Title: Science Fiction and Reality

Date: May 07, 2008 07:00 AM

URL: http://pirsa.org/08050023

Abstract: In the recent past, rapid scientific and technological developments have had tremendous impact on human society. Notably, the personal computer, internet and mobile telephones changed the world and shrank our planet. These developments are vastly different from the forecasts by science fiction authors who promised us space travel and intelligent humanoid robots. Could real scientists have done a better job in forecasting the future? What can we say about the future now?

 Many science fiction fantasies will never materialize. Some will, but only over time spans of millions of years rather than a couple of centuries. Nature's laws are very strict and forbidding but also show gaps that might promise fantastic possibilities for a scientific future, even within our lifetime.

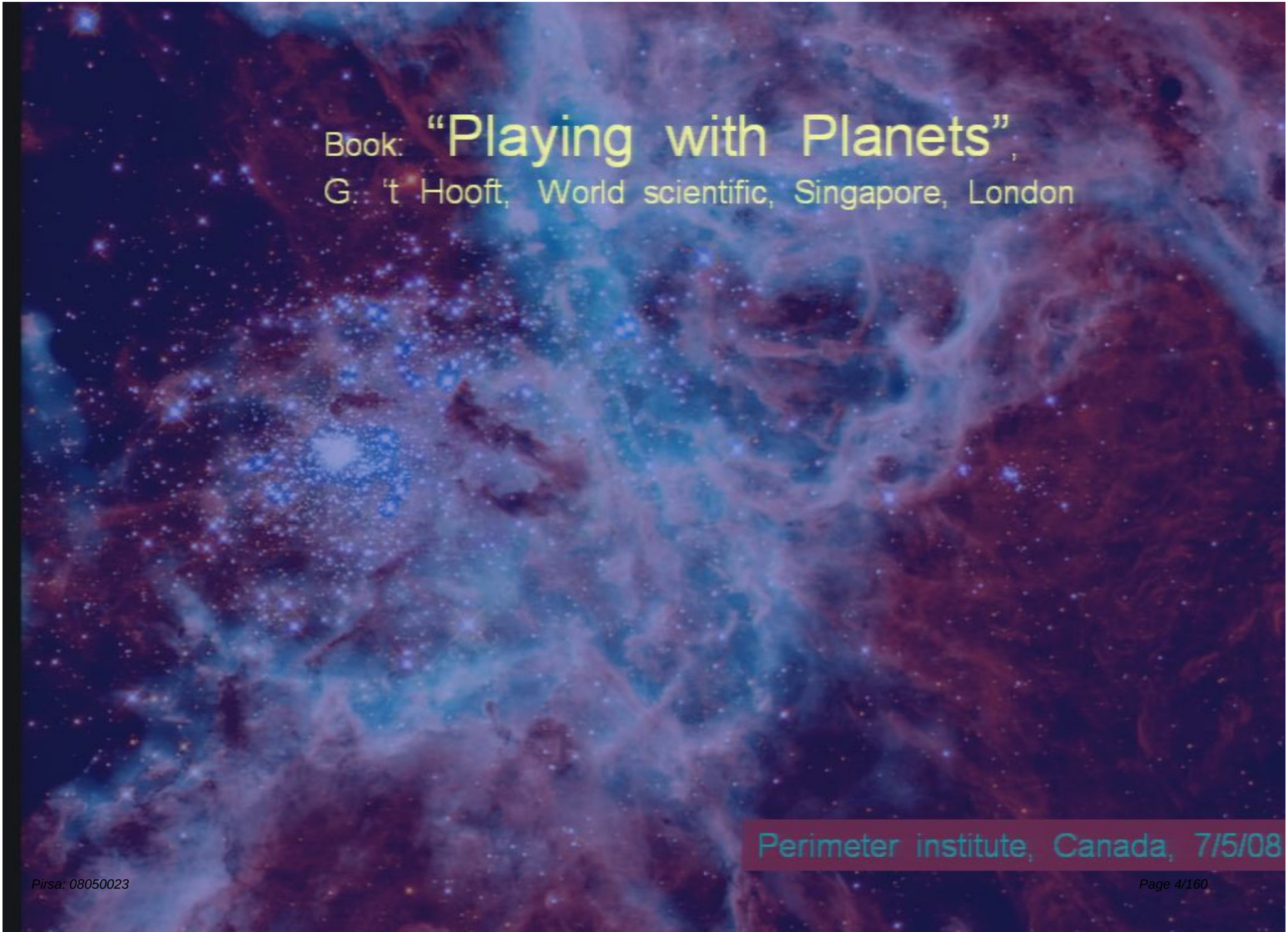
 Gerard T' Hooft was born in 1946, and raised in the Netherlands. He studied theoretical physics at the University of Utrecht in the Netherlands, completing his thesis work in 1972, under the supervision of Martin Veltman. For two years he continued his research at the European particle physics laboratory CERN, Geneva. After lectureships at Utrecht and in the USA (Harvard, Stanford), he was appointed full professor at Utrecht University in 1976. Among his many honours, he and Veltman were awarded the The Nobel Prize in physics 1999, ""For elucidating the quantum structure of electroweak interactions in physics"", which refers to their joint work in 1972. More recently, T' Hooft became a member of Perimeter Instituteâ€™s highly esteemed Scientific Advisory Committee (SAC).

 His research brought important new insights showing how to use quantized fields to describe sub-atomic particles, such as renormalization, magnetic monopoles, quark confinement and the physical effects of instantons. Later he turned his interest to the quantum aspects of gravitation and black holes. Dr. T' Hooft also supports educational outreach activities and considers the communication of fundamental science to the public as one of his most important duties.


Utrecht University
Science Fiction
and REALITY
Gerard 't Hooft
Perimeter institute, Canada, 7/5/0

Questions

- What can we do with modern science, and what will stay out of reach forever ?
  - Will we solve problems concerning energy, poverty, climate change ?
- How far will we prolong human lifetimes?
  - How will society change ?
- Will humanity be able to conquer space, and how far will we get ?
  - Will we outlive planet Earth?
    - What can modern science say, using things known today ?


Book: "Playing with Planets",
G. 't Hooft, World scientific, Singapore, London
Perimeter institute, Canada, 7/5/08

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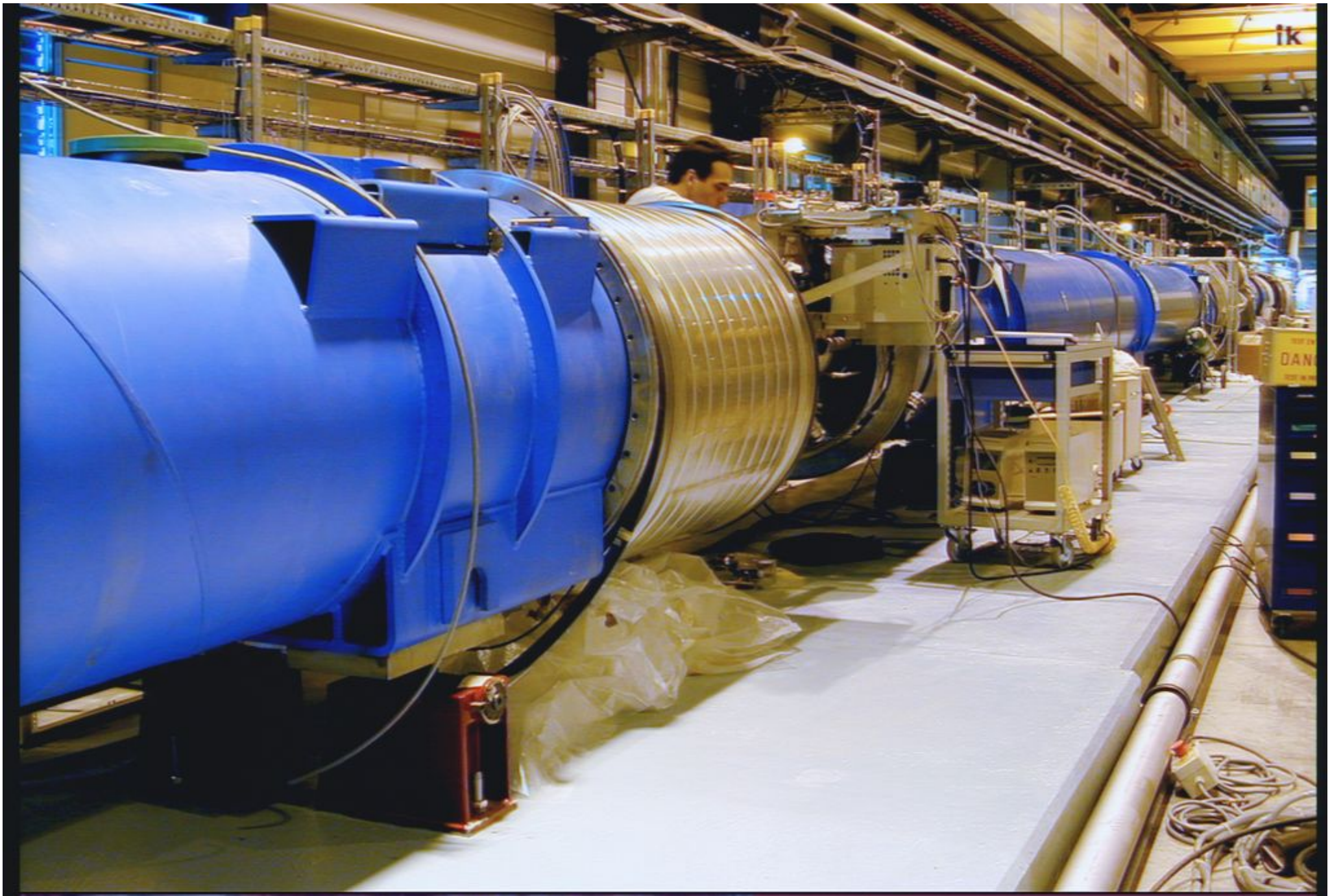
G. 't Hooft, World scientific, Singapore, London

This talk: excerpts:

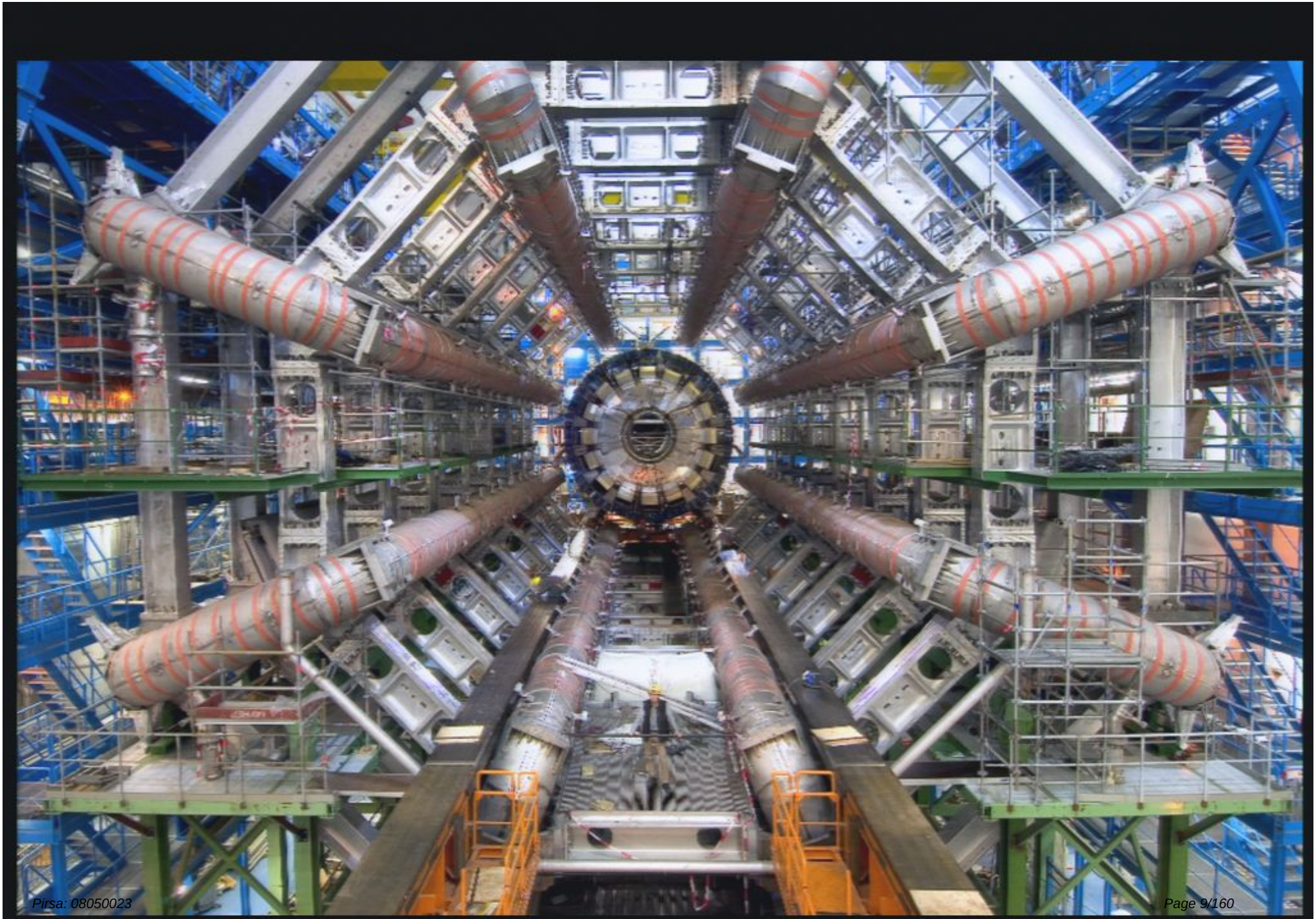
Atoms
Nanoscience,
Intelligent computers
Robots
Conquering outer space

