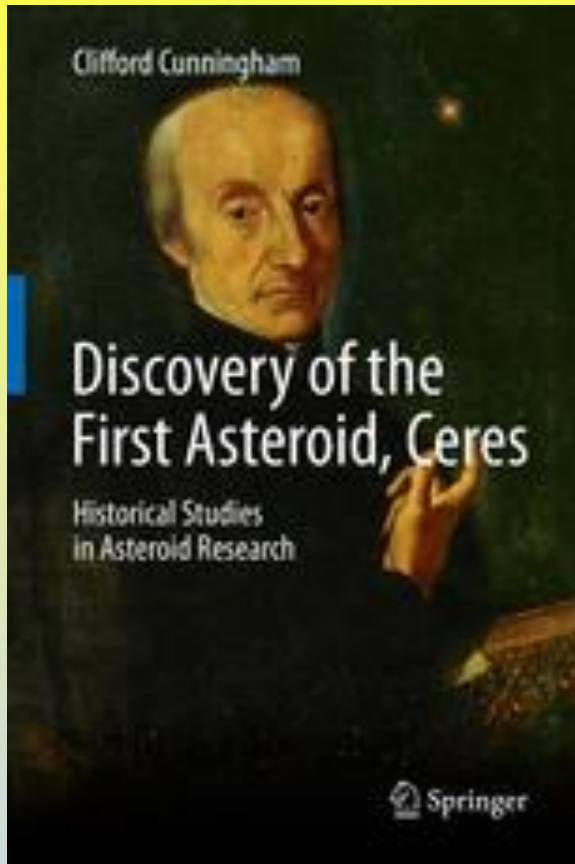
Bagaimana Tata Surya Terbentuk? (5-4)

Model yang tepat harus mampu menjelaskan fakta teramati:

- **Benda-benda kecil** hadir di kawasan tertentu →
- Asteroid dan komet



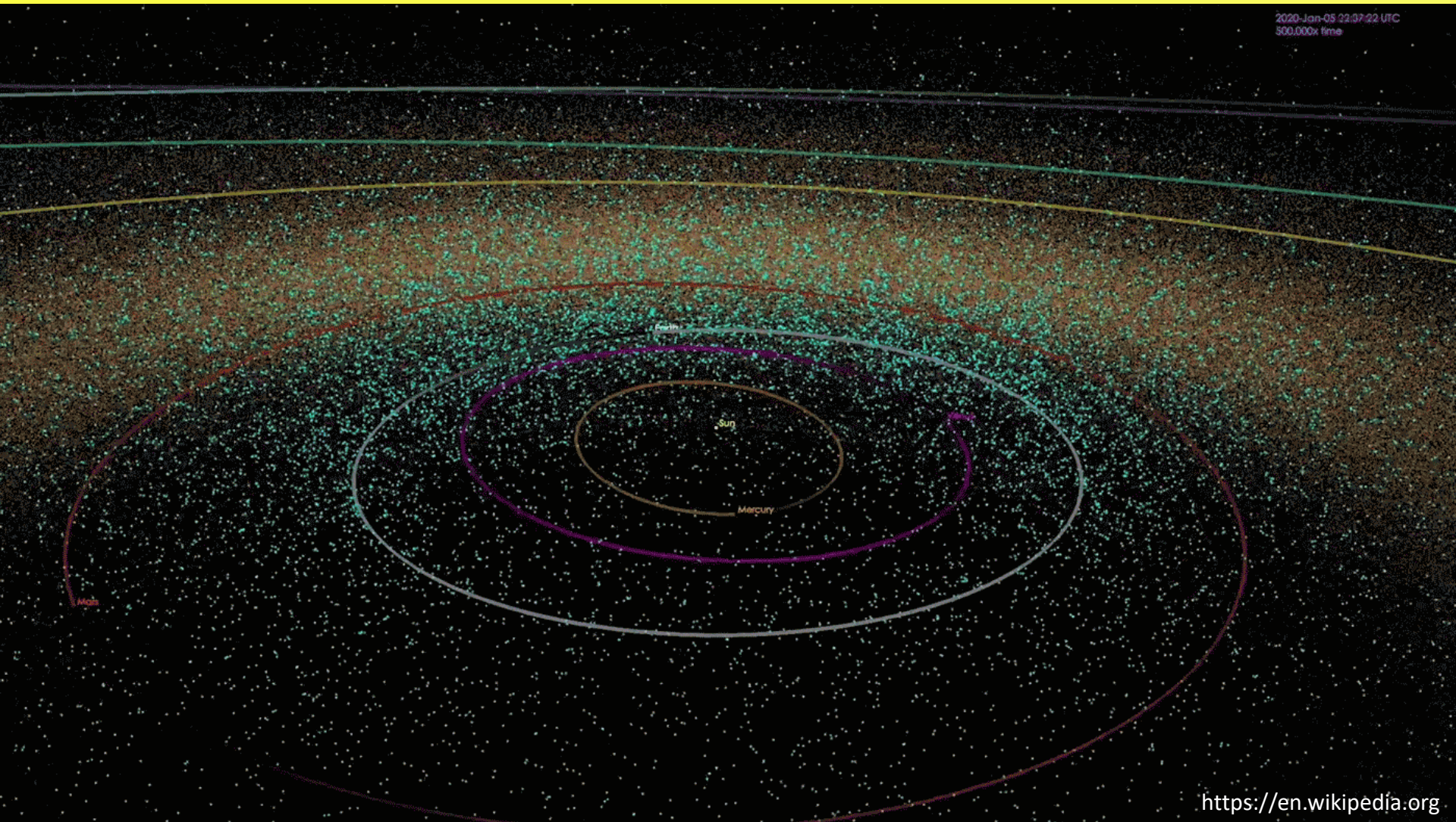
Momen “Aha...!” pada Abad Baru



Ditemukan pada 1 Januari 1801 oleh **Giuseppe Piazzi** di Observatorium Astronomi Palermo, Italia.