Perimeter institute, Canada, 7/5/08

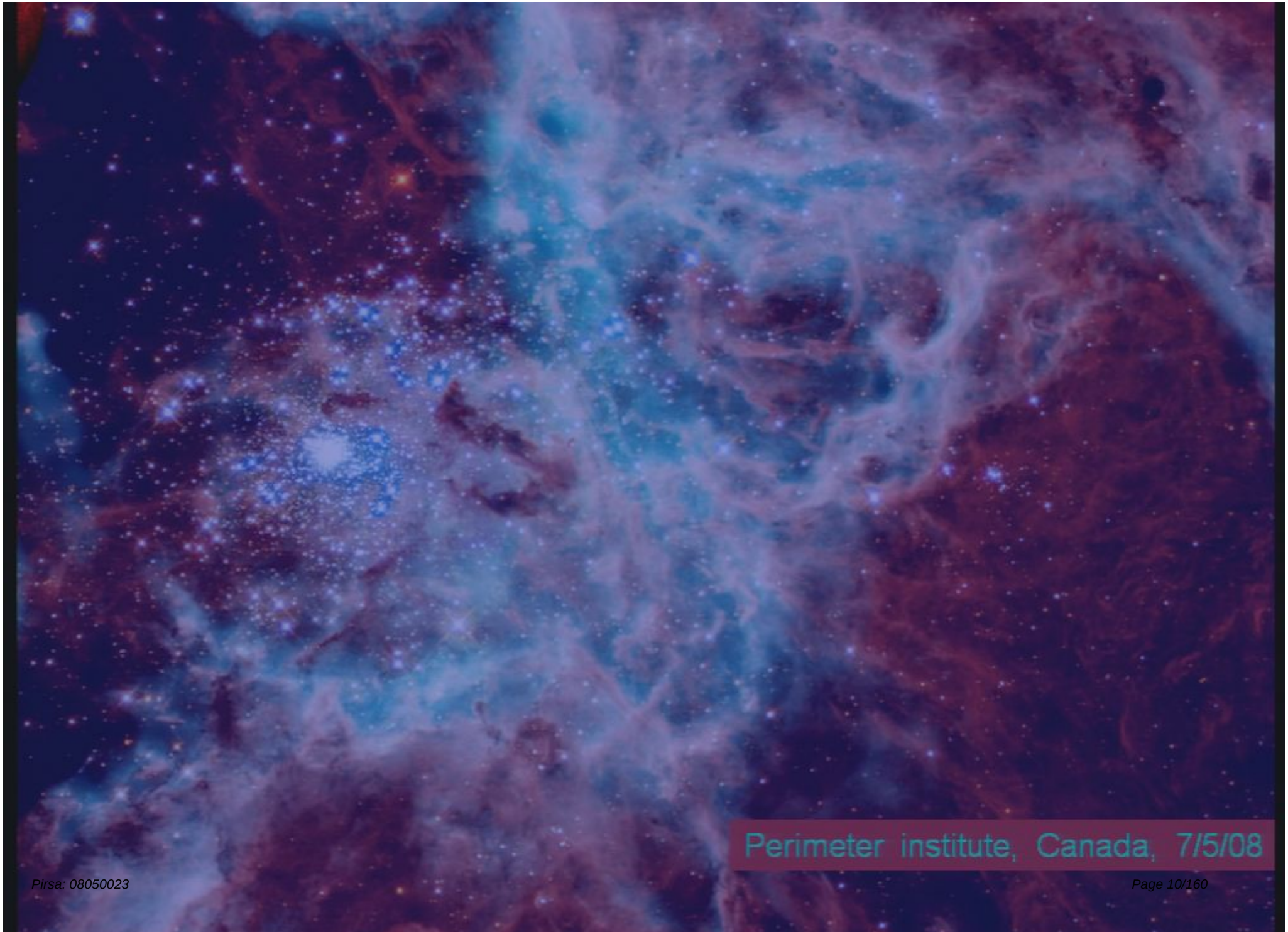

Questions on Earth

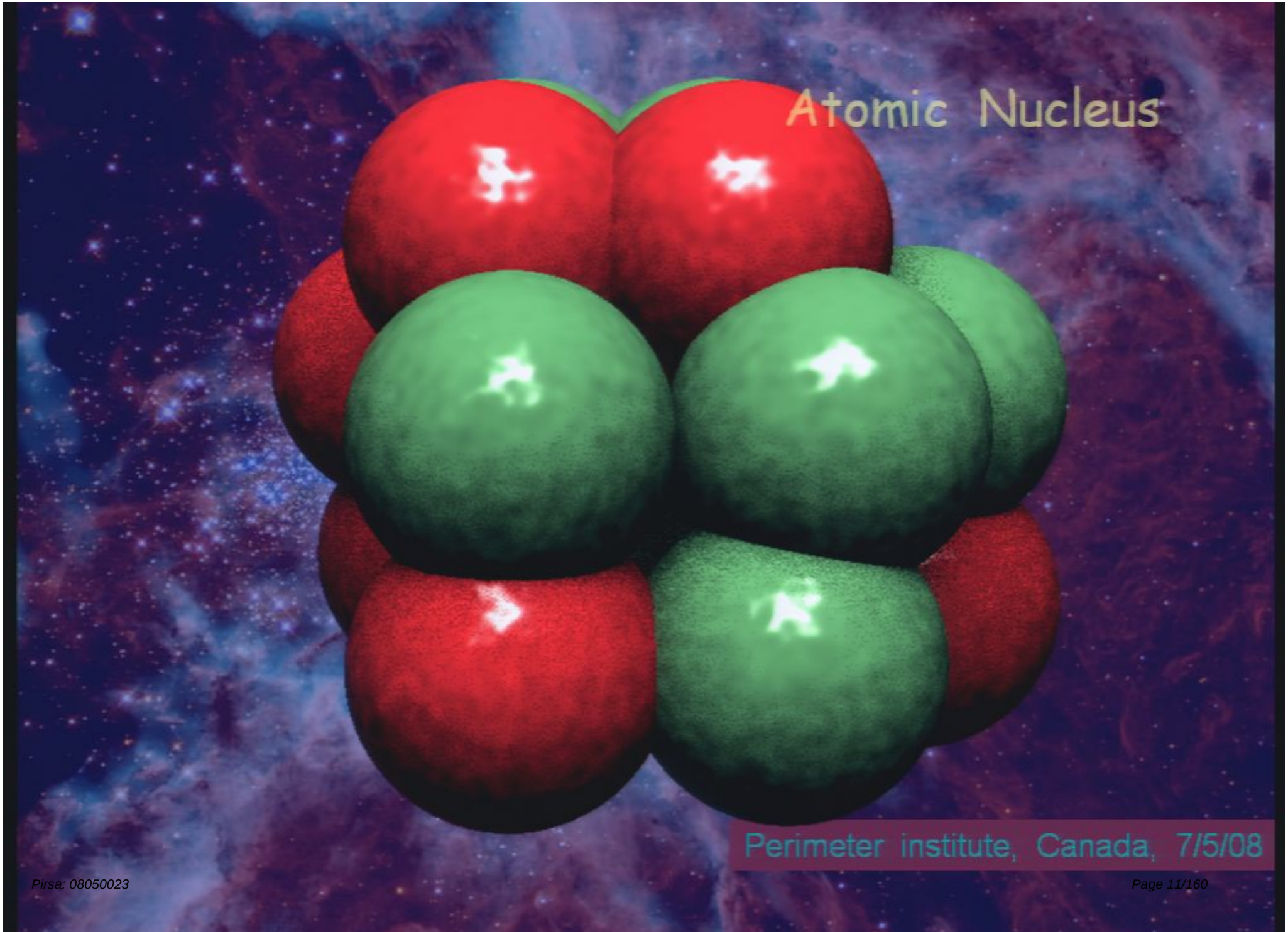


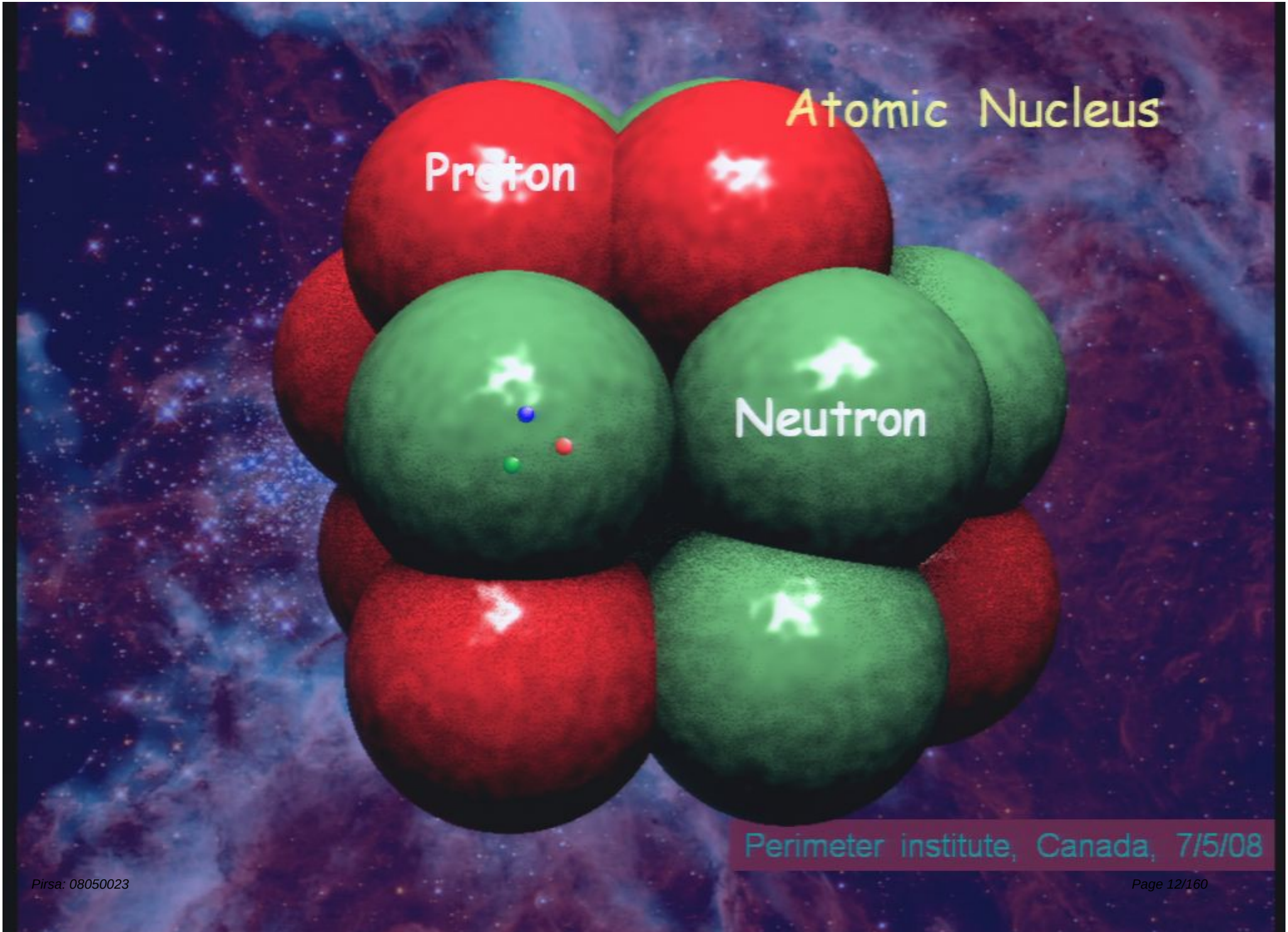
LHC, CERN, Geneva, magnets

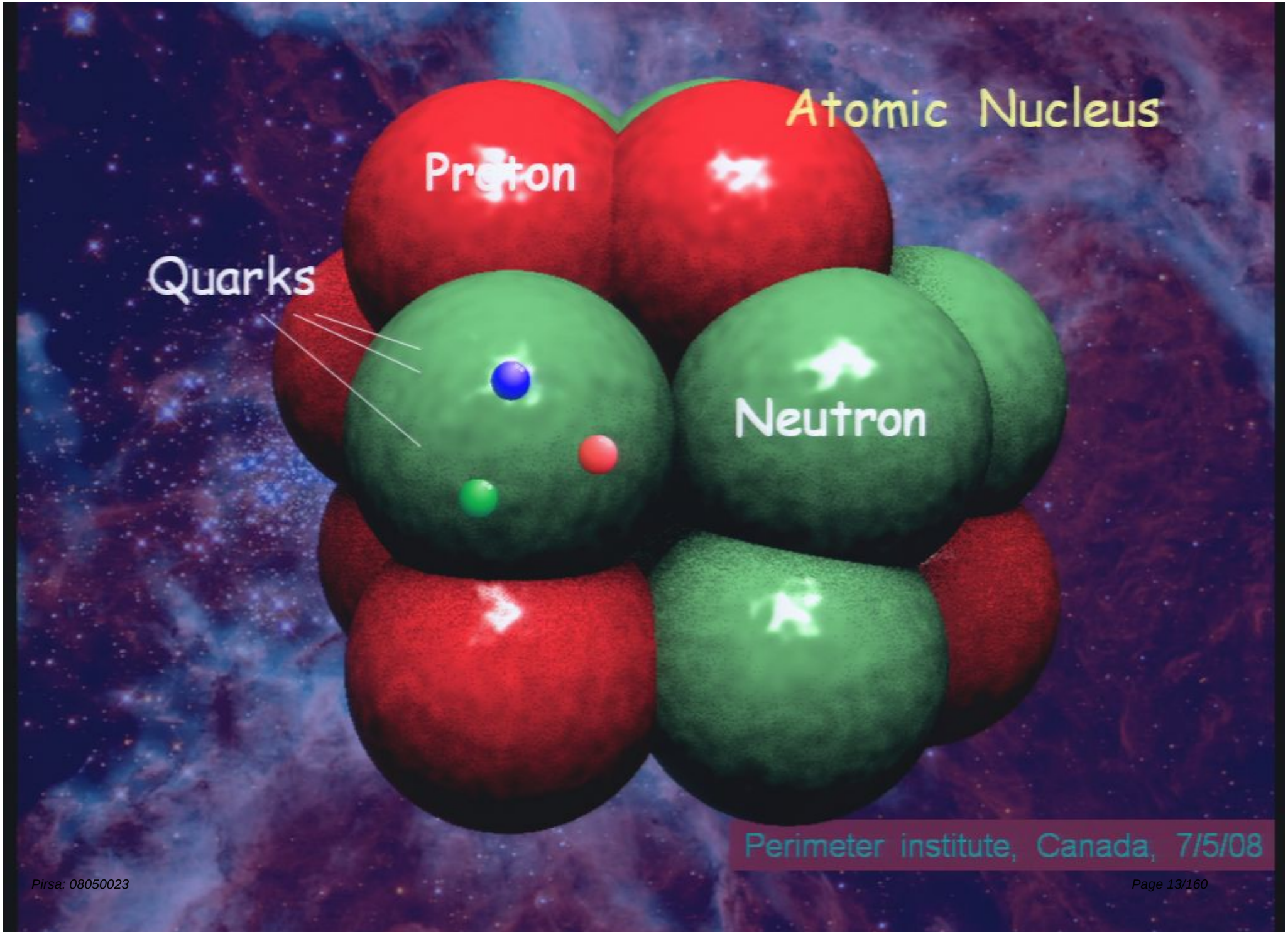


Atlas Detector CERN


Perimeter institute, Canada, 7/5/08


Atomic Nucleus
Perimeter institute, Canada, 7/5/08

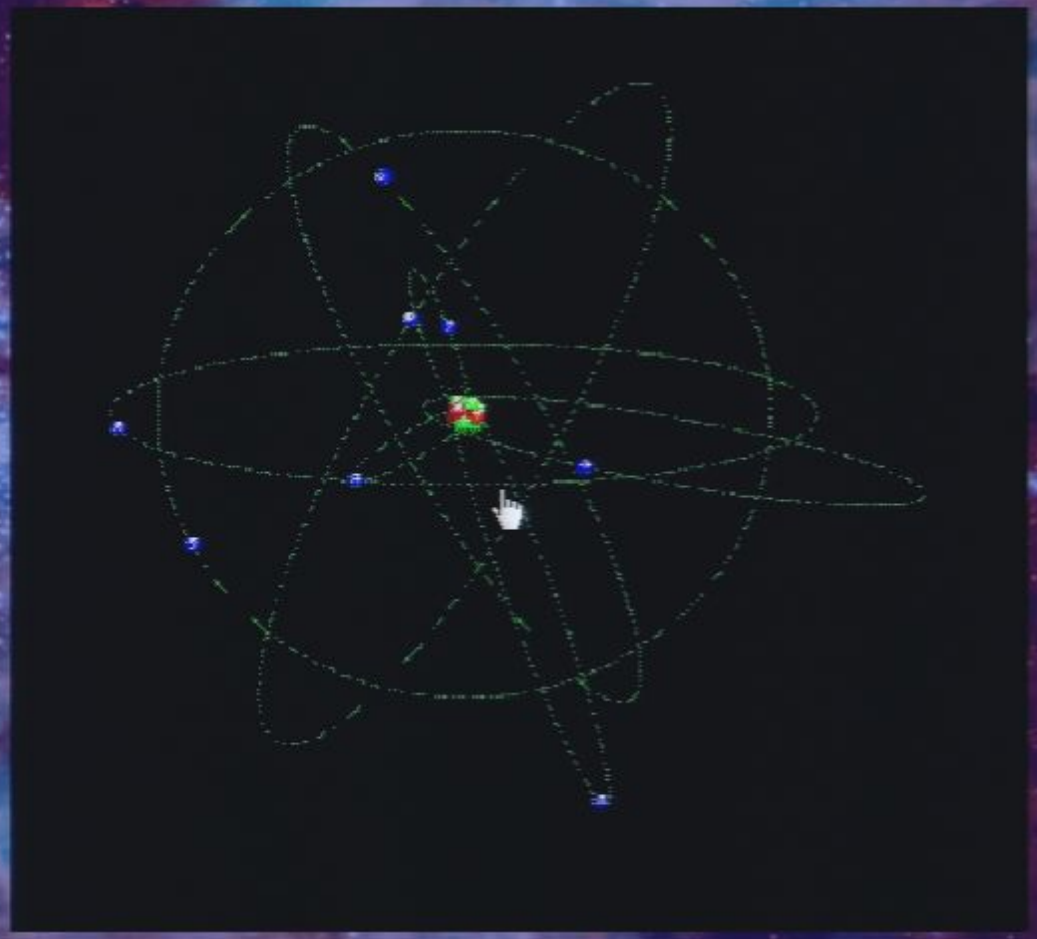

Atomic Nucleus
Proton
Neutron
Perimeter institute, Canada, 7/5/08


Atomic Nucleus
Proton
Quarks
Neutron
Perimeter institute, Canada, 7/5/08

the ATOM

Perimeter institute, Canada, 7/5/08

the ATOM



Perimeter institute, Canada, 7/5/08

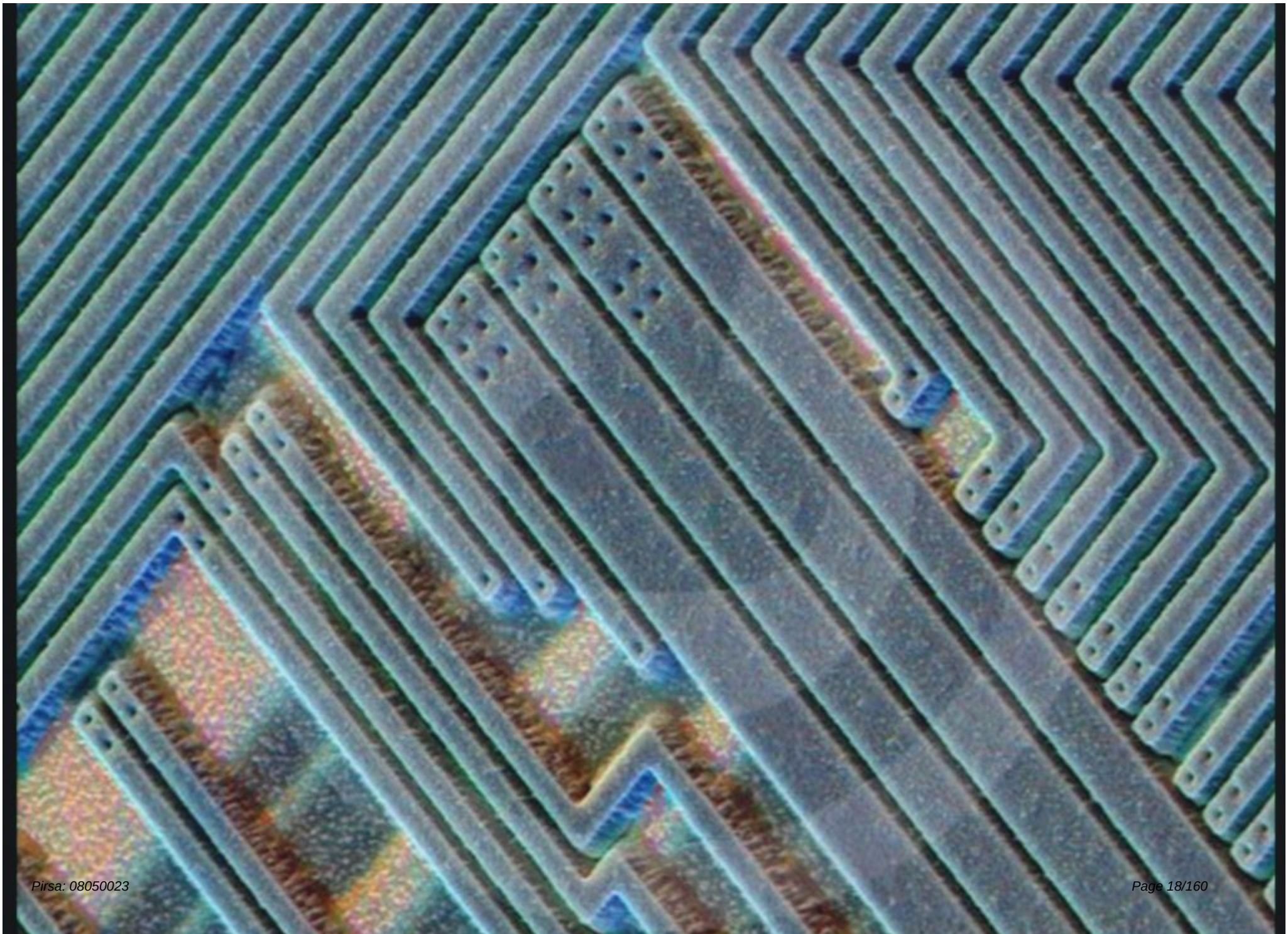
Richard Feynman, 1959,
APS CalTech:

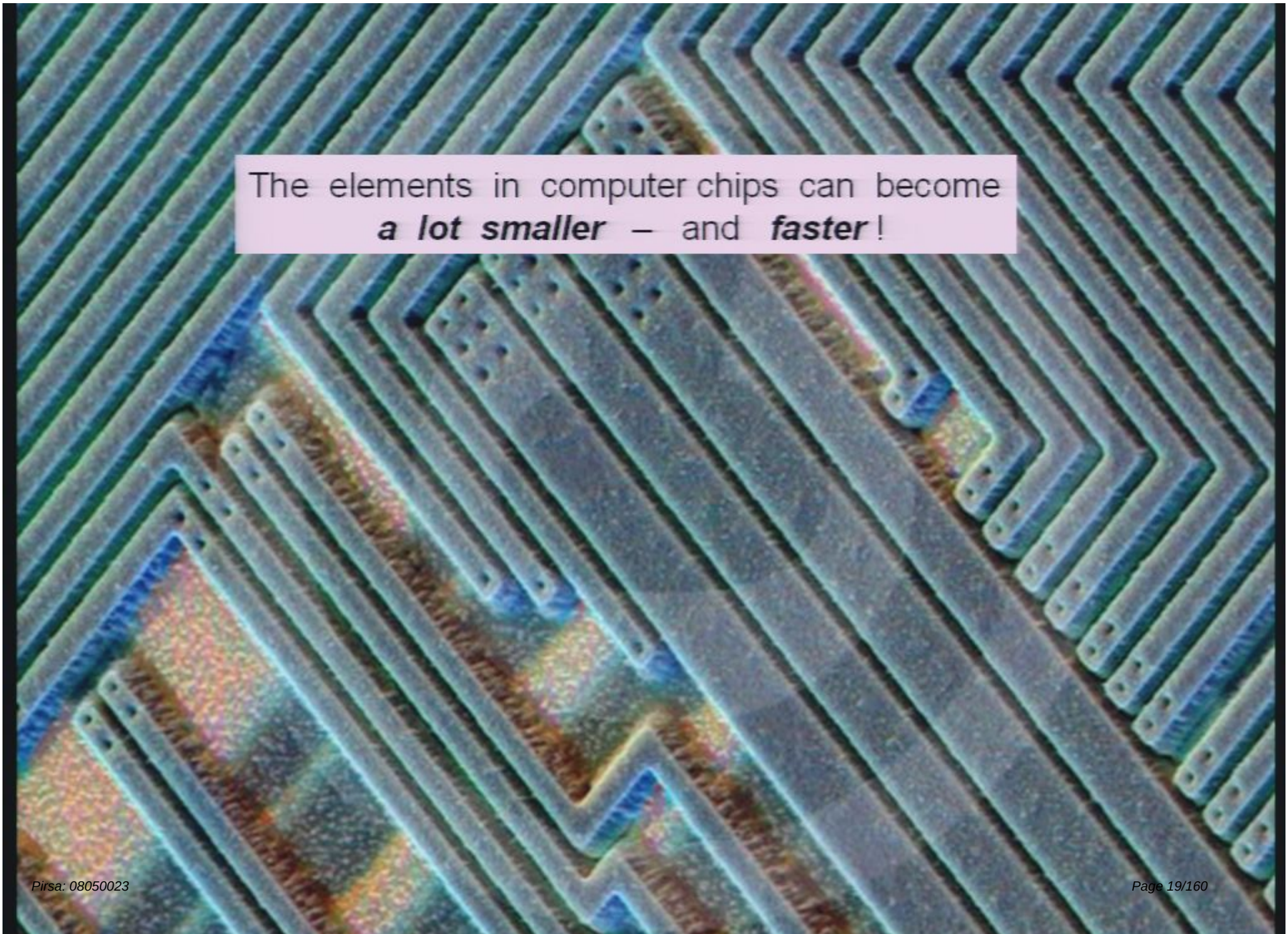
Perimeter institute, Canada, 7/5/08

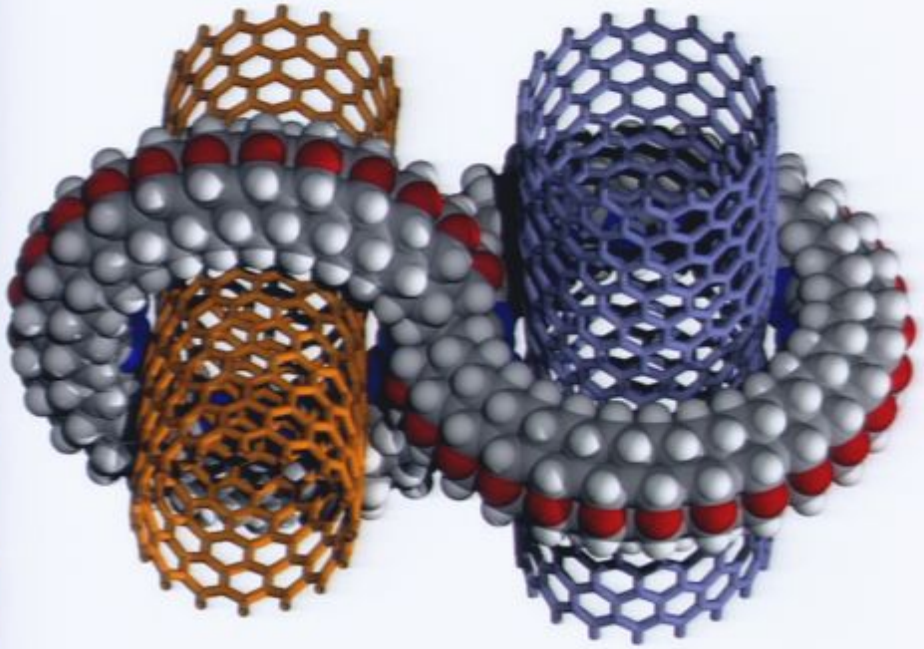
Richard Feynman, 1959,
APS CalTech:

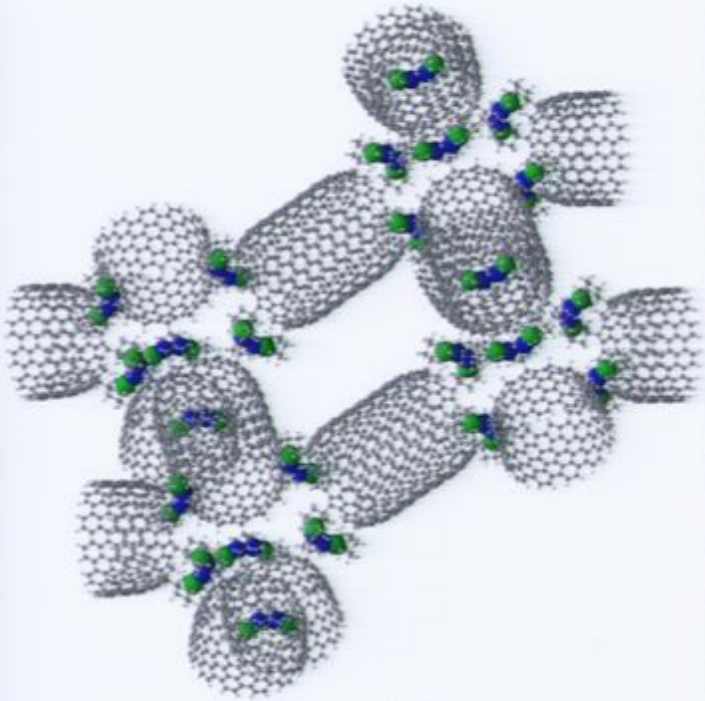
"There is plenty of Room at the Bottom!"

Perimeter institute, Canada, 7/5/08



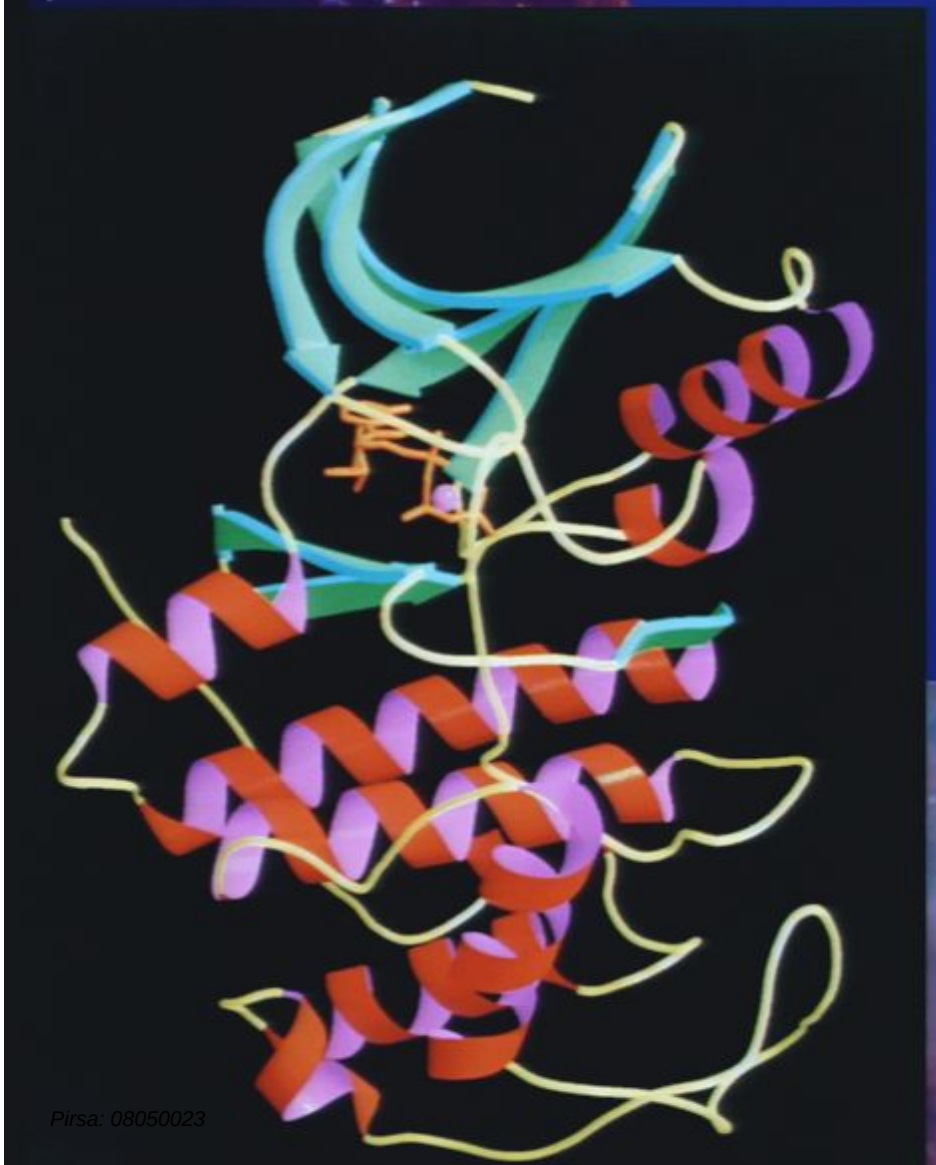

The elements in computer chips can become
a lot smaller – and faster!

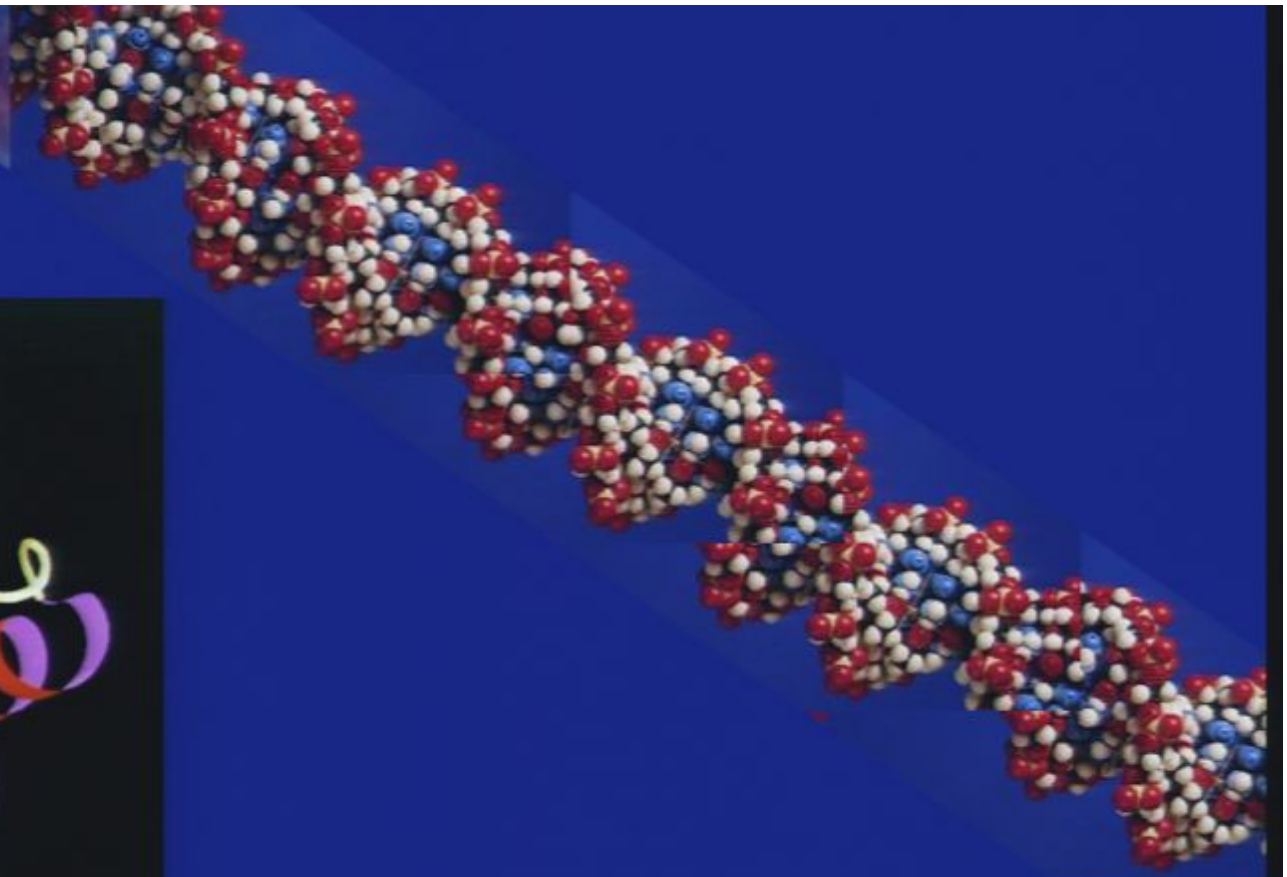




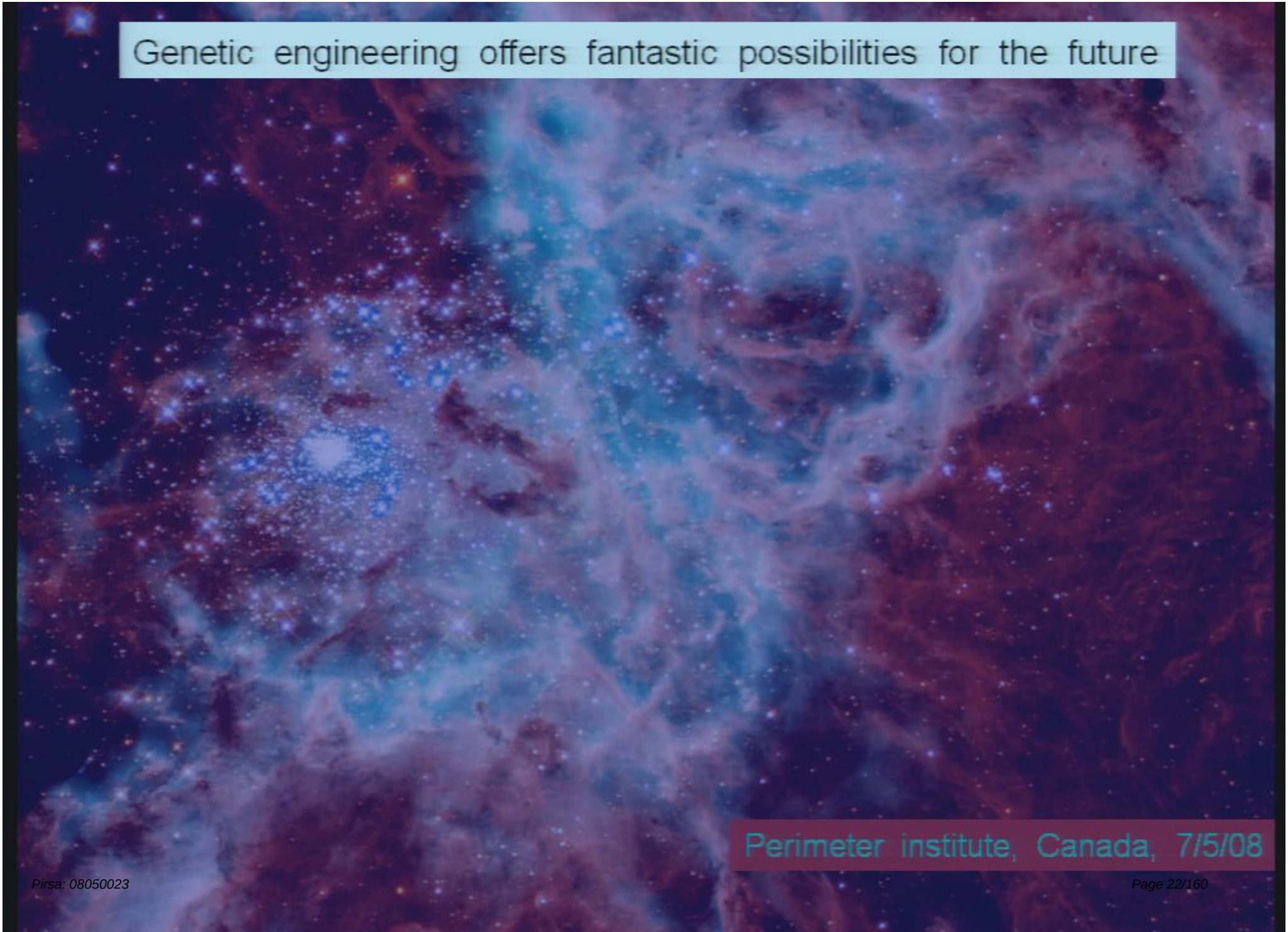
Will **NANO TECHNOLOGY**
determine our future?

A proteine
and DNA

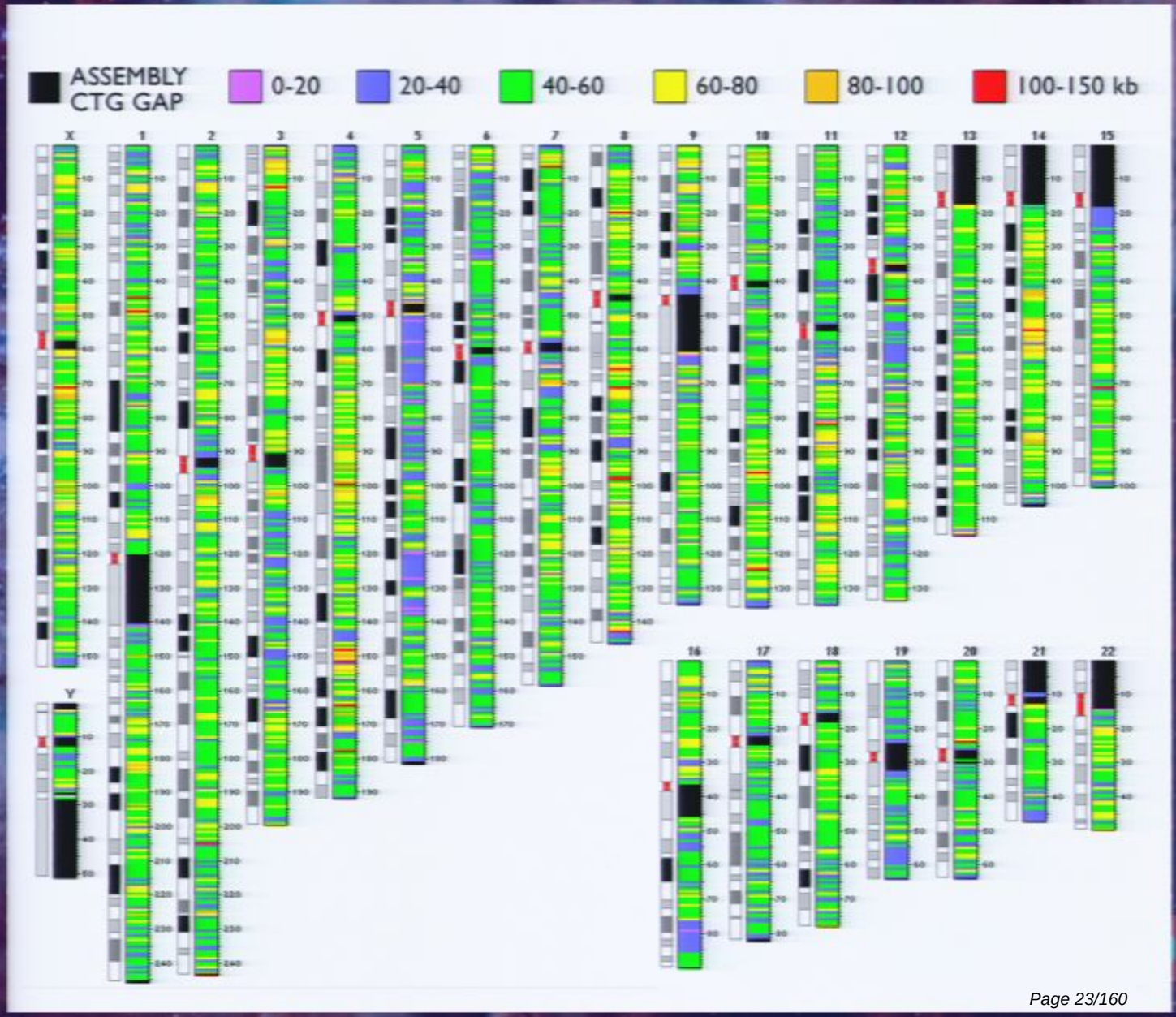




Perimeter institute, Canada, 7/5/08


Genetic engineering offers fantastic possibilities for the future
Perimeter institute, Canada, 7/5/08

Genetic engineering offers fantastic possibilities for the future



The human Genome

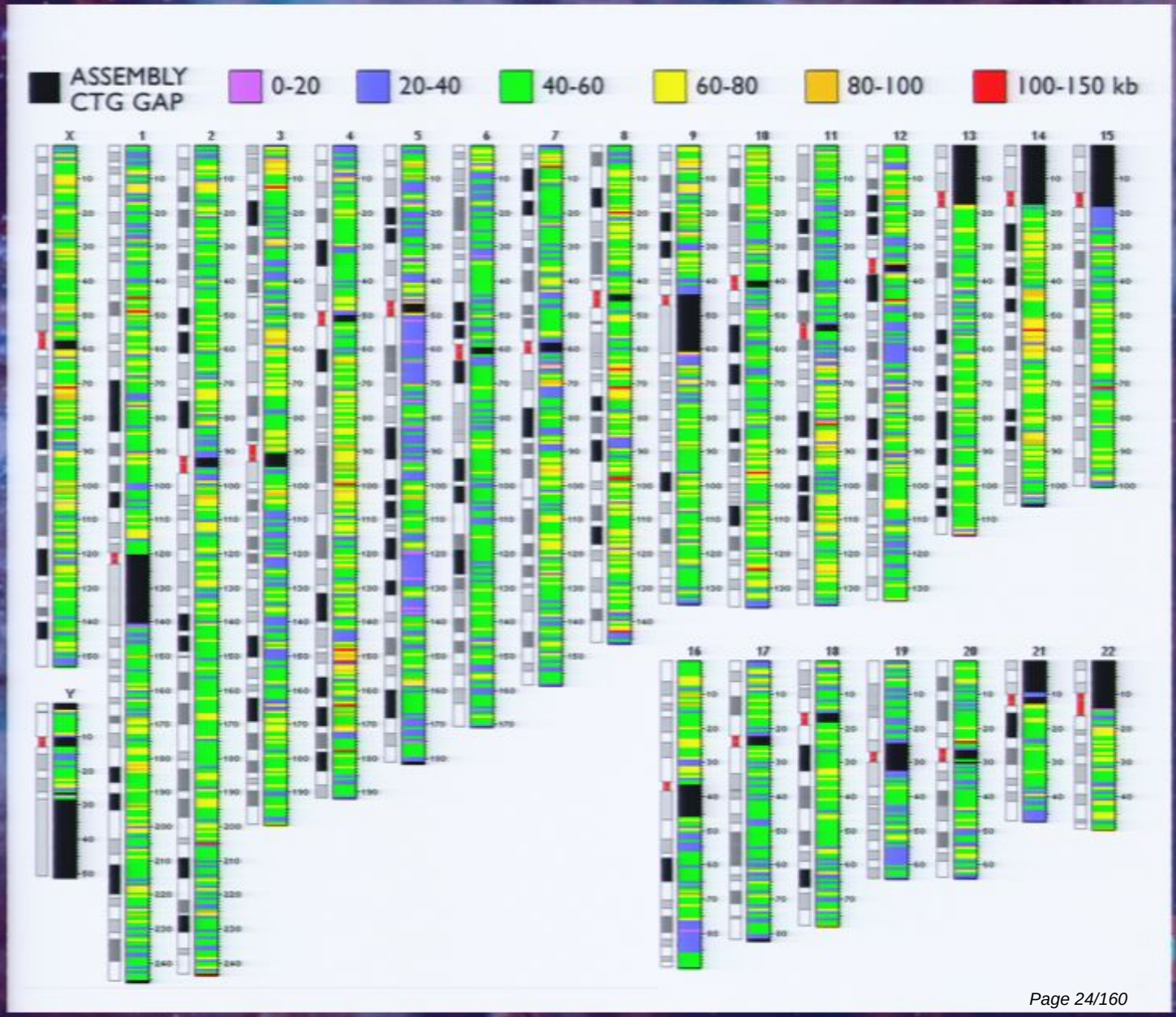
Genetic engineering offers fantastic possibilities for the future

Food

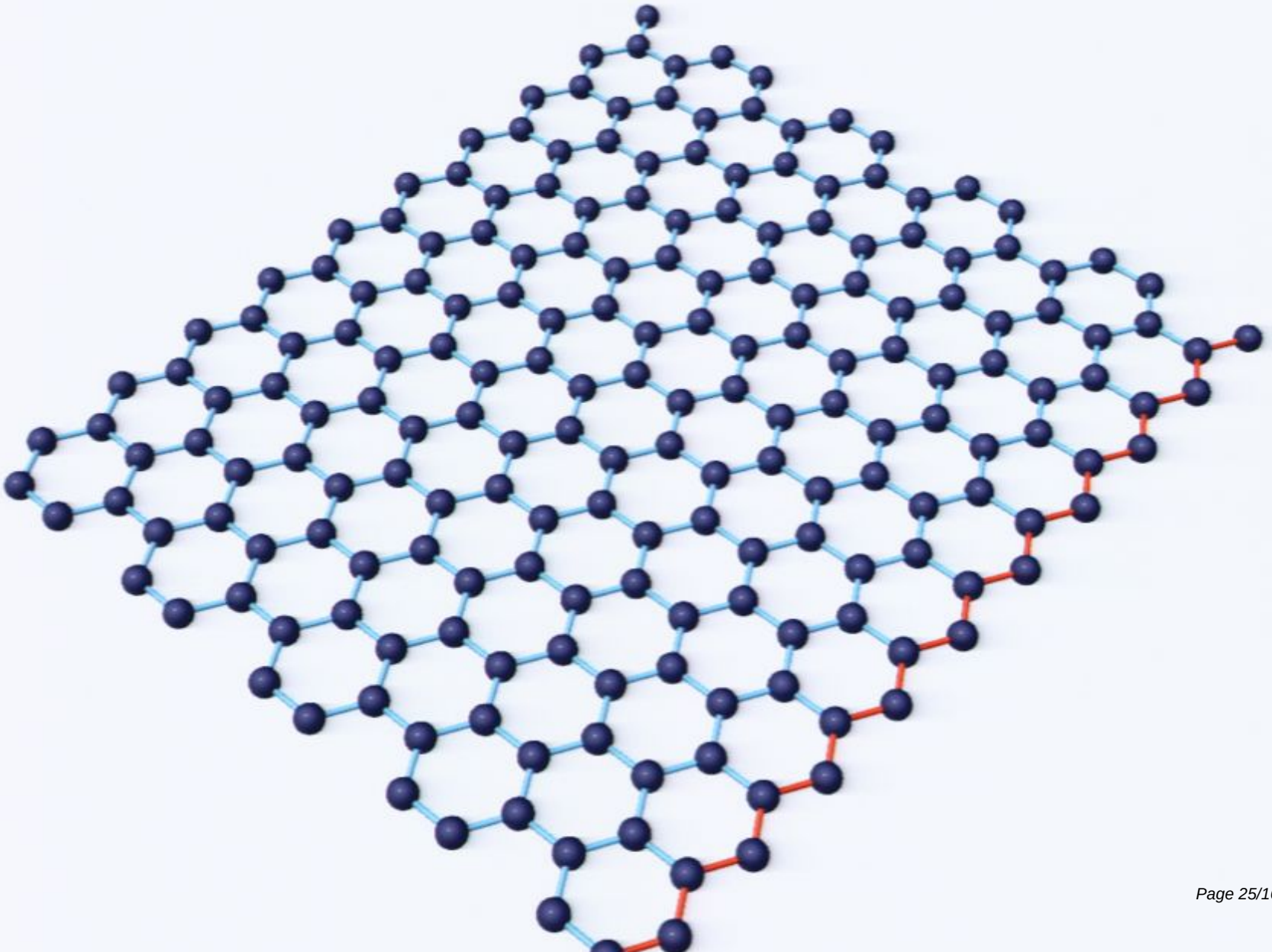
water

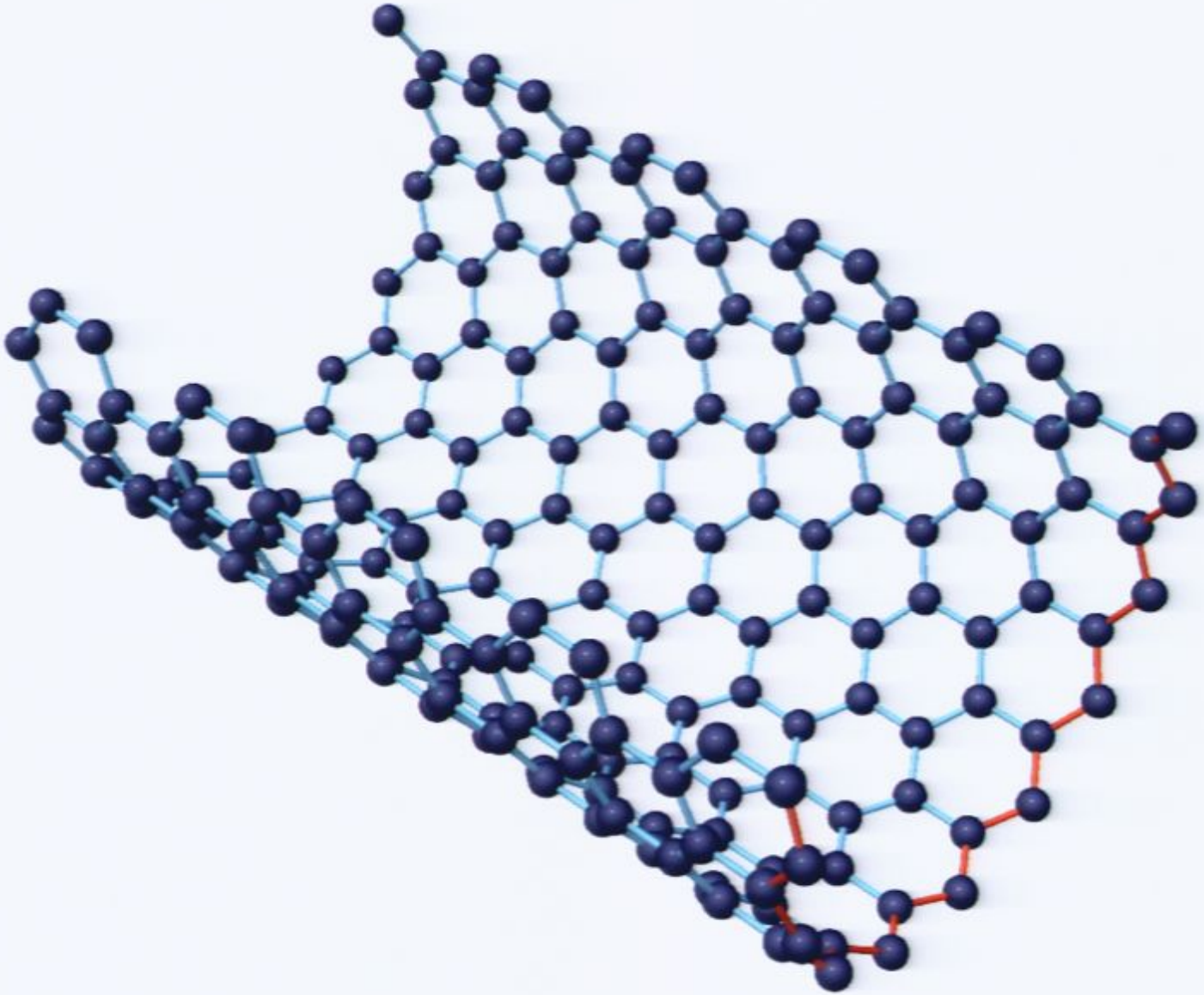
energy

space colonization

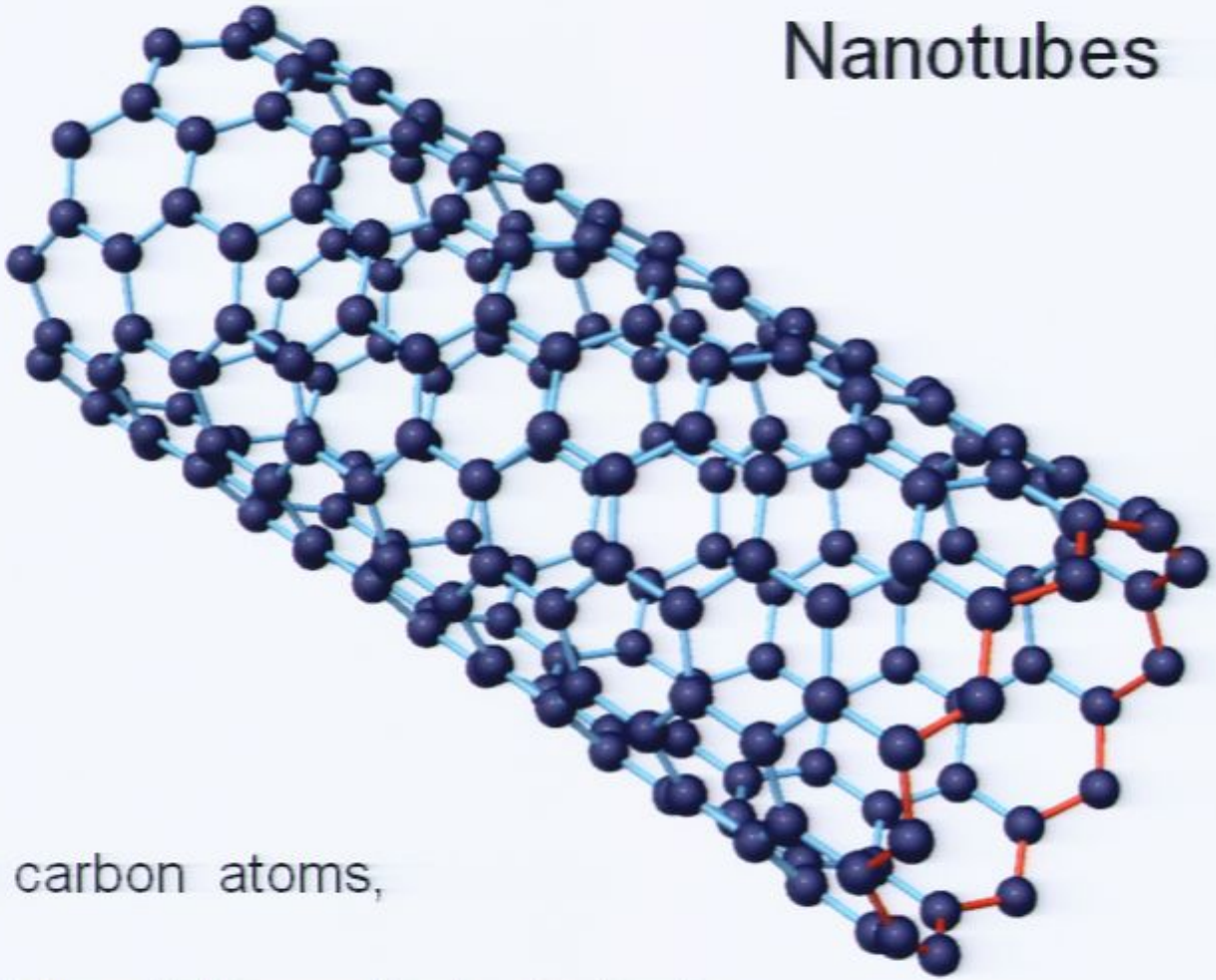


The human Genome





Nanotubes



Exclusively carbon atoms,

Young modulus 5 times that of steel;

semi-conducting or metallic, depending on “chirality”

The information era has just started ...