Sempat berstatus “**planet**”, sebelum diubah menjadi asteroid pada tahun 1850-an.

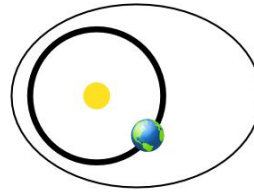
Mereka Menjelajah hingga ke Dekat-Bumi



Populasi Asteroid Dekat-Bumi (ADB)

Amors

Earth-approaching NEAs with orbits exterior to Earth's but interior to Mars' (named after asteroid (1221) Amor)



CNEOS-NASA

$$a > 1.0 \text{ AU} \\ 1.017 \text{ AU} < q < 1.3 \text{ AU}$$

Apollos

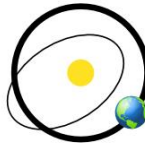
Earth-crossing NEAs with semi-major axes larger than Earth's (named after asteroid (1862) Apollo)



$$a > 1.0 \text{ AU} \\ q < 1.017 \text{ AU}$$

Atens

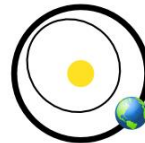
Earth-crossing NEAs with semi-major axes smaller than Earth's (named after asteroid (2062) Aten)



$$a < 1.0 \text{ AU} \\ Q > 0.983 \text{ AU}$$

Atiras

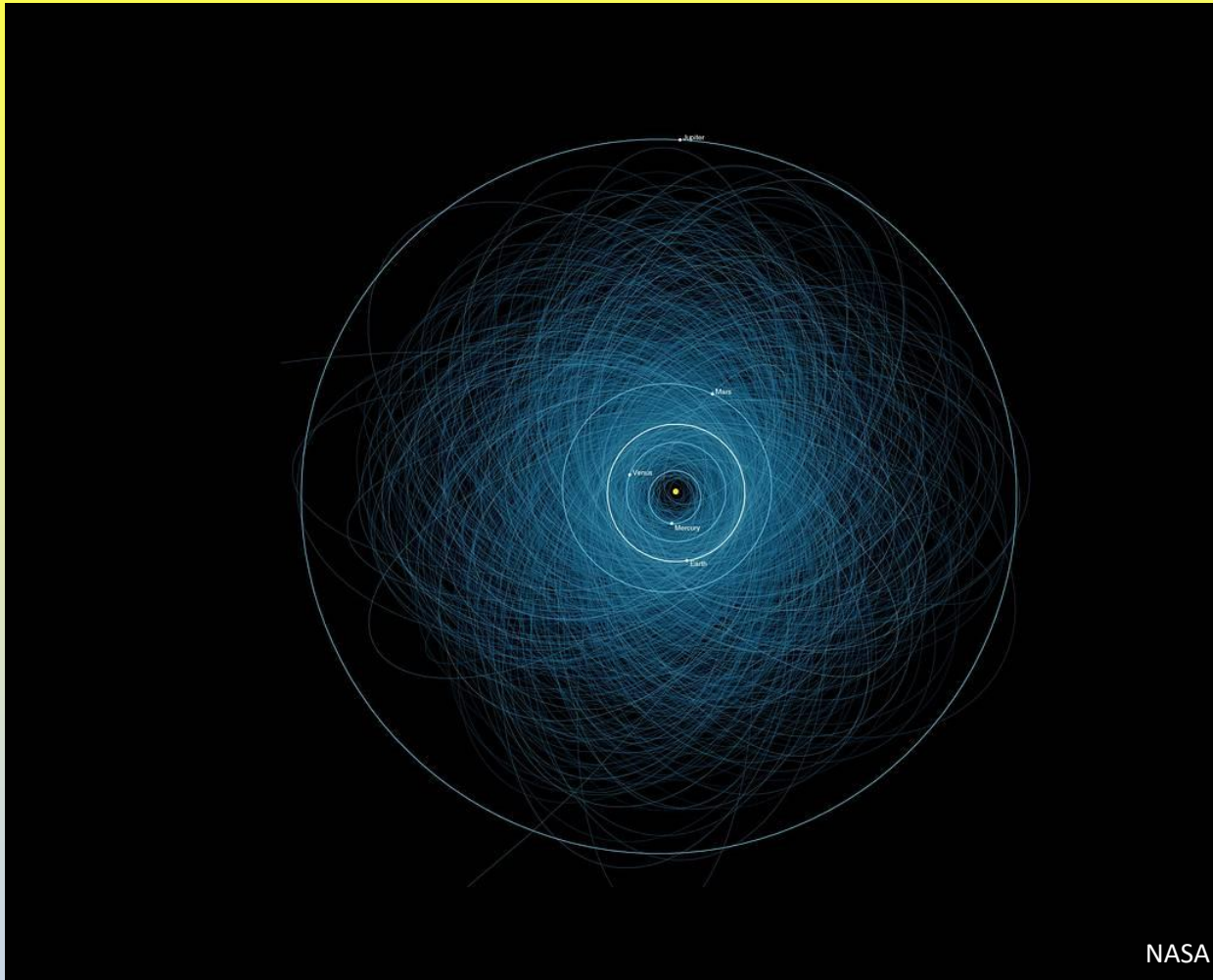
NEAs whose orbits are contained entirely within the orbit of the Earth (named after asteroid (163693) Atira)



$$a < 1.0 \text{ AU} \\ Q < 0.983 \text{ AU}$$

(q = perihelion distance, Q = aphelion distance, a = semi-major axis)

Kelas Khusus: PHAs



Definisi:

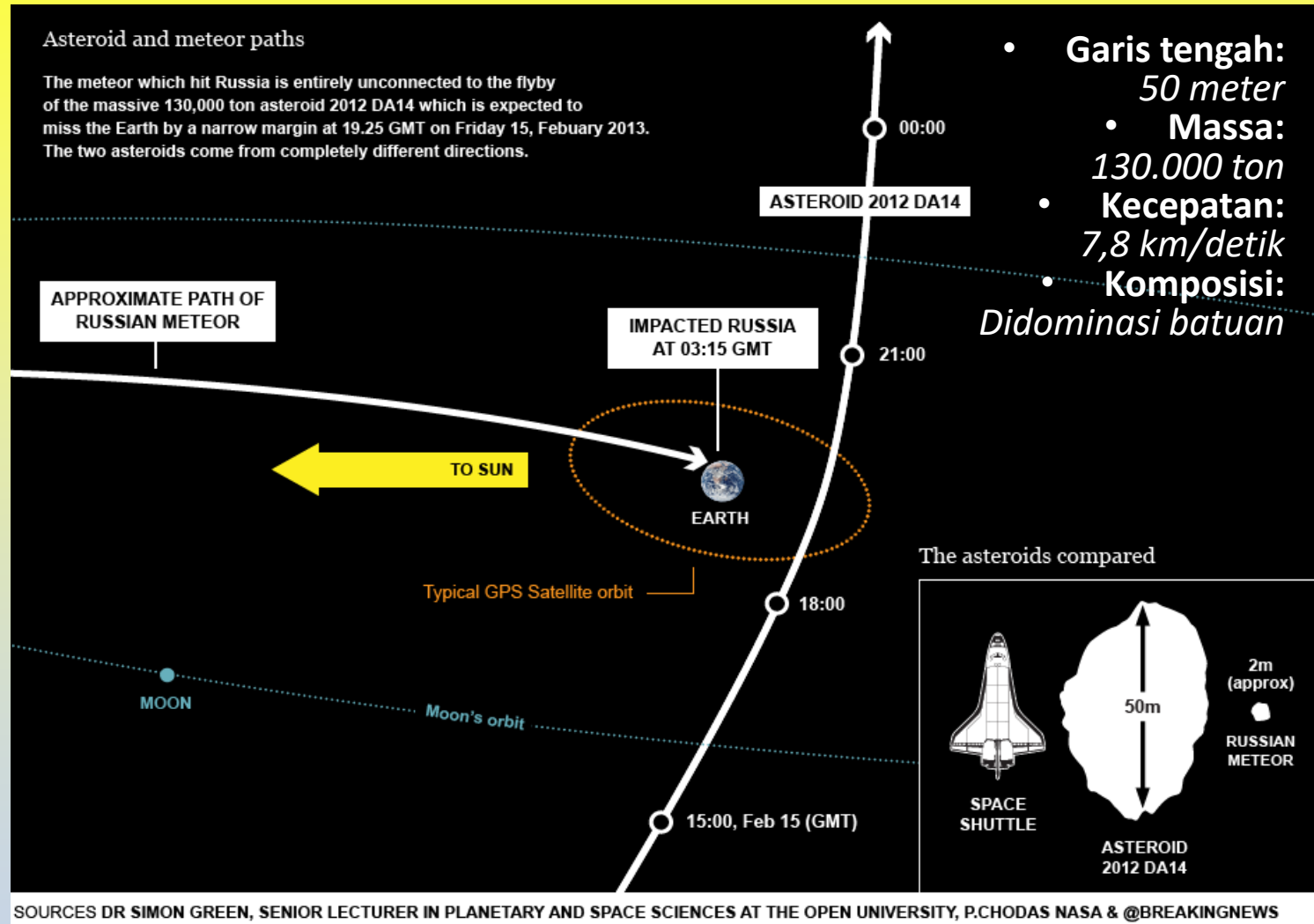
Asteroid dengan **MOID** $< 0,05$ sa (kurang dari 19,5x jarak Bumi-Bulan) dan **magnitudo absolut** < 22 ($D > 140$ m).

Per 17 Oktober 2020:
2058 PHAs. Sebagian besar dari kelas **Apollo**.

Yang terbesar:

3122 Florence (1981 ET3)
dengan **H** = 14,0 yang setara $4 \text{ km} < D < 9 \text{ km}$.

Populasi ADB Adakalanya *Nyelonong*



Menarik Perhatian Kami Juga (☺)