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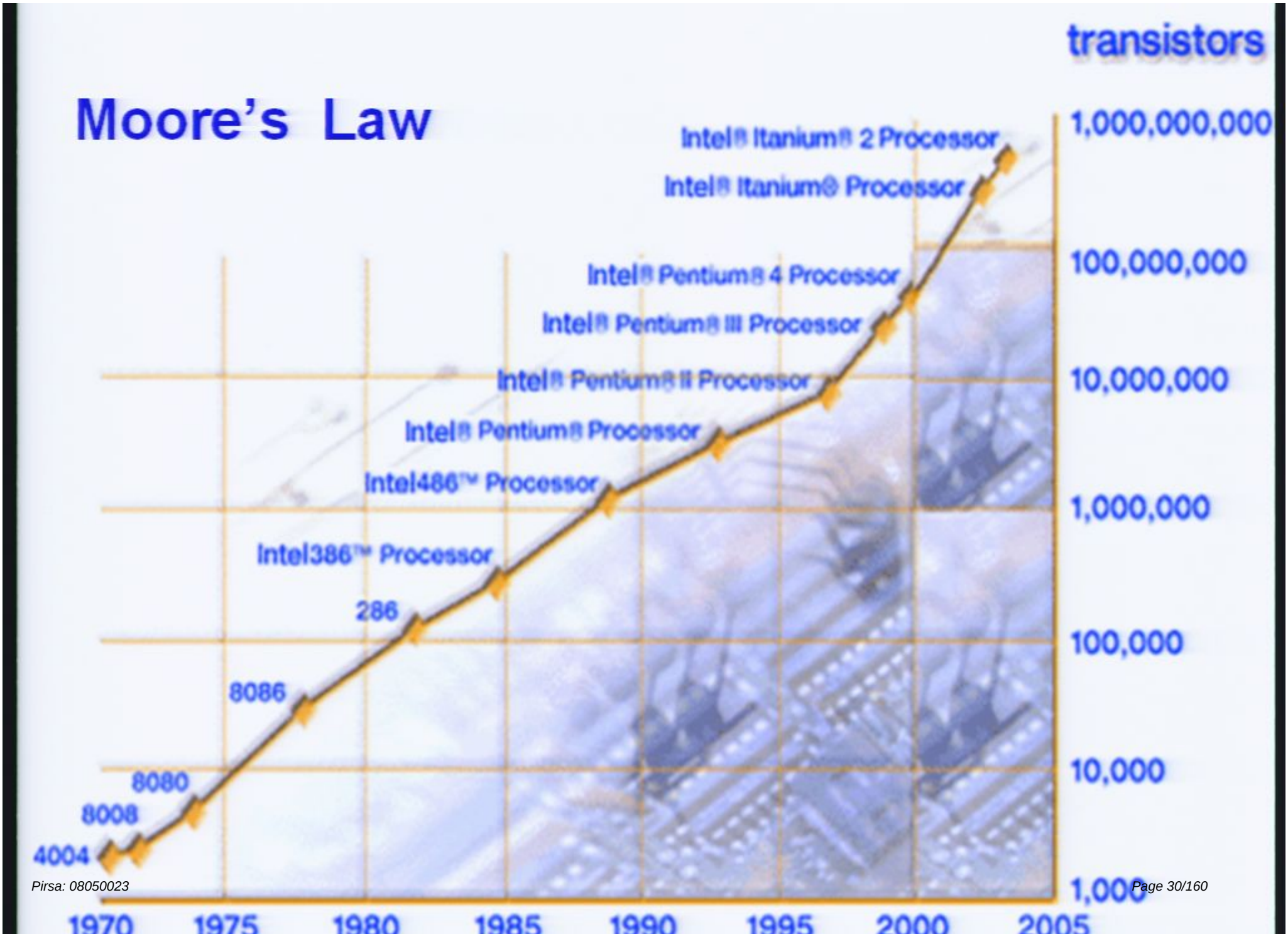
Computer **software** and **hardware** can become gigantically faster and better ...


Moore's Law
transistors
Intel® Itanium® 2 Processor
Intel® Itanium® Processor
Intel® Pentium® 4 Processor
Intel® Pentium® III Processor
Intel® Pentium® II Processor
Intel® Pentium® Processor
Intel486™ Processor
Intel386™ Processor
286
8086
8080
8008
4004
1,000,000,000
100,000,000
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100,000
10,000
1,000
1970
1975
1980
1985
1990
1995
2000
2005

The information era has just started ...

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Computers can become **intelligent**, even surpass humans ...

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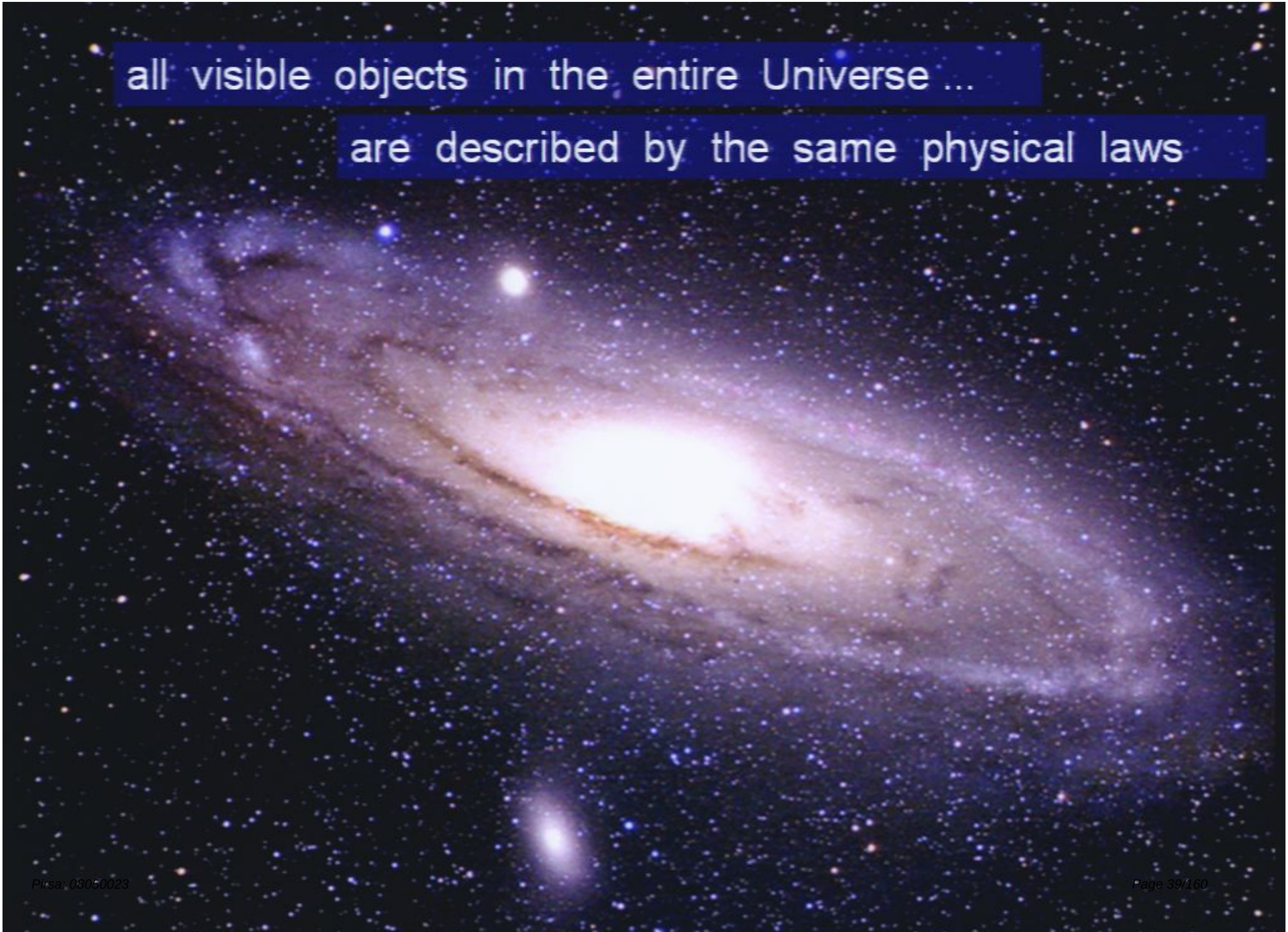
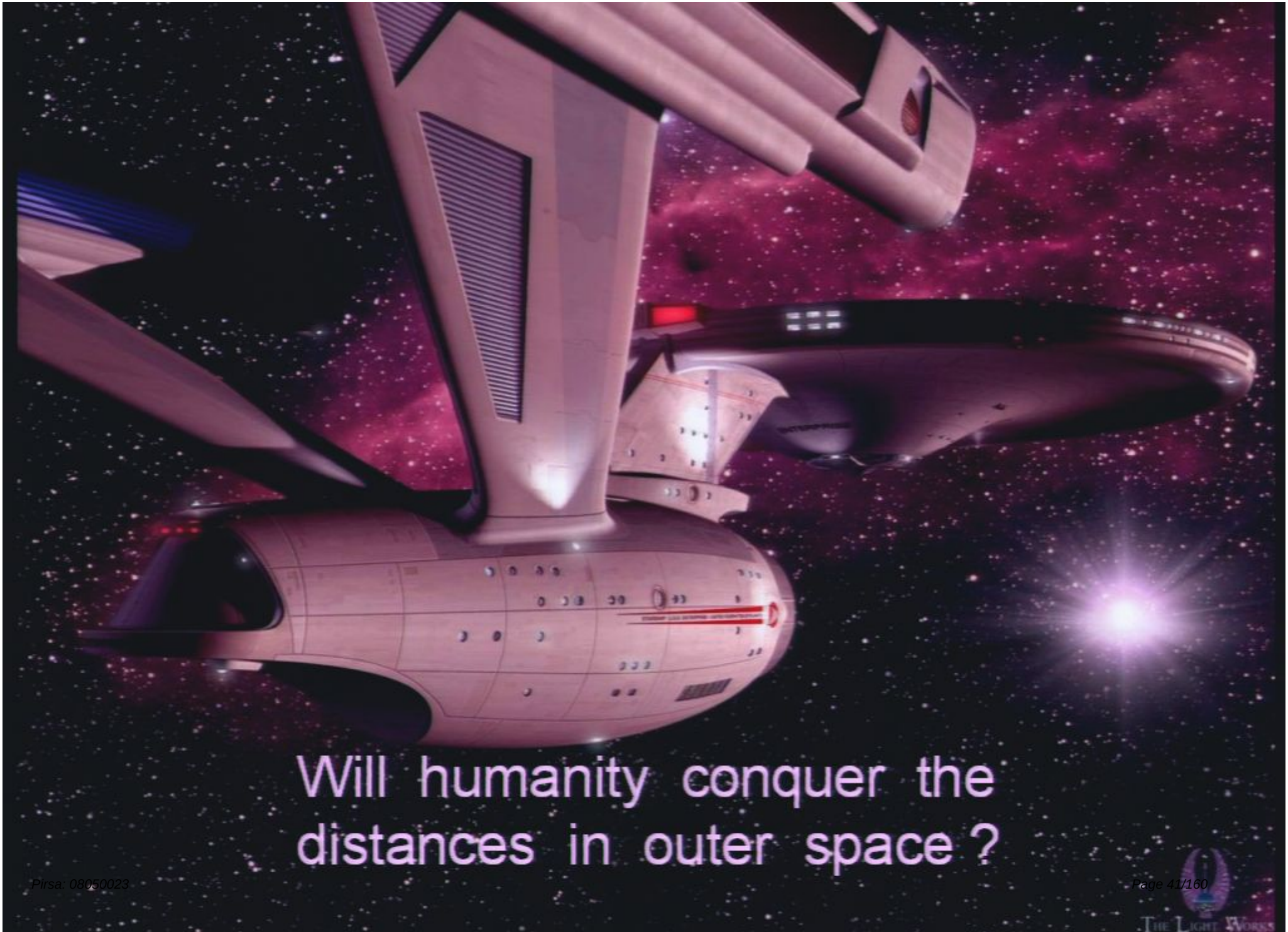
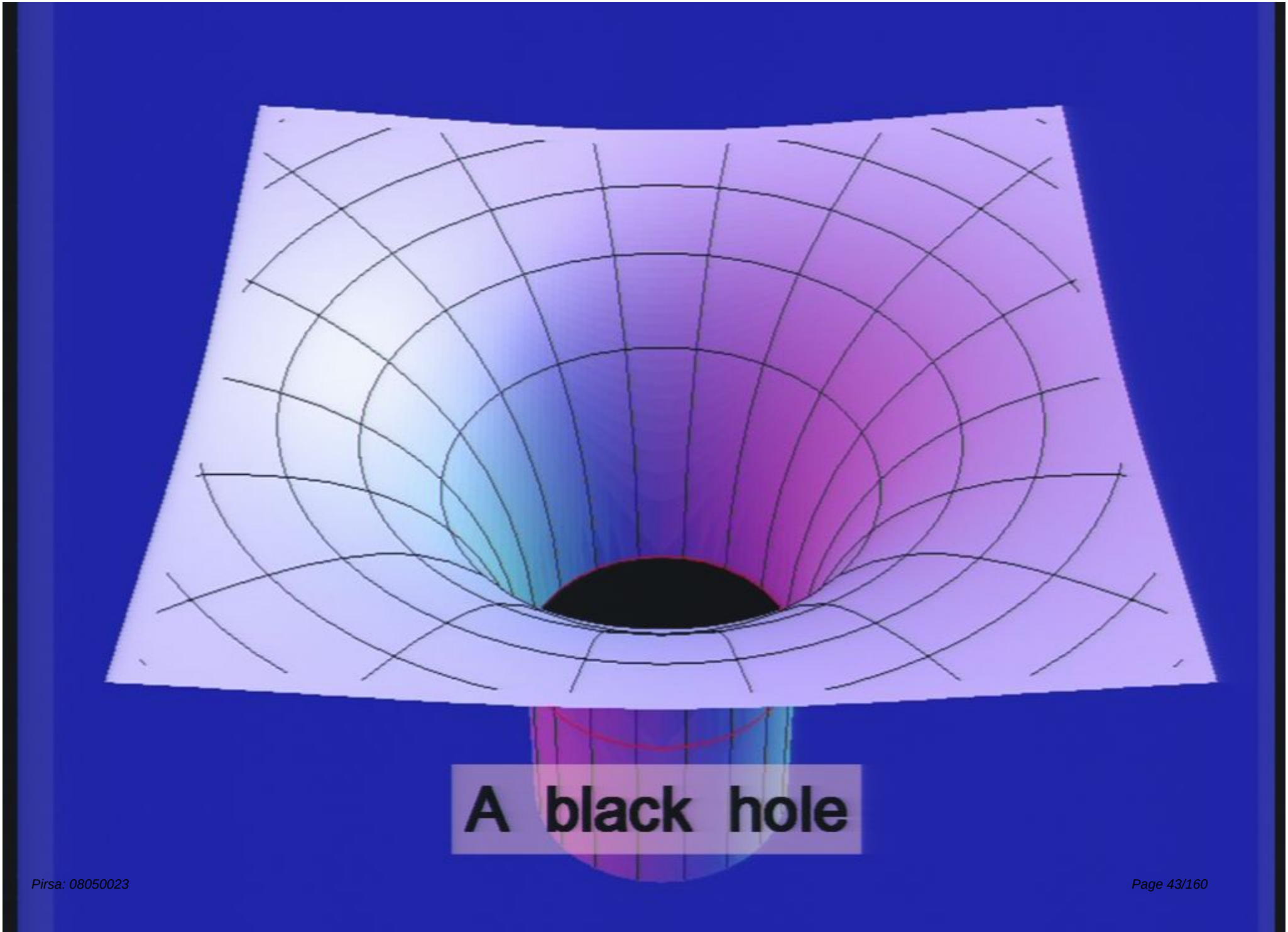
All that Earth is made of, is described by modern physics, *very accurately !*

and furthermore ...


all visible objects in the entire Universe ...


all visible objects in the entire Universe ...
are described by the same physical laws


Will humanity conquer the
distances in outer space ?


A black hole


Black holes can *not* be used as “wormholes” for transportation !
Perimeter institute, Canada, 7/5/08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Why not ?

A black hole generates tremendous tidal forces; only large ones would be gentle enough not to tear us to pieces:

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$$v \simeq \frac{c}{2GM_{BH}}$$

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$$\nu \simeq \frac{c}{2GM_{BH}}$$

$$M_{BH} = M_{\odot}: \quad \nu \simeq 100,000 \ \text{sec}^{-1}$$

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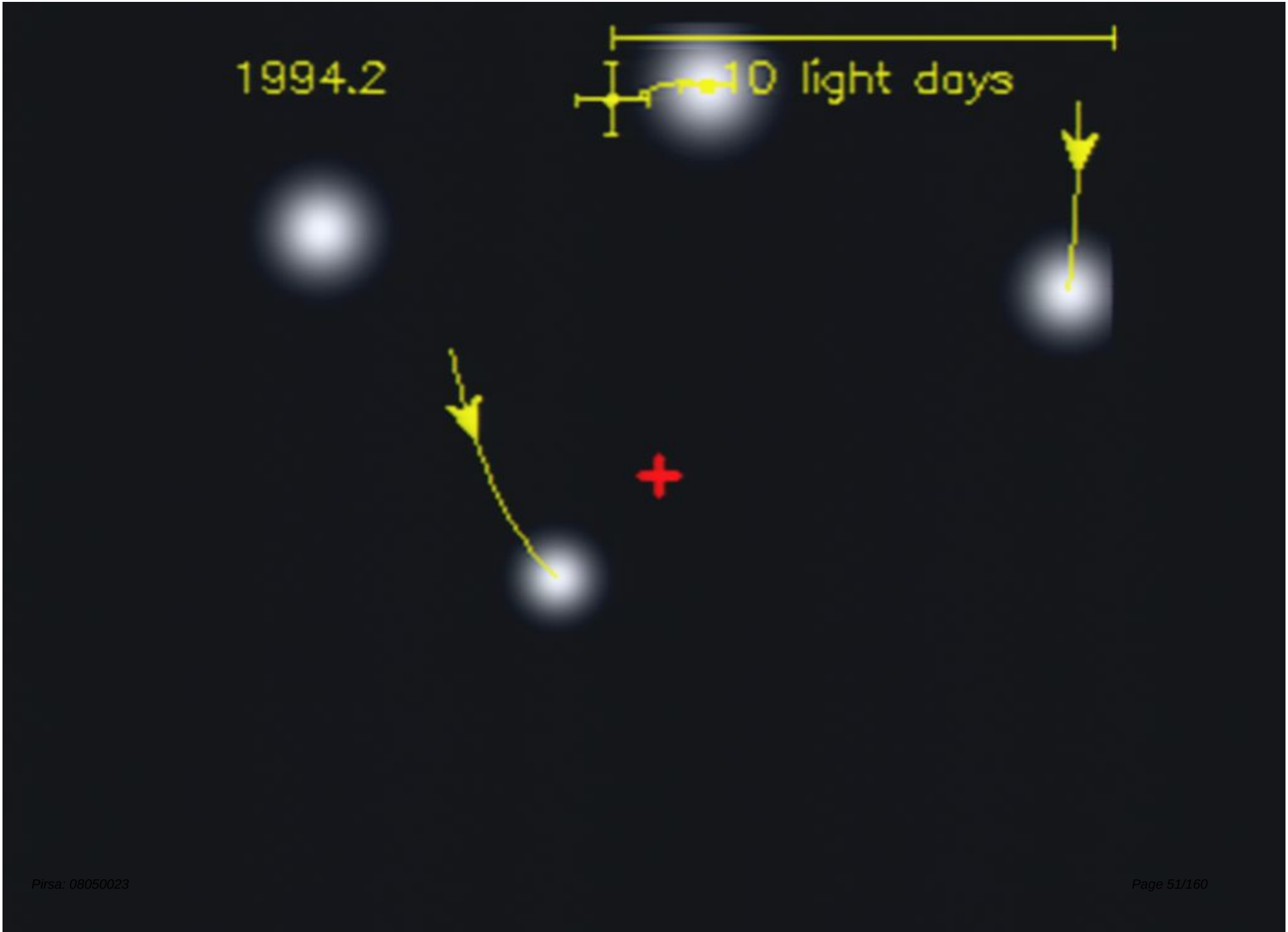
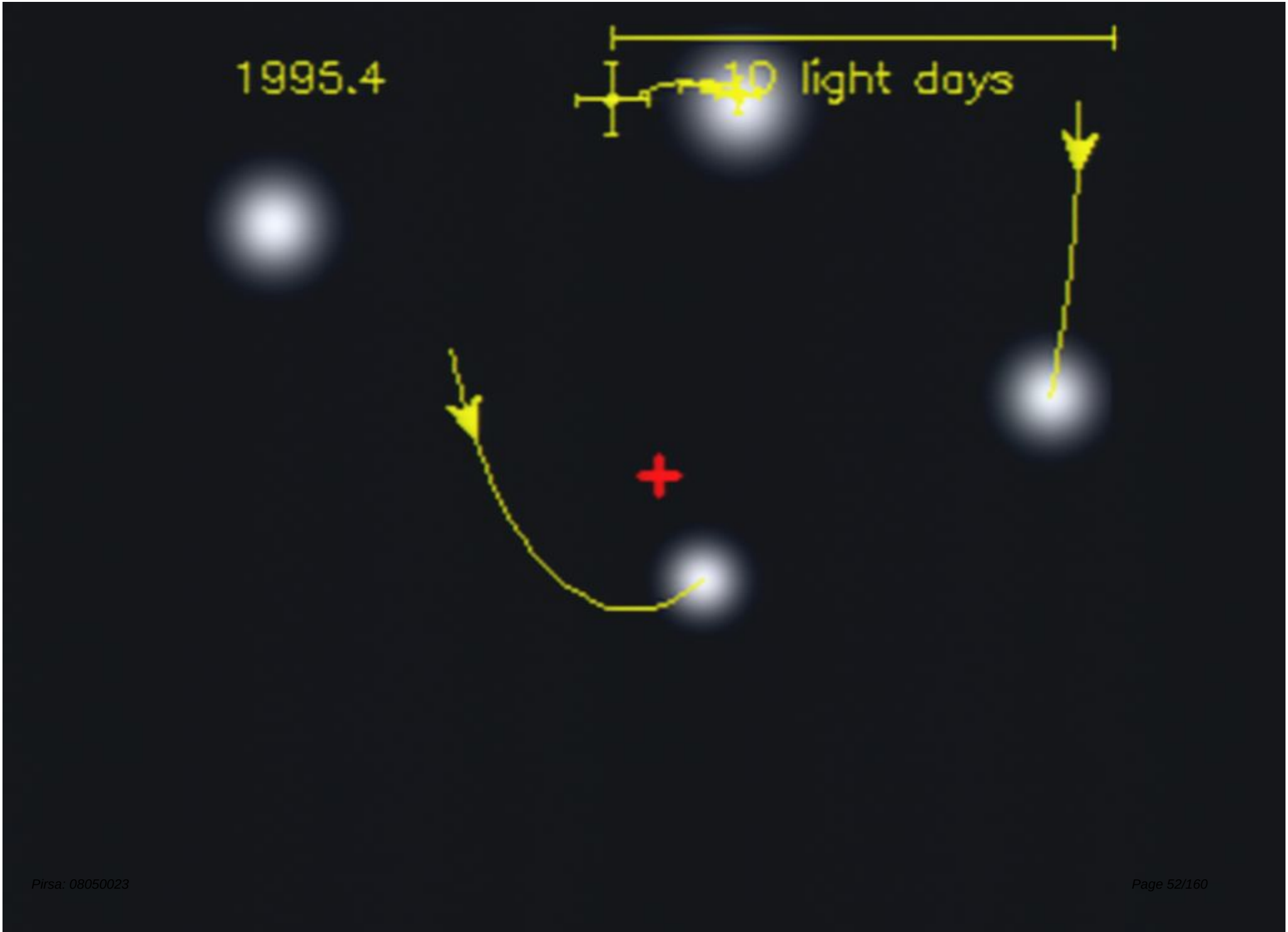
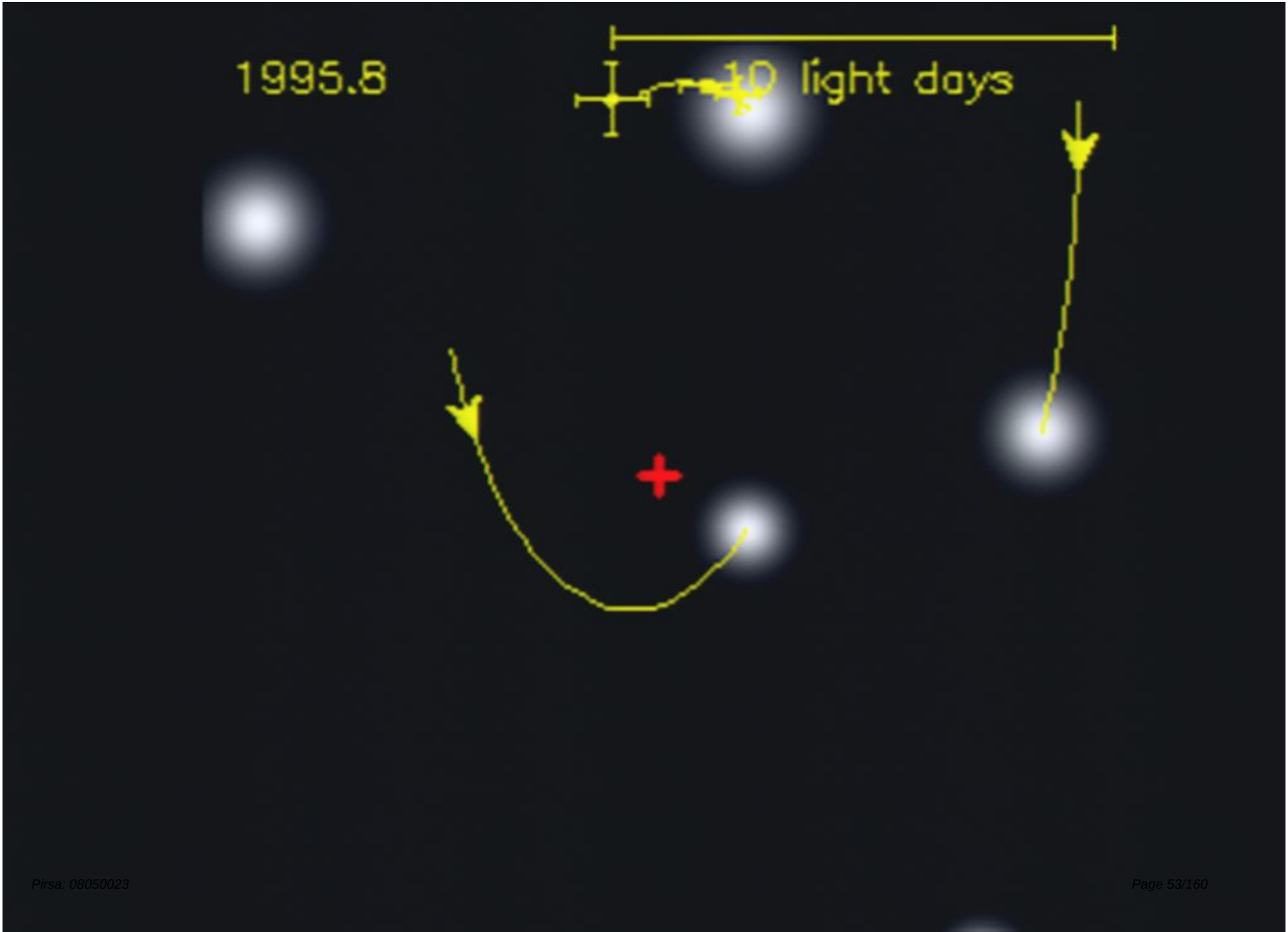
$$M_{BH} = M_{\odot} : \quad \nu \simeq 100,000 \ \text{sec}^{-1}$$