DINAMIKA ORBIT ASTEROID 2012 DA14 PASCAPAPASAN DEKAT DENGAN BUMI

Judhistira Aria Utama^{1*)}, Budi Dermawan², Taufiq Hidayat², Umar Fauzi³

¹Program Studi Astronomi, Jl. Ganesha 10, Bandung 40132

²KK Astronomi, Jl. Ganesha 10, Bandung 40132

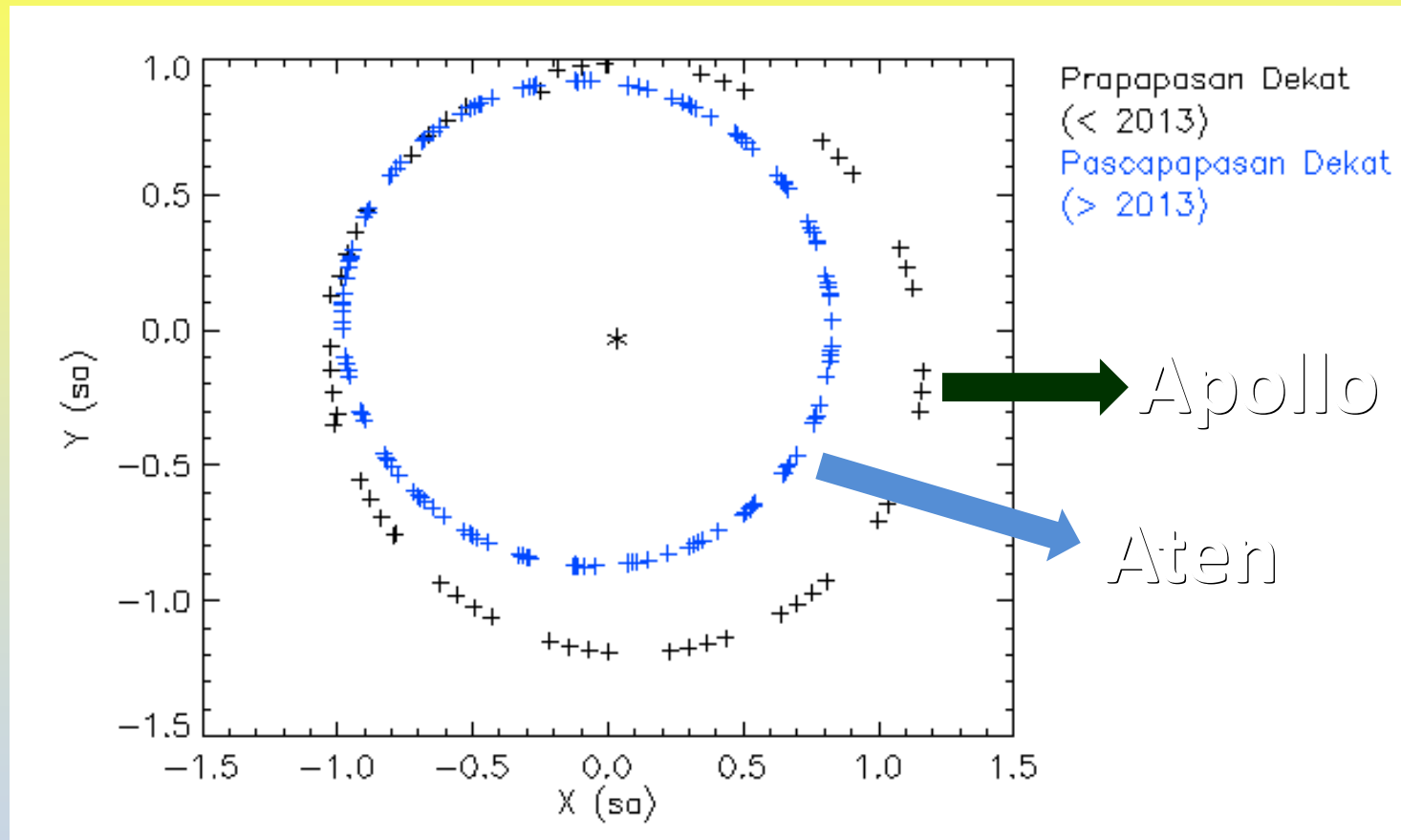
²KK Astronomi, Jl. Ganesha 10, Bandung 40132

³KK Fisika Bumi dan Sistem Kompleks, Jl. Ganesha 10, Bandung 40132

^{*)} Email: ariautama@students.itb.ac.id

Papasan Dekat:

Perubahan bentuk, ukuran, & orientasi orbit



Namun Ada Juga yang Menumbuk Bumi (1)

Terkecil, paling sering



Sangat besar, sangat jarang

15 km
100 Juta thn

Kepunahan dinosaurus, 65 juta tahun silam



*Perluakah Kita
Khawatir?*

500.000 tahun



Tunguska, 1908



Namun Ada Juga yang Menumbuk Bumi (2)



Asteroid **2008 TC3** masuk dan meledak di atmosfer di atas gurun Nubian, Sudan, pada 7 Oktober 2008.

Diameter: 4,1 m

Massa: 80.000 kg



Namun Ada Juga yang Menumbuk Bumi (3)

Usia kawah: 50.000 tahun

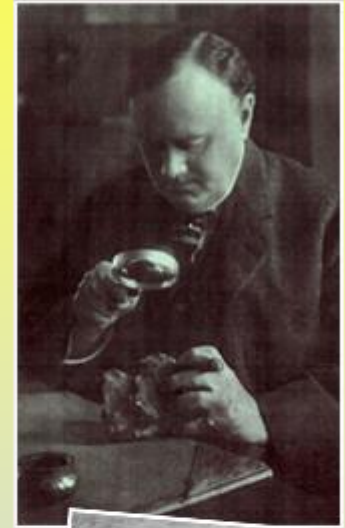
Massa penumbuk: 300.000 ton

Kecepatan penumbuk: 12 km/detik

Energi tumbukan: 150x bom atom Hiroshima



apod.nasa.gov



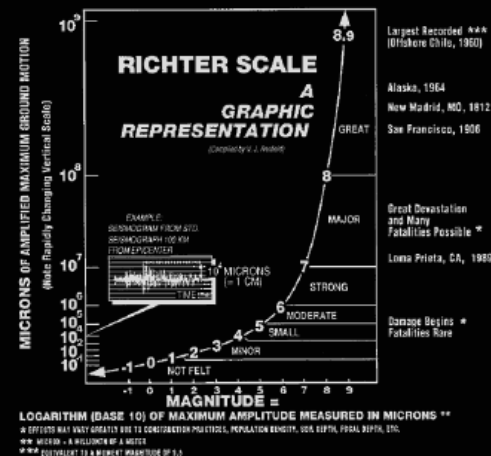
Kawah Tumbukan di Indonesia?



Skala Bahaya

"It's a 100 per cent certain we'll be hit [by a devastating asteroid], but we're not 100 per cent sure when."
(B612 Foundation, 2018)

		number per year
<2.5	generally not felt	900,000
2.5-5.4	Often felt Minor damage	30,000
5.5-6.0	Some damage to structures	500
6.1-6.9	Destructive in populous regions	100
7.0-7.9	Major earthquake with serious damage	20
≥8.0	Great earthquake with total destruction	1 every 5 - 10 years



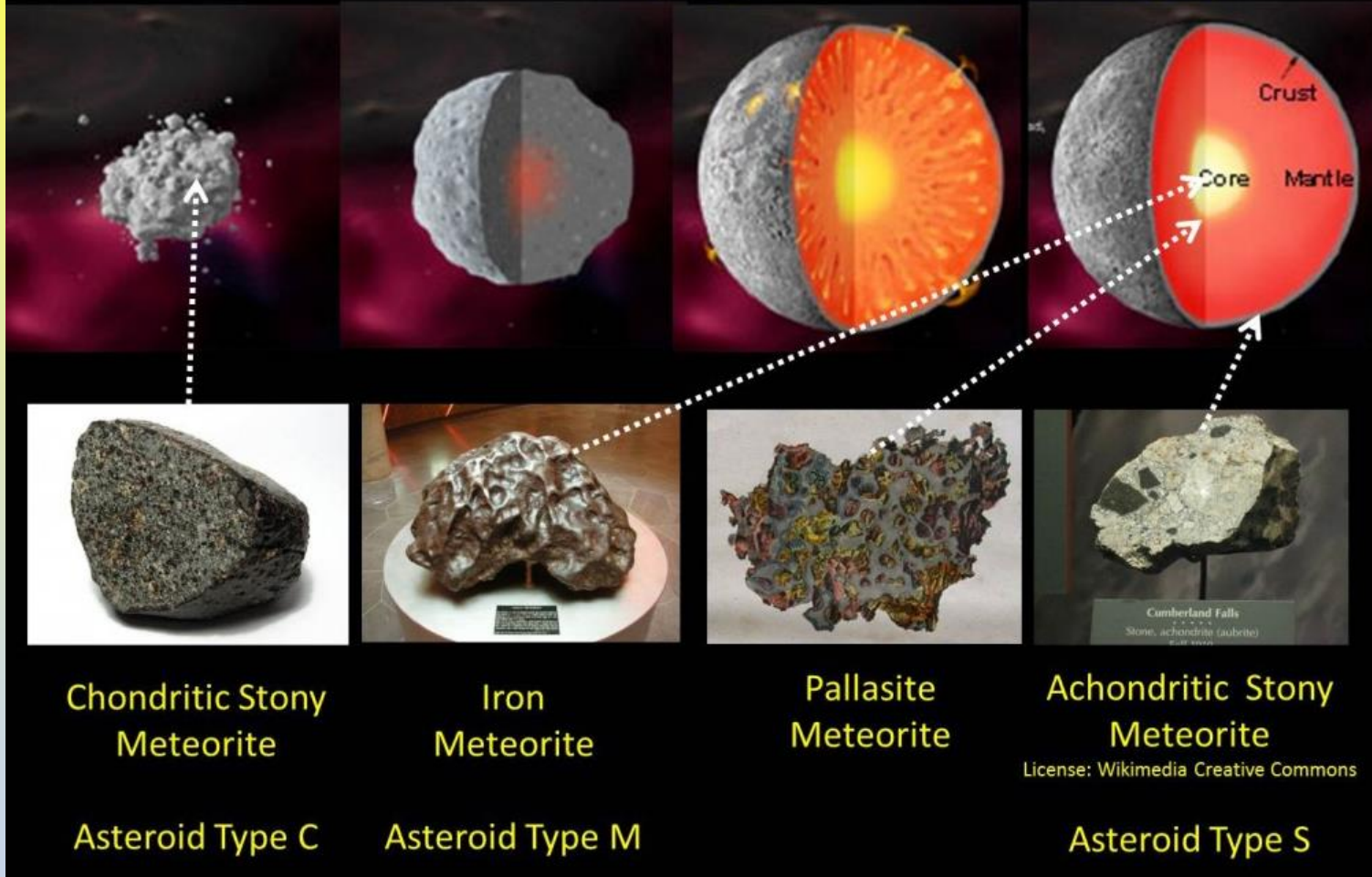
THE TORINO SCALE Assessing Asteroid and Comet Impact Hazard Predictions in the 21st Century

Events Having No Likely Consequences	0	The likelihood of a collision is zero, or well below the chance that a random object of the same size will strike the Earth within the next few decades. This designation also applies to any small object that, in the event of a collision, is unlikely to reach the Earth's surface intact.
Events Meriting Careful Monitoring	1	The chance of collision is extremely unlikely, about the same as a random object of the same size striking the Earth within the next few decades.
	2	A somewhat close, but not unusual encounter. Collision is very unlikely.
Events Meriting Concern	3	A close encounter, with 1% or greater chance of a collision capable of causing localized destruction.
	4	A close encounter, with 1% or greater chance of a collision capable of causing regional devastation.
Threatening Events	5	A close encounter, with a significant threat of a collision capable of causing regional devastation.
	6	A close encounter, with a significant threat of a collision capable of causing a global catastrophe.
Certain Collisions	7	A close encounter, with an extremely significant threat of a collision capable of causing a global catastrophe.
	8	A collision capable of causing localized destruction. Such events occur somewhere on Earth between once per 50 years and once per 1000 years.
	9	A collision capable of causing regional devastation. Such events occur between once per 1000 years and once per 100,000 years.
	10	A collision capable of causing a global climatic catastrophe. Such events occur once per 100,000 years, or less often.

Peluang Apa yang Dapat Diambil? (1)