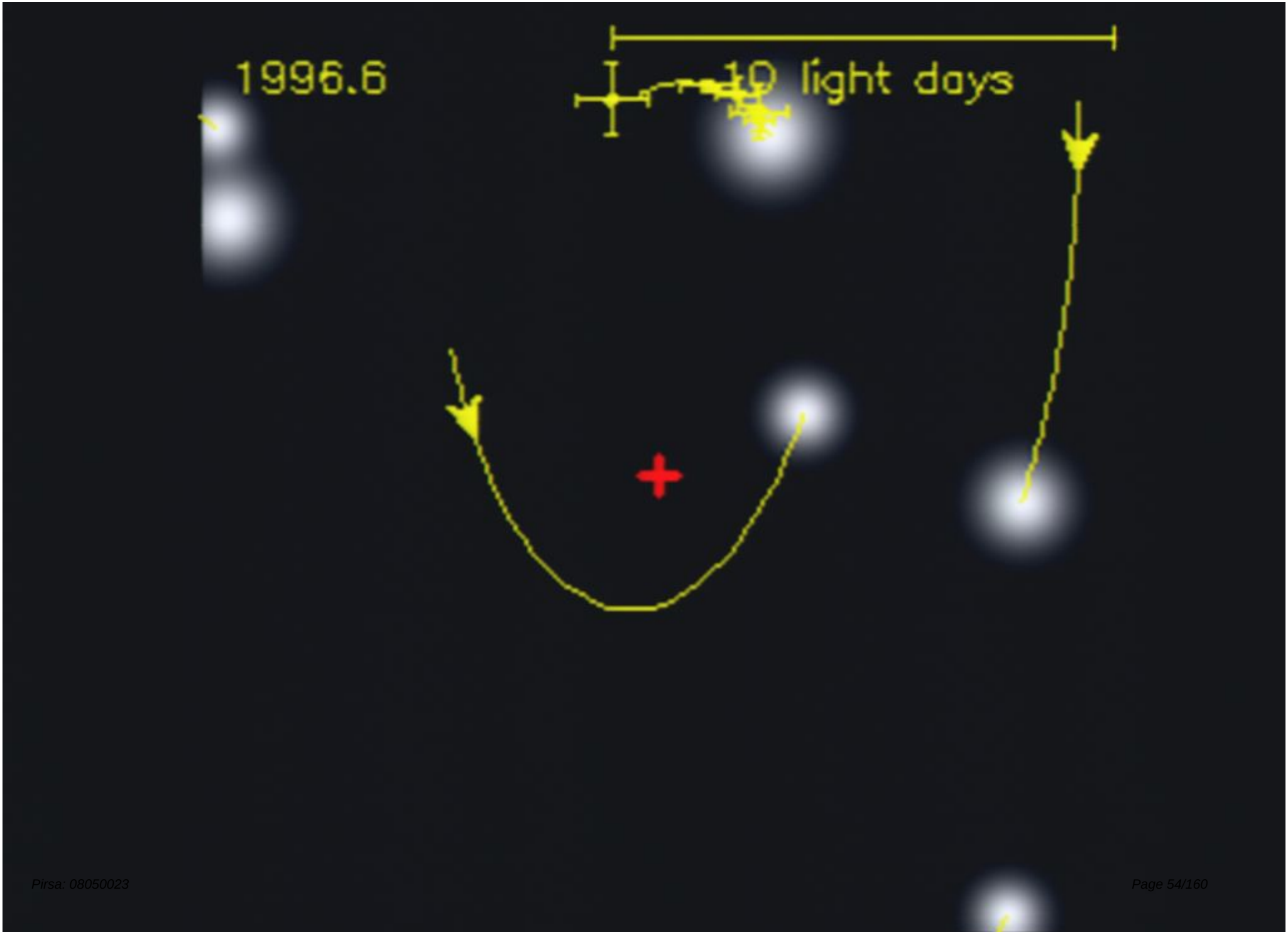
$$M_{BH} = 10,000 \ M_{\odot} \ ??$$


1992.6
10 light days


1994.2
10 light days


1995.4
10 light days


1995.8
10 light days


1996.6
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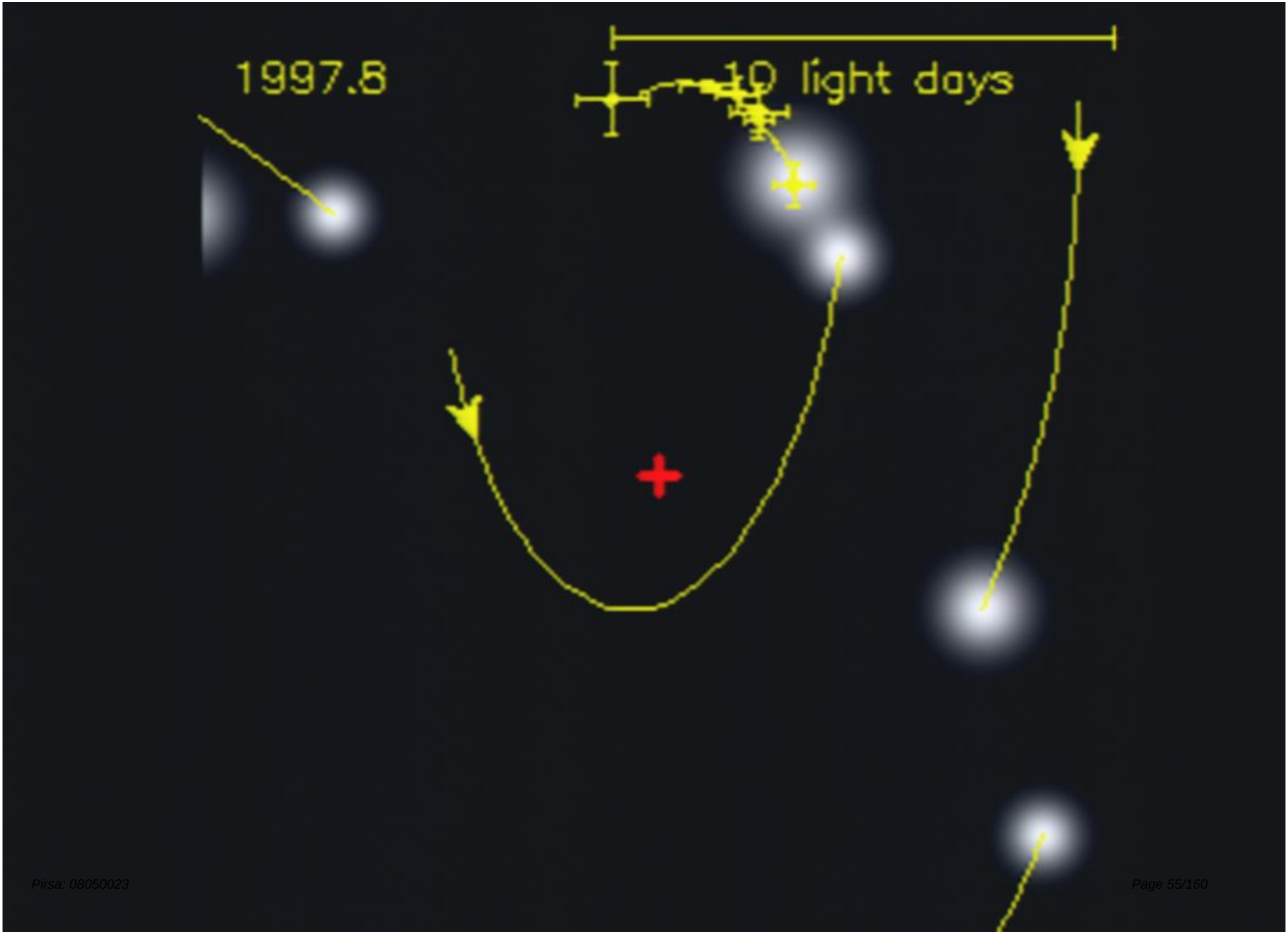
1997.8
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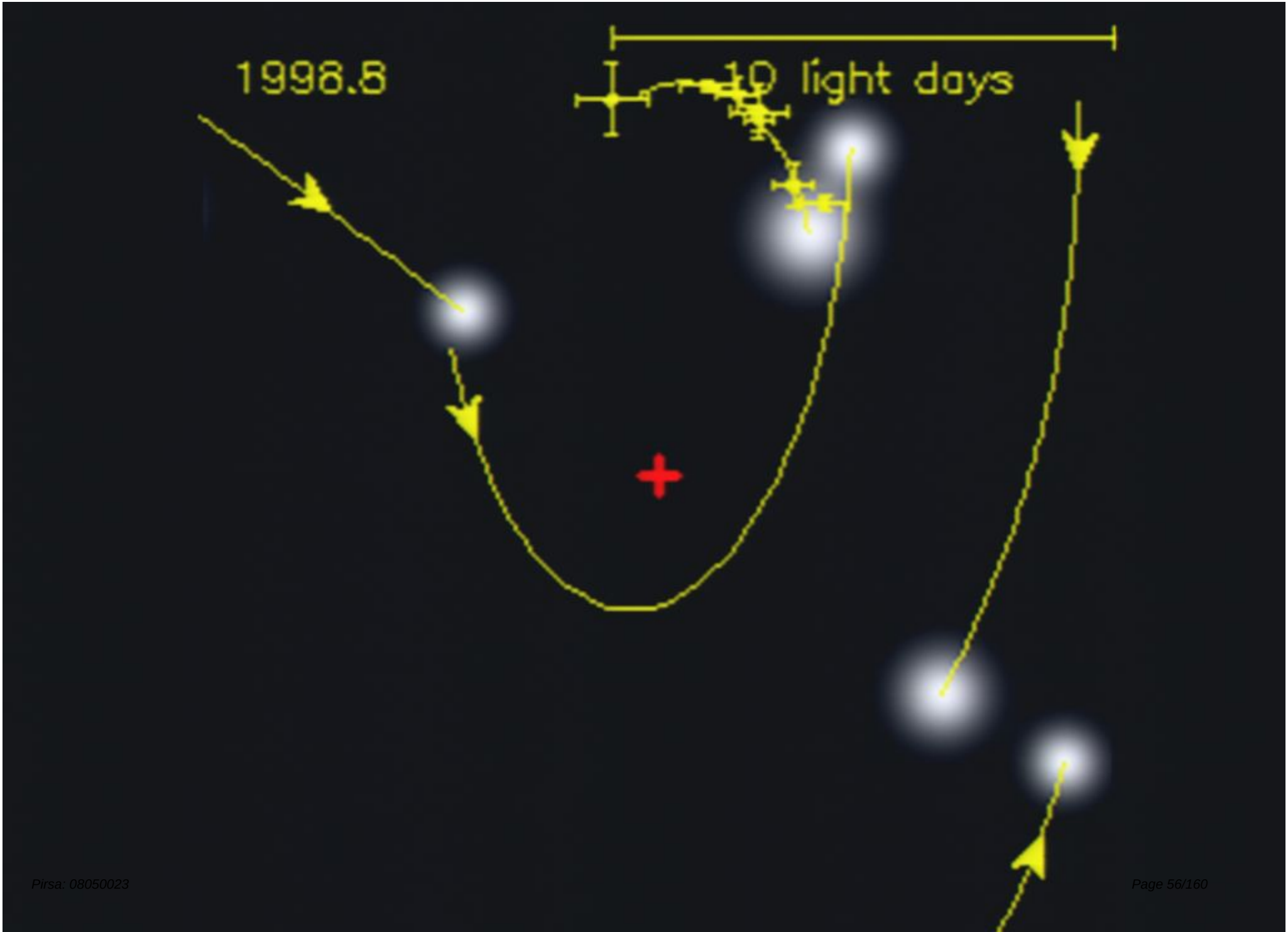
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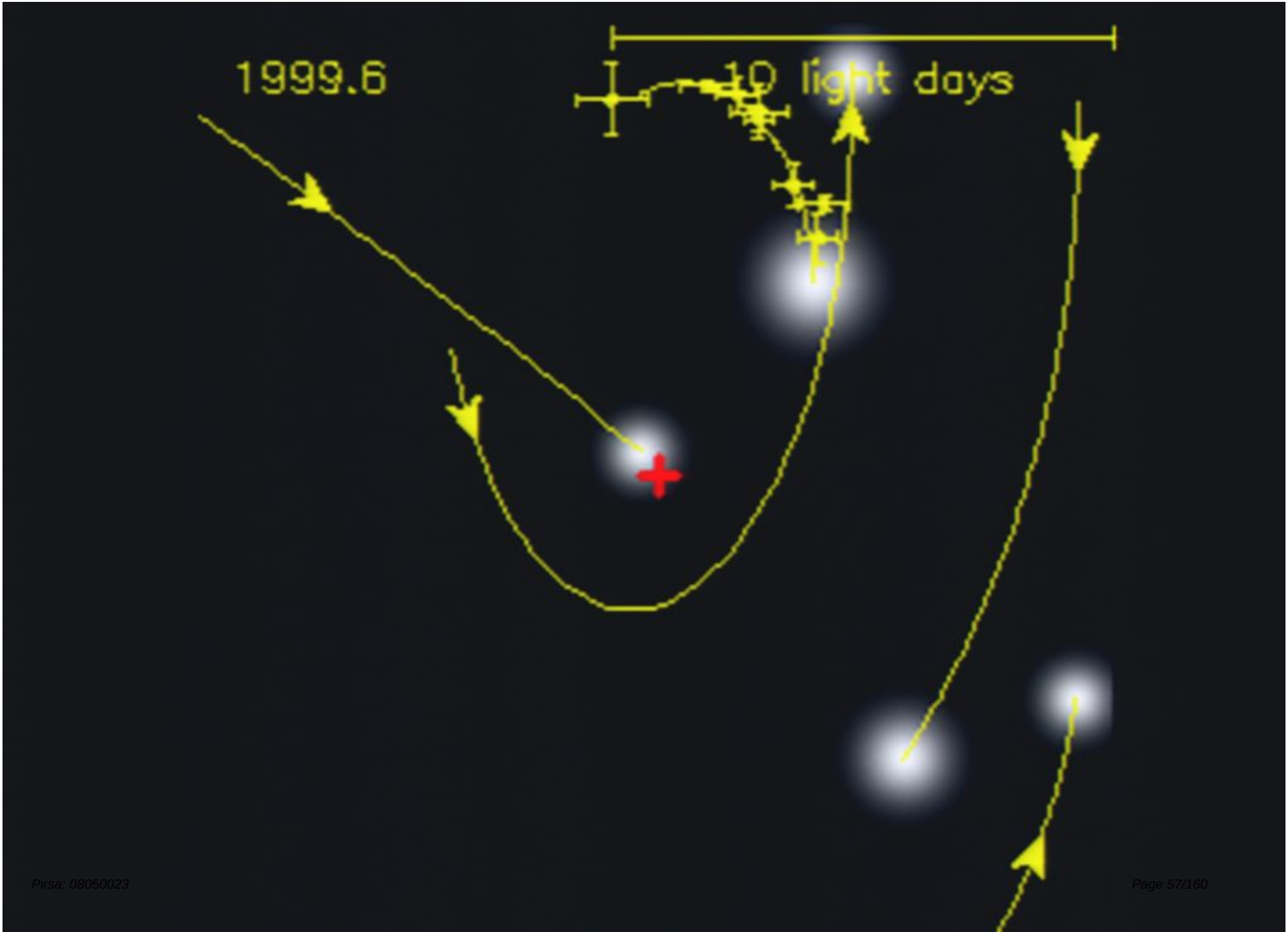
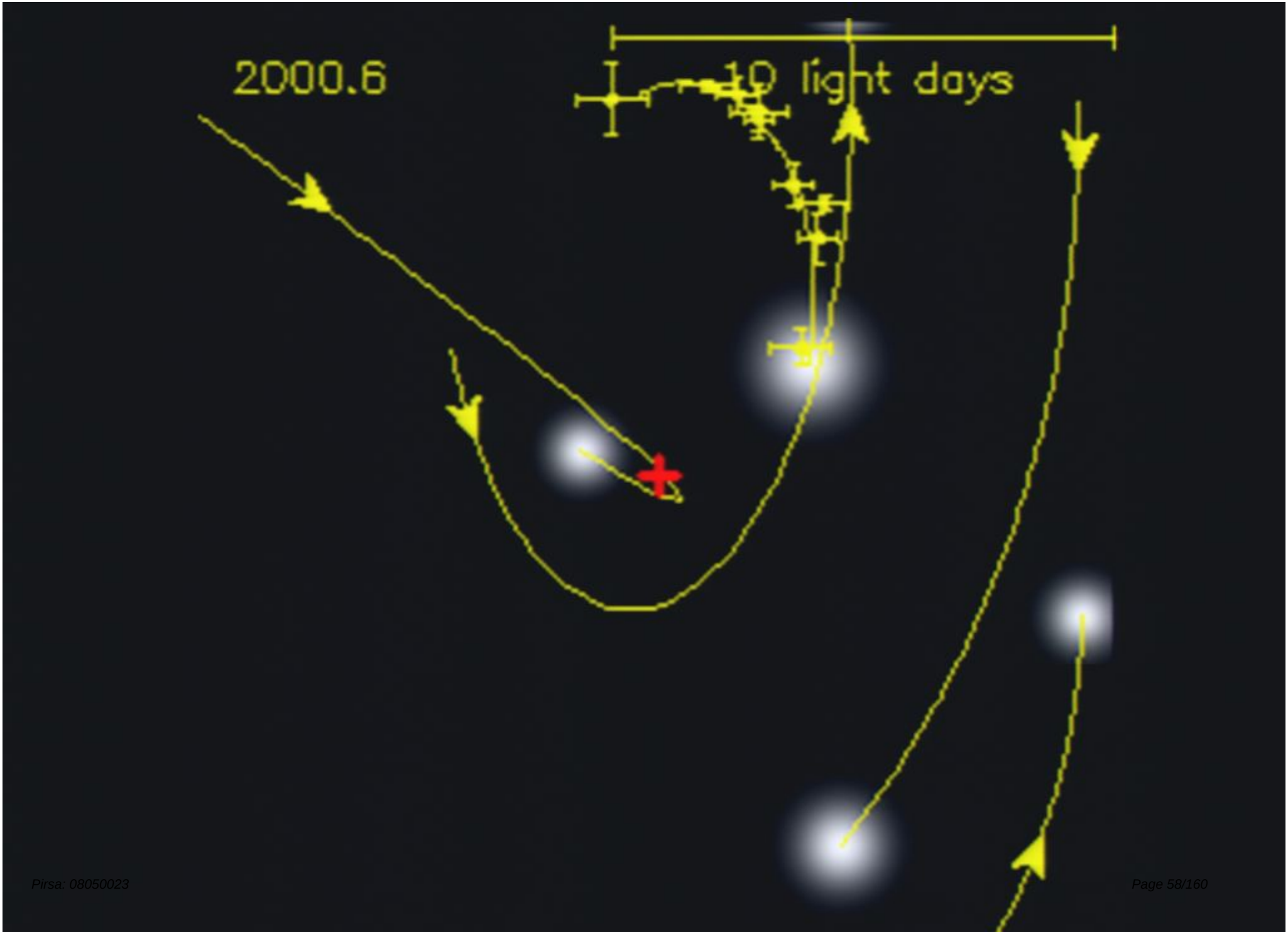
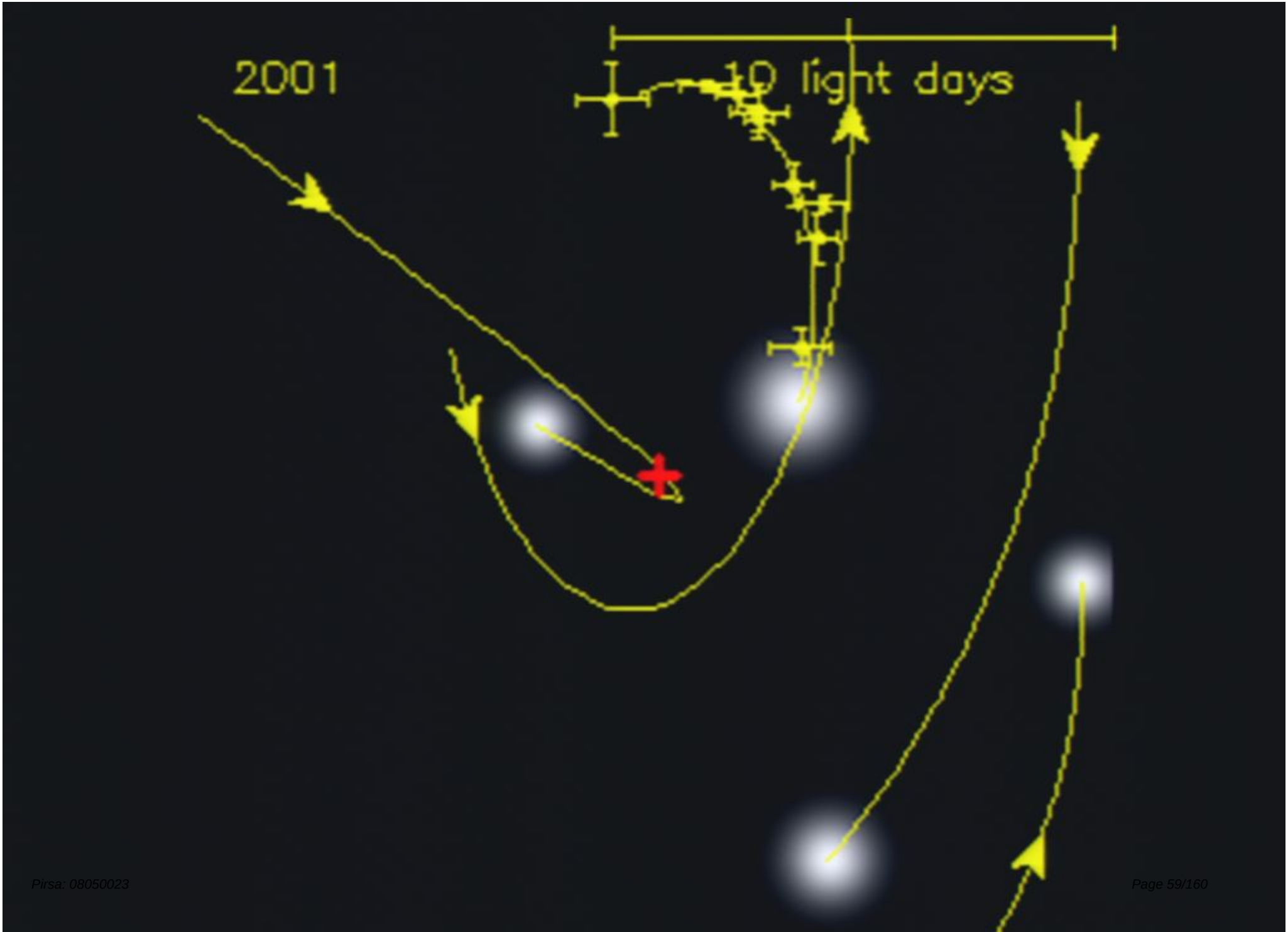
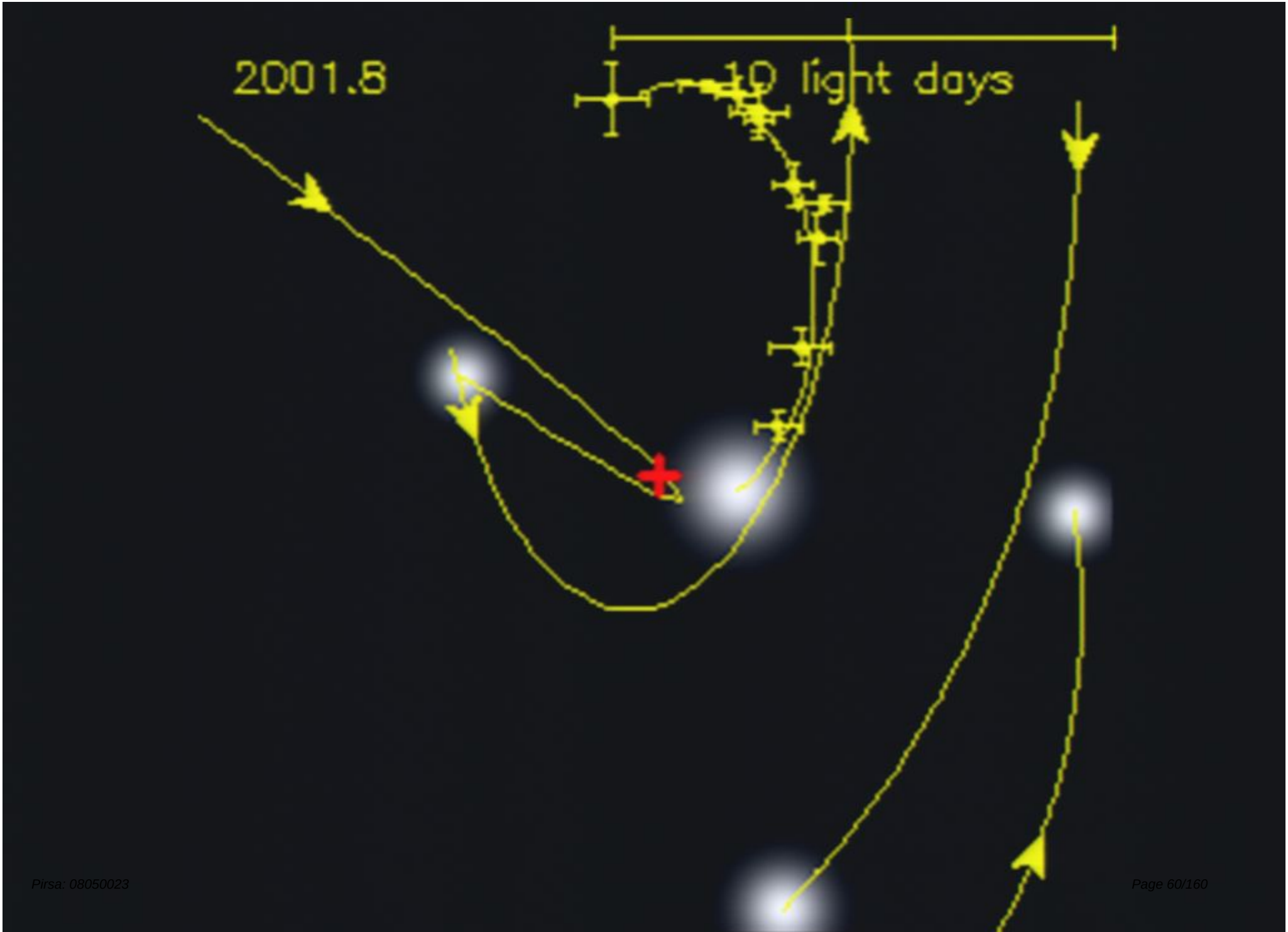
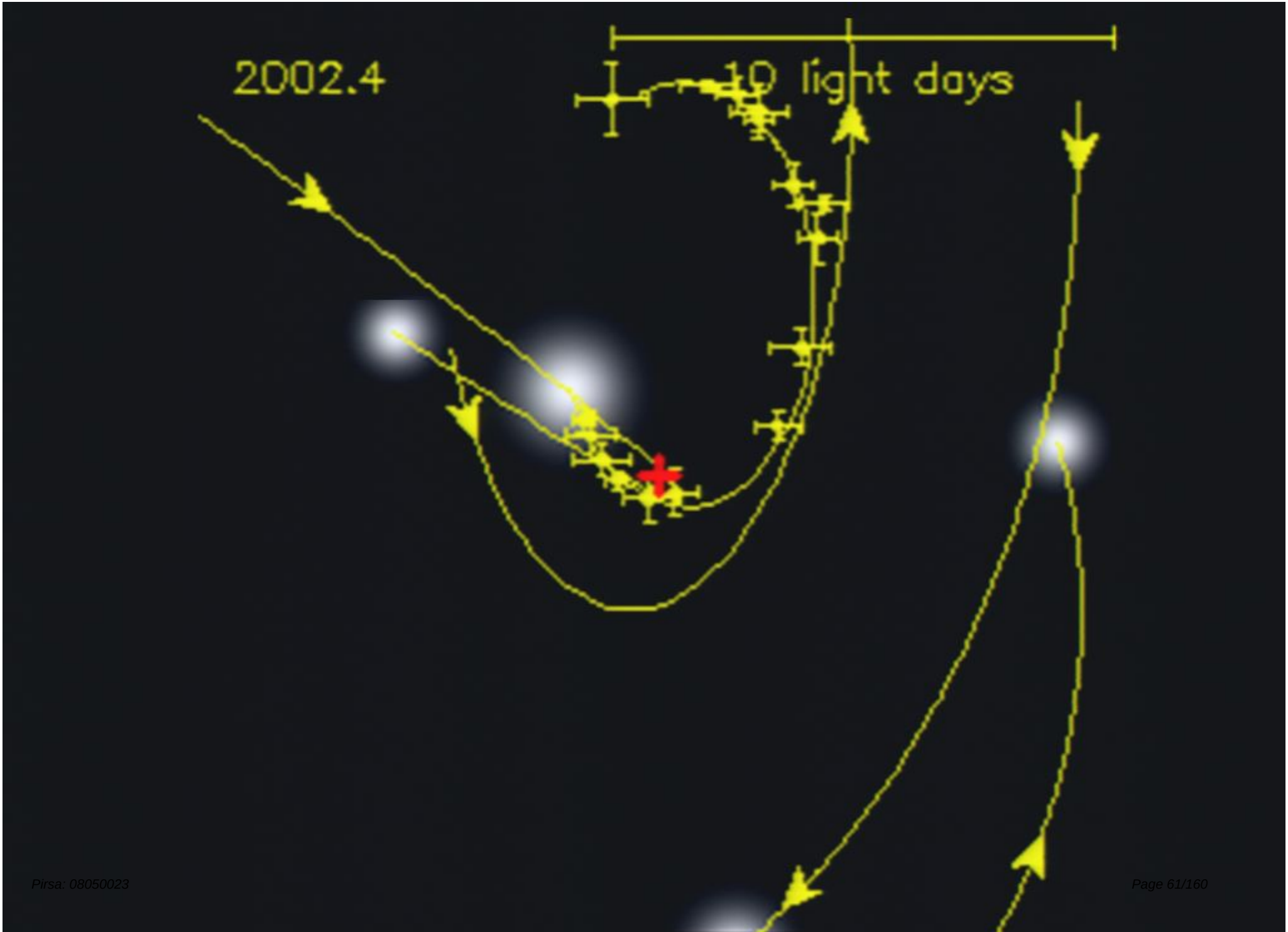
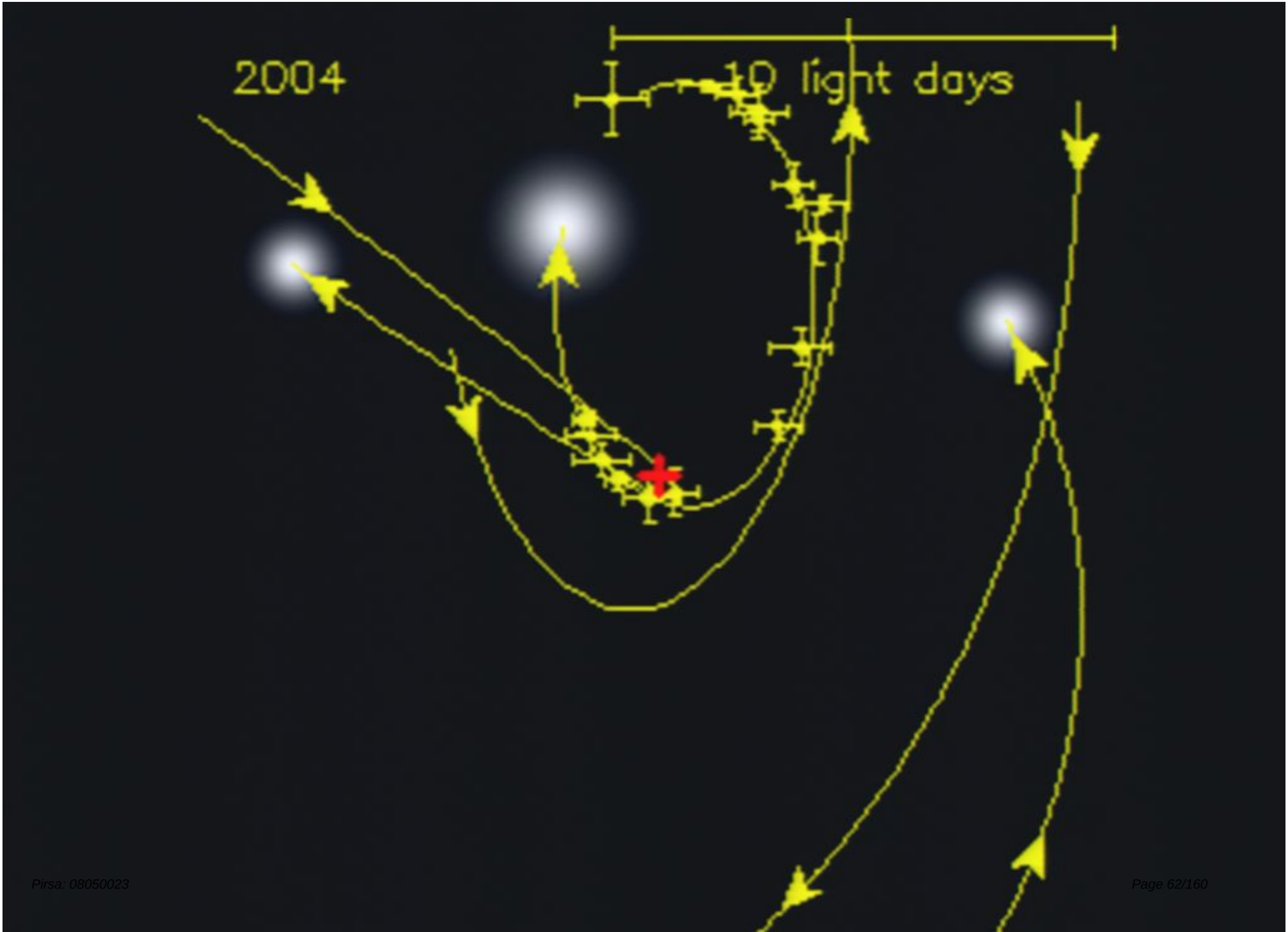