Different Asteroid & Meteorite Types

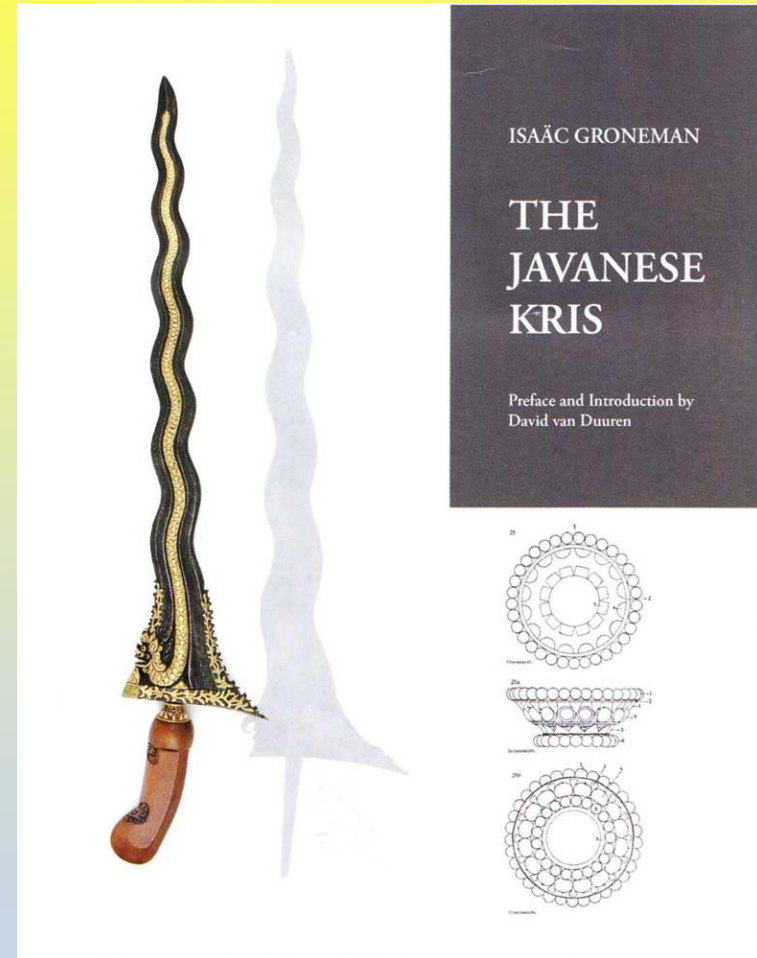
Source: Smithsonian Museum of Natural History http://www.mnh.si.edu/earth/text/5_1_4_0.html



Peluang Apa yang Dapat Diambil? (2)

Bahan pembuat pamor keris di kesultanan Yogya-karta dan Surakarta berasal dari **meteorit besi** yang jatuh di abad-18, di sekitar Candi Prambanan.

“Bagaimana memperoleh material yang jarang dijumpai di Bumi, yang justru tersedia melimpah di langit?”



Peluang Apa yang Dapat Diambil? (3)

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Defining a successful commercial asteroid mining program[☆]

Dana G. Andrews^{*}, K.D. Bonner, A.W. Butterworth, H.R. Calvert, B.R.H. Dagang, K.J. Dimond, L.G. Eckenroth, J.M. Erickson, B.A. Gilbertson, N.R. Gompertz, O.J. Igbinosun, T.J. Ip, B.H. Khan, S.L. Marquez, N.M. Neilson, C.O. Parker, E.H. Ransom, B.W. Reeve, T.L. Robinson, M. Rogers, P.M. Schuh, C.J. Tom, S.E. Wall, N. Watanabe, C.J. Yoo

University of Washington, USA



THE ASTROPHYSICAL JOURNAL LETTERS, 785:L4 (5pp), 2014 April 10
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doi:10.1088/2041-8205/785/1/L4

HOW TO FIND METAL-RICH ASTEROIDS

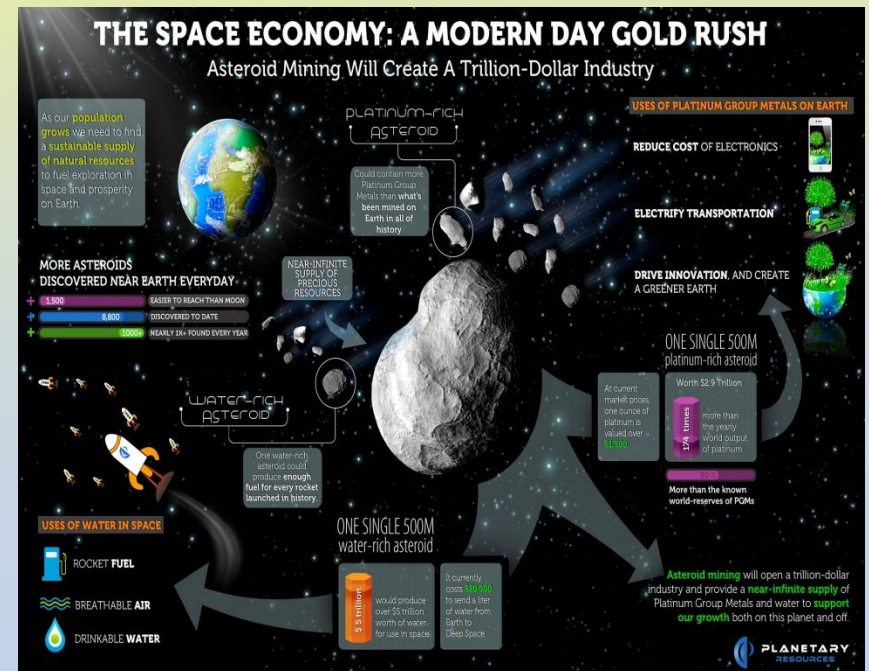
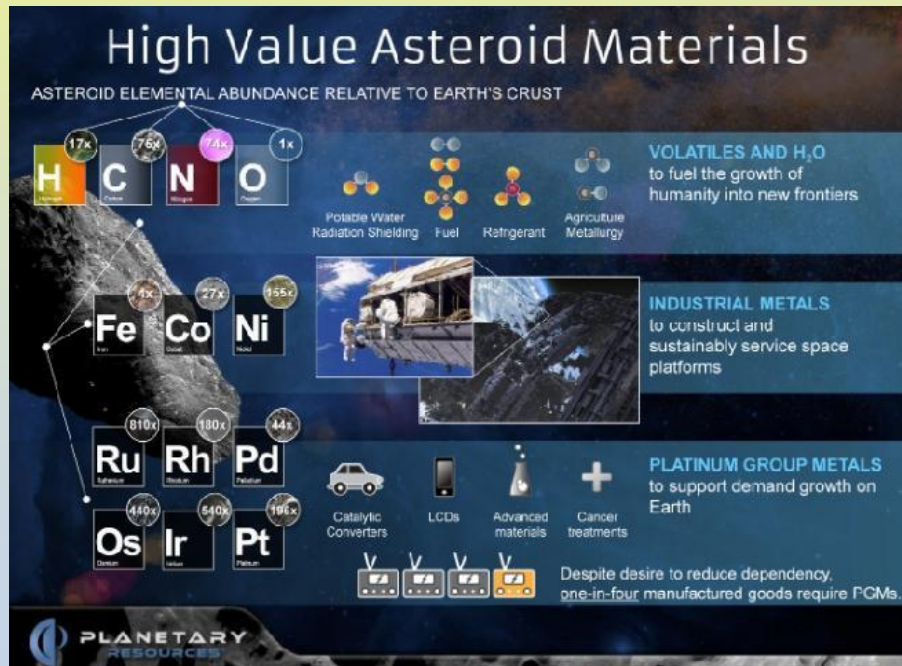
ALAN W. HARRIS AND LINE DRUBE

German Aerospace Center (DLR) Institute of Planetary Research, Rutherfordstrasse 2, D-12489 Berlin, Germany; alan.harris@dlr.de
Received 2014 February 3; accepted 2014 March 8; published 2014 March 24

ABSTRACT

The metal content of asteroids is of great interest, not only for theories of their origins and the evolution of the solar system but, in the case of near-Earth objects (NEOs), also for impact mitigation planning and endeavors in the field of planetary resources. However, since the reflection spectra of metallic asteroids are largely featureless, it is difficult to identify them and relatively few are known. We show how data from the *Wide-field Infrared Survey Explorer* (WISE)/NEOWISE thermal-infrared survey and similar surveys, fitted with a simple thermal model, can reveal objects likely to be metal rich. We provide a list of candidate metal-rich NEOs. Our results imply that future infrared surveys with the appropriate instrumentation could discover many more metal-rich asteroids, providing valuable data for assessment of the impact hazard and the potential of NEOs as reservoirs of vital materials for future interplanetary space activities and, eventually perhaps, for use on Earth.

Key words: infrared: planetary systems – minor planets, asteroids: general



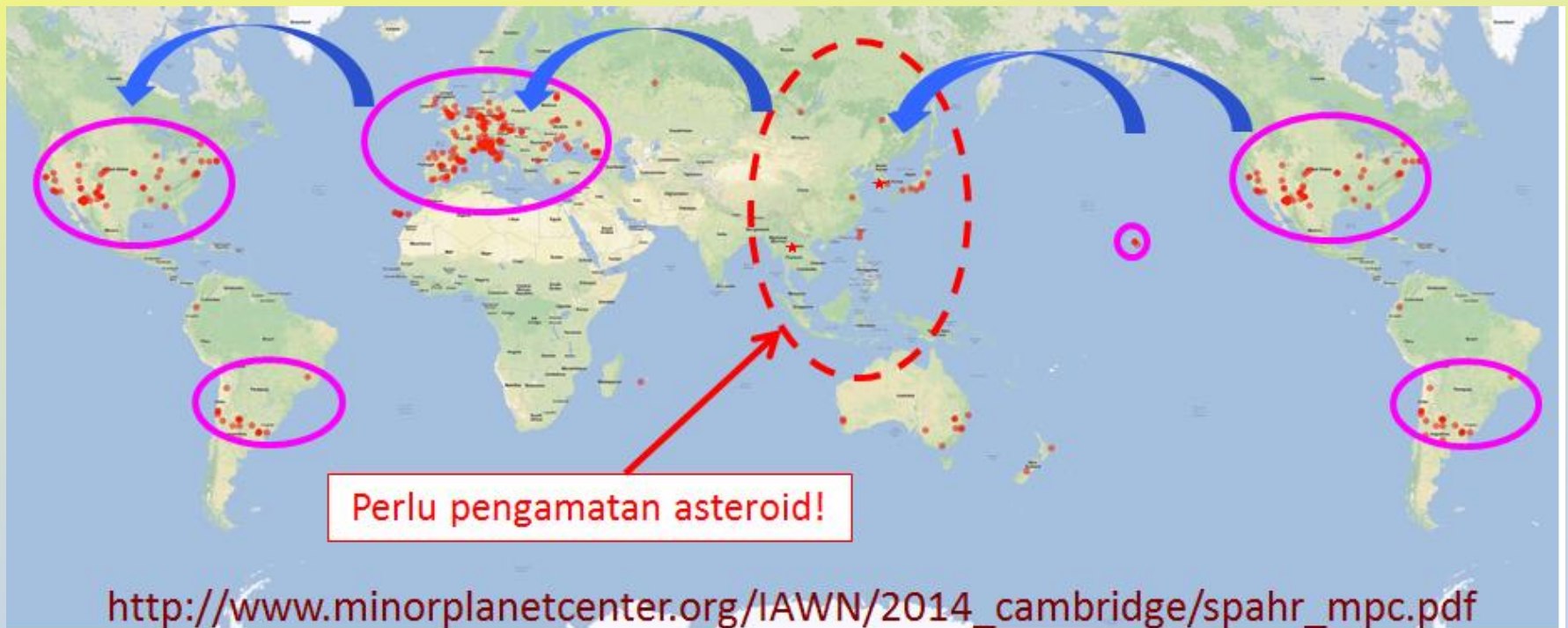
Asteroid “Mendadak” jadi Penting

1. **Alasan ilmu pengetahuan:** Asteroid bisa menjelaskan sejarah pembentukan Tata Surya.
2. **Alasan ekonomi:** Sumber daya alam yang jauh lebih besar daripada yang bisa diperoleh di Bumi.
3. **Alasan keberlangsungan kehidupan di Bumi:** Potensi ancaman asteroid yang bisa menumbuk Bumi.
4. **Bukti kemajuan umat manusia:** Target umat manusia setelah pendaratan di Bulan.
5. PBB mendeklarasikan **30 Juni 2016** sebagai **hari asteroid Internasional** sebagai pembangun wawasan akan pentingnya asteroid bagi manusia dan generasi mendatang.

Kerja Sama Internasional

Rekomendasi PBB tahun 2013: *International Response to the NEO Impact Threat* (A/AC.105/C.1/L.329)

International Asteroid Warning Network (IAWN)



Fasilitas Baru di Indonesia (1)

“Timau dipilih, selain kondisi alamnya, juga kondisi geografis dan kependudukannya, di mana kondisi langit bebas polusi cahayanya bisa bertahan lama, seperti Bosscha dahulu. Diharapkan Gunung Timau bisa mengakses langit bebas polusi cahaya, setidaknya sampai 50 tahun ke depan, seperti Bosscha yang bisa menikmati langit malam bebas polusi setidaknya selama 60 tahun (era 1920-an – 1980-an).”

Thomas Djamaluddin, Kepala LAPAN RI



Fasilitas Baru di Indonesia (2)

Teleskop Optik 3,8 meter

Dengan diameter bukaan 3,8 meter, teleskop ini akan masuk dalam daftar teleskop besar dunia. Teleskop ini memiliki desain yang unik serta memiliki bobot yang ringan (~20 ton).

Struktur 'laba-laba'
menopang cermin sekunder

Cermin primer
berbentuk hiperbola yang terdiri atas 18 segmen berbentuk kelopak bunga.

Sistem optika aktif
menopang setiap segmen cermin dan memastikan cermin primer tetap berbentuk hiperbola sempurna.

Struktur dasar
berbentuk cincin yang menopang teleskop di atas pilar beton.

Struktur 'laba-laba'
menopang cermin sekunder

Cermin sekunder
berbentuk hiperbola berdiameter 1 meter dapat bergerak dengan 5 derajat bebas.

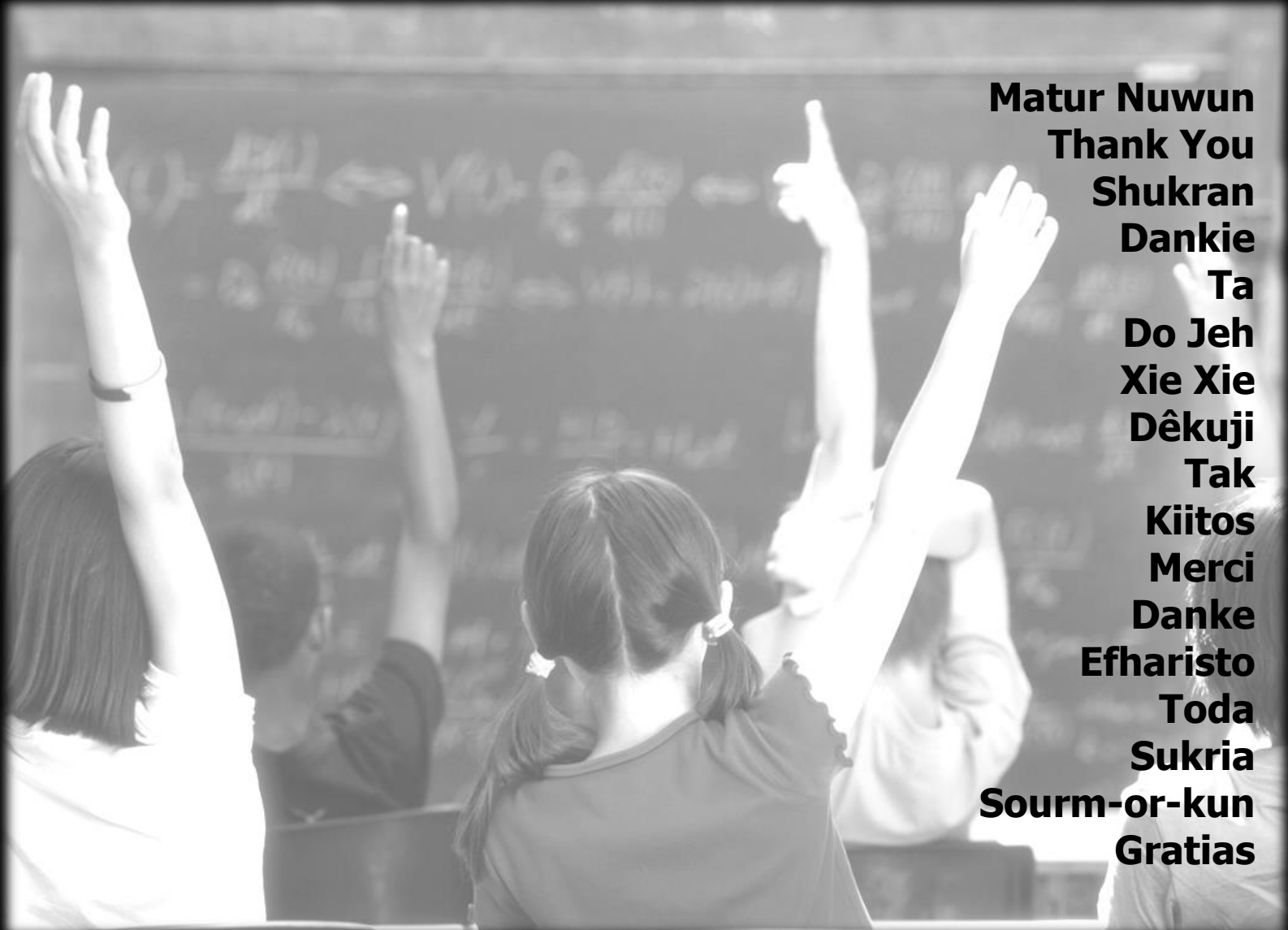
Cermin tersier
untuk mengarahkan sinar ke titik fokus Nasmyth.

Nasmyth platform
yang mampu menopang instrumen dengan bobot hingga 1 ton.

Busur vertikal
yang menjadi bagian kunci pergerakan teleskop arah altitude.



TERIMA KASIH



Matur Nuwun

Thank You

Shukran

Dankie

Ta

Do Jeh

Xie Xie

Dêkuji

Tak

Kiitos

Merci

Danke

Efharisto

Toda

Sukria

Sourm-or-kun

Gratias

Catatan Akhir

“It is the time to raise awareness about asteroids and what can be done to protect the Earth, its families, communities, and future generations from a catastrophic event and make advantages from them.”