1999.6
10 light days

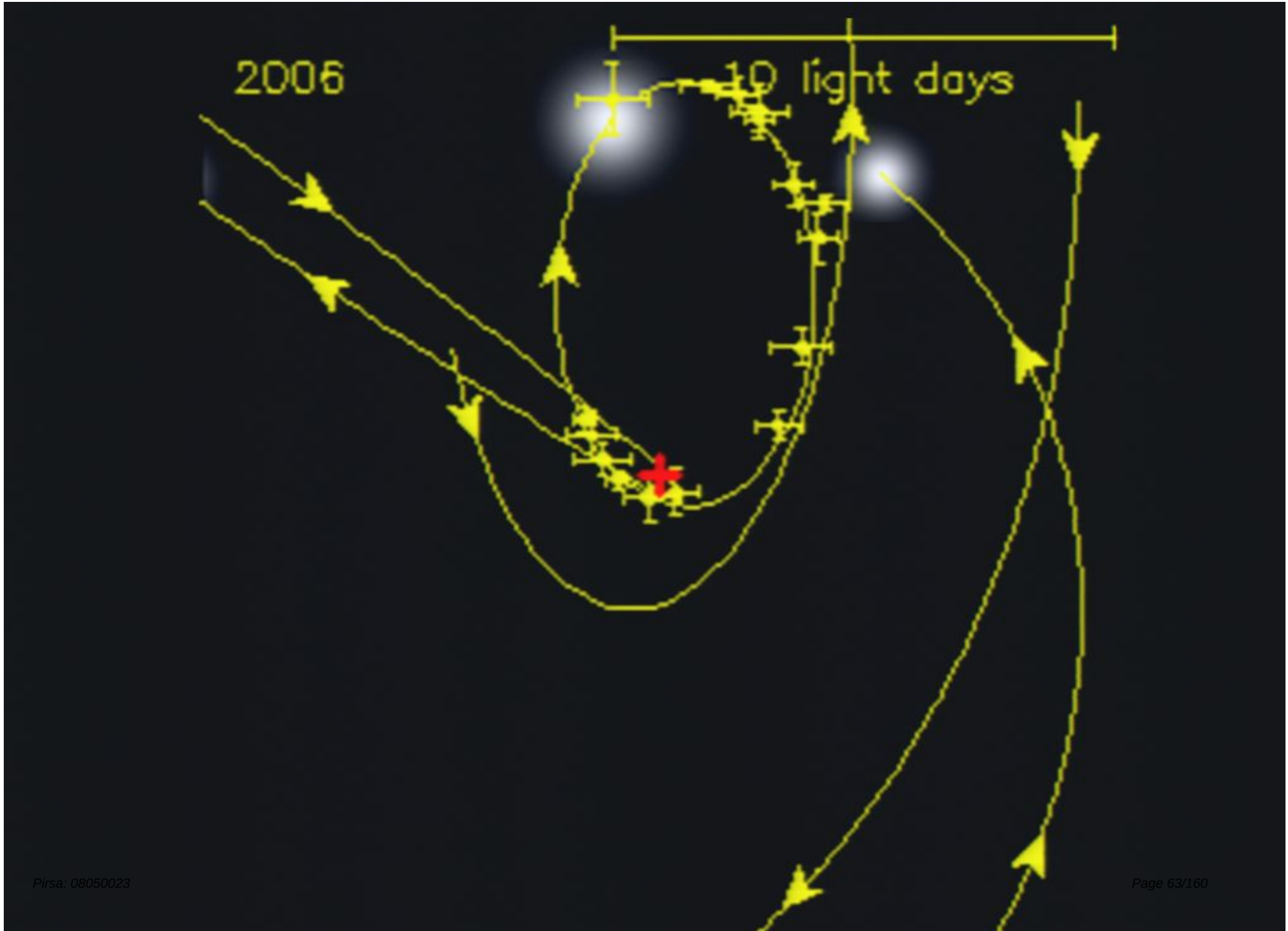

2000.6
10 light days

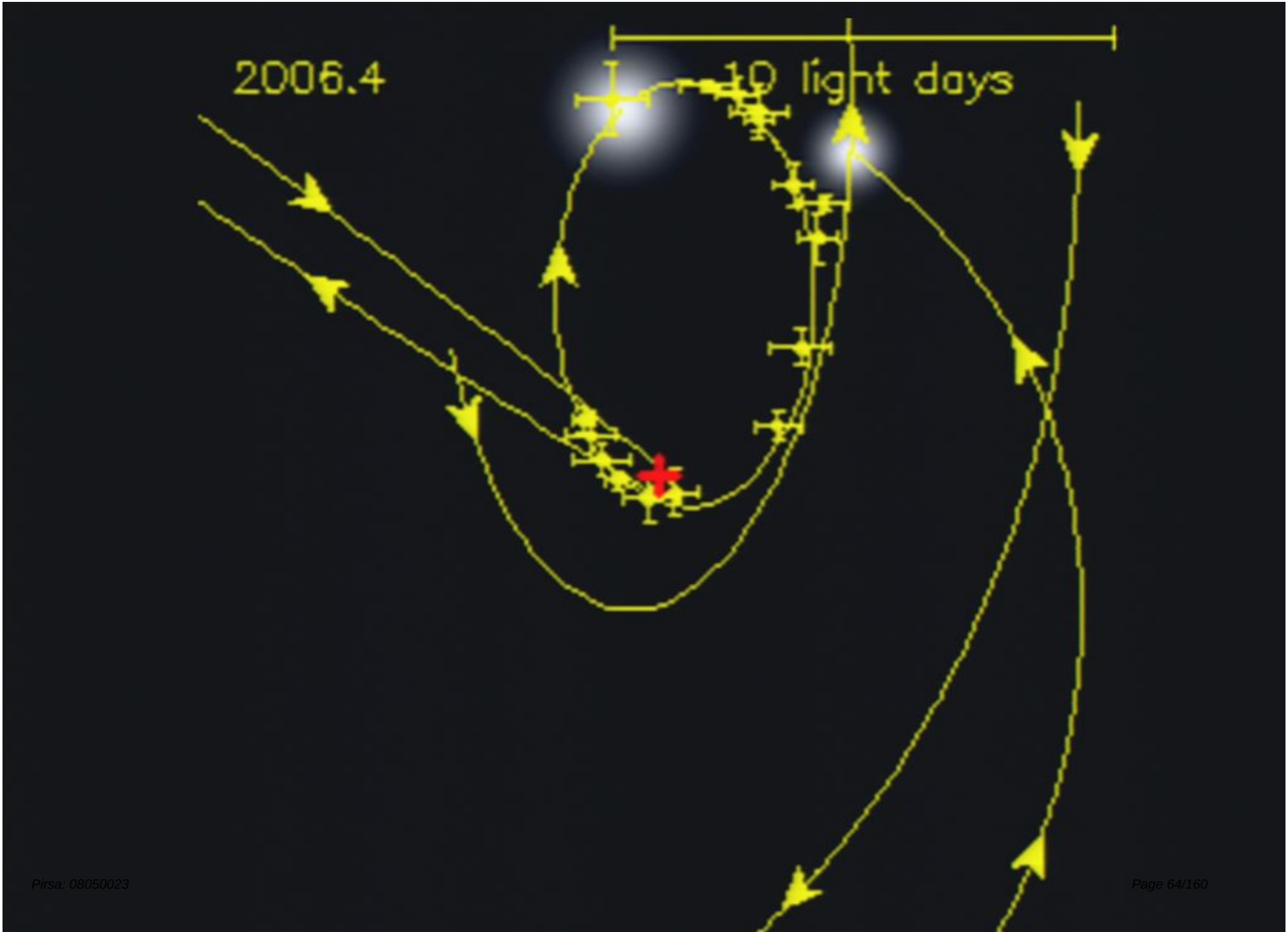

2001
10 light days


2001.8
10 light days


2002.4
10 light days


2004
10 light days

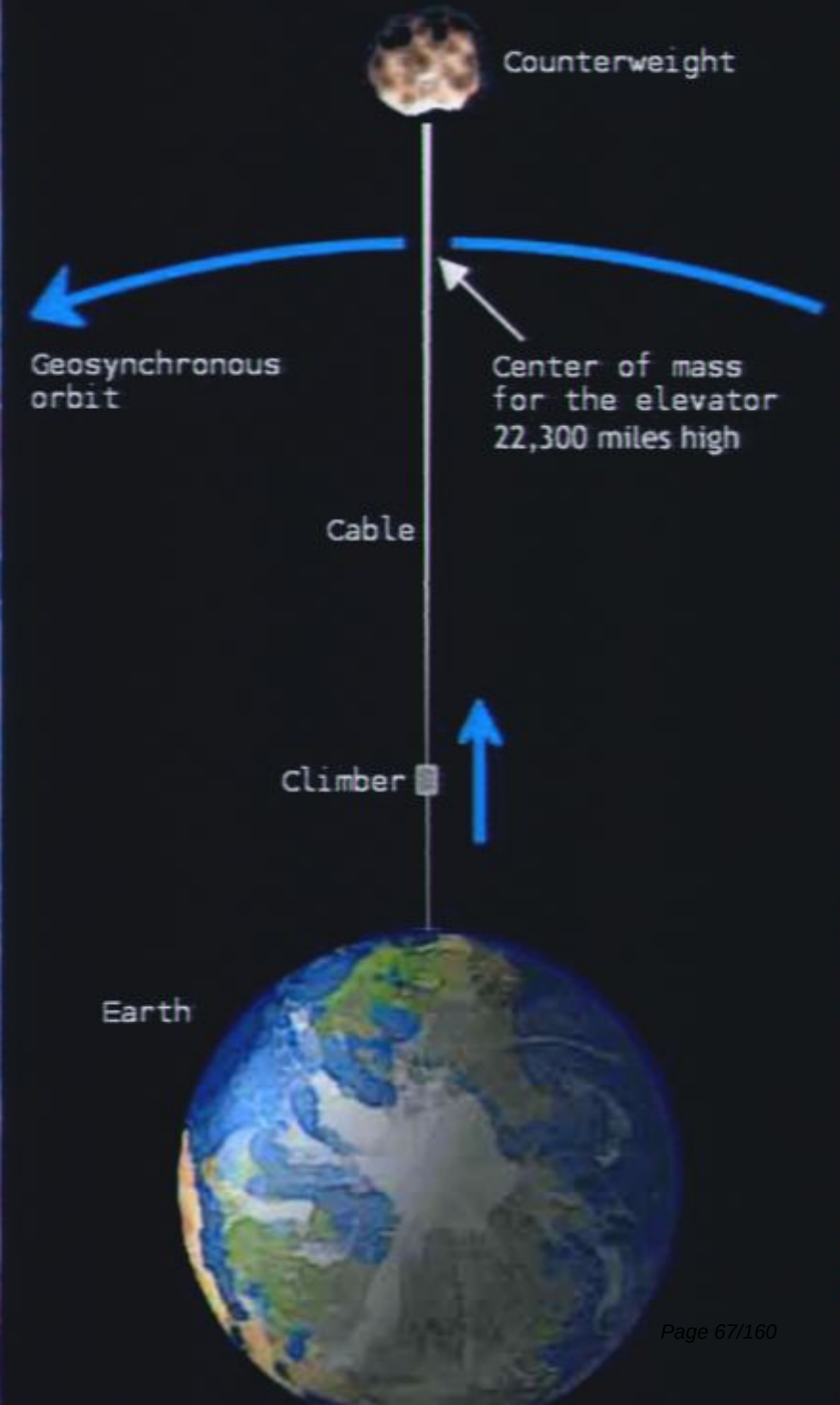

2006
10 light days


2006.4
10 light days


SGR A*


The possible role of tethers
Perimeter institute, Canada, 7/5/08

The characteristic factor is the **strength** of a cable *compared to its weight*



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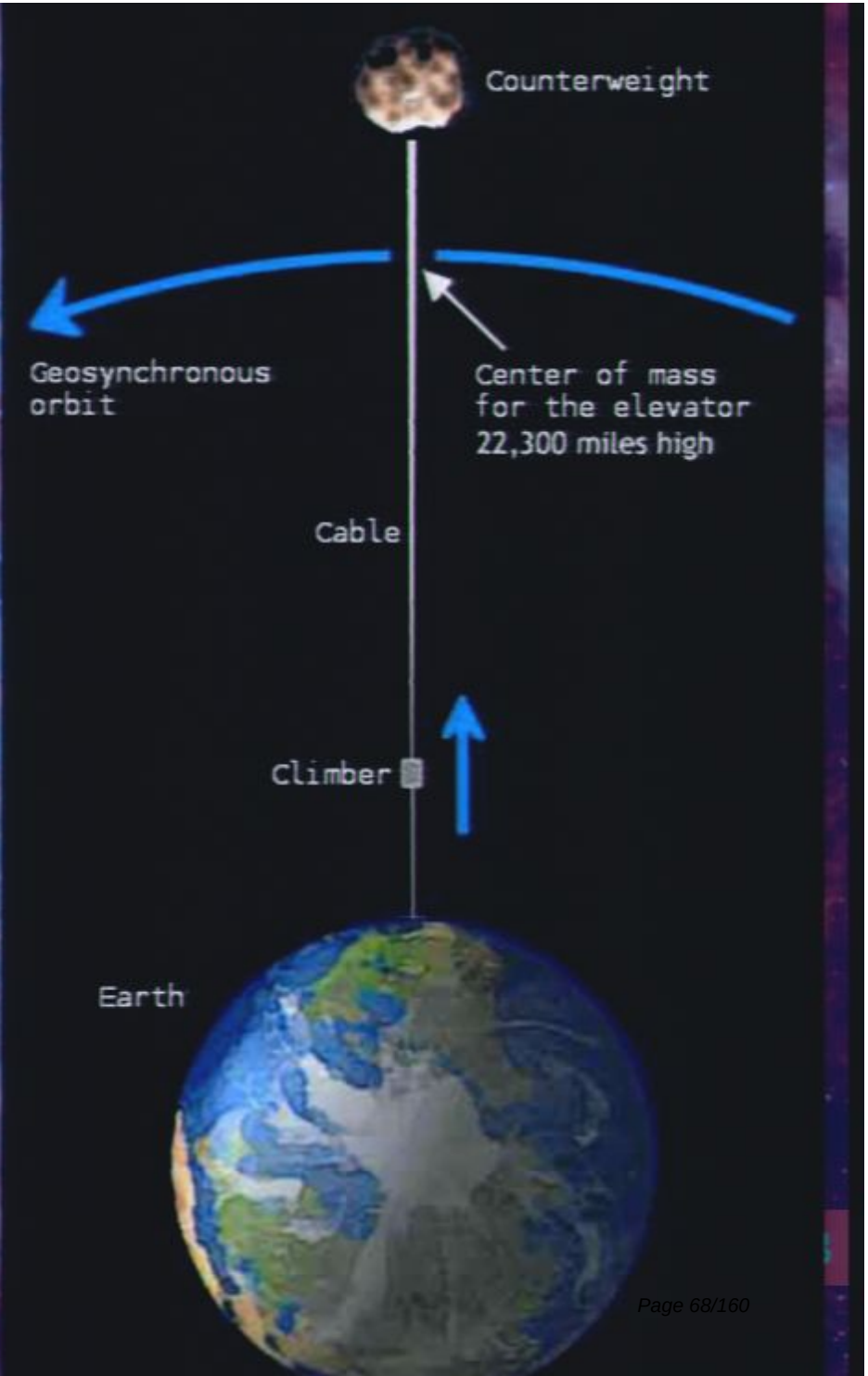
is expressed in
GigaPascal / (weight/ meter), or
Newton meter / kg



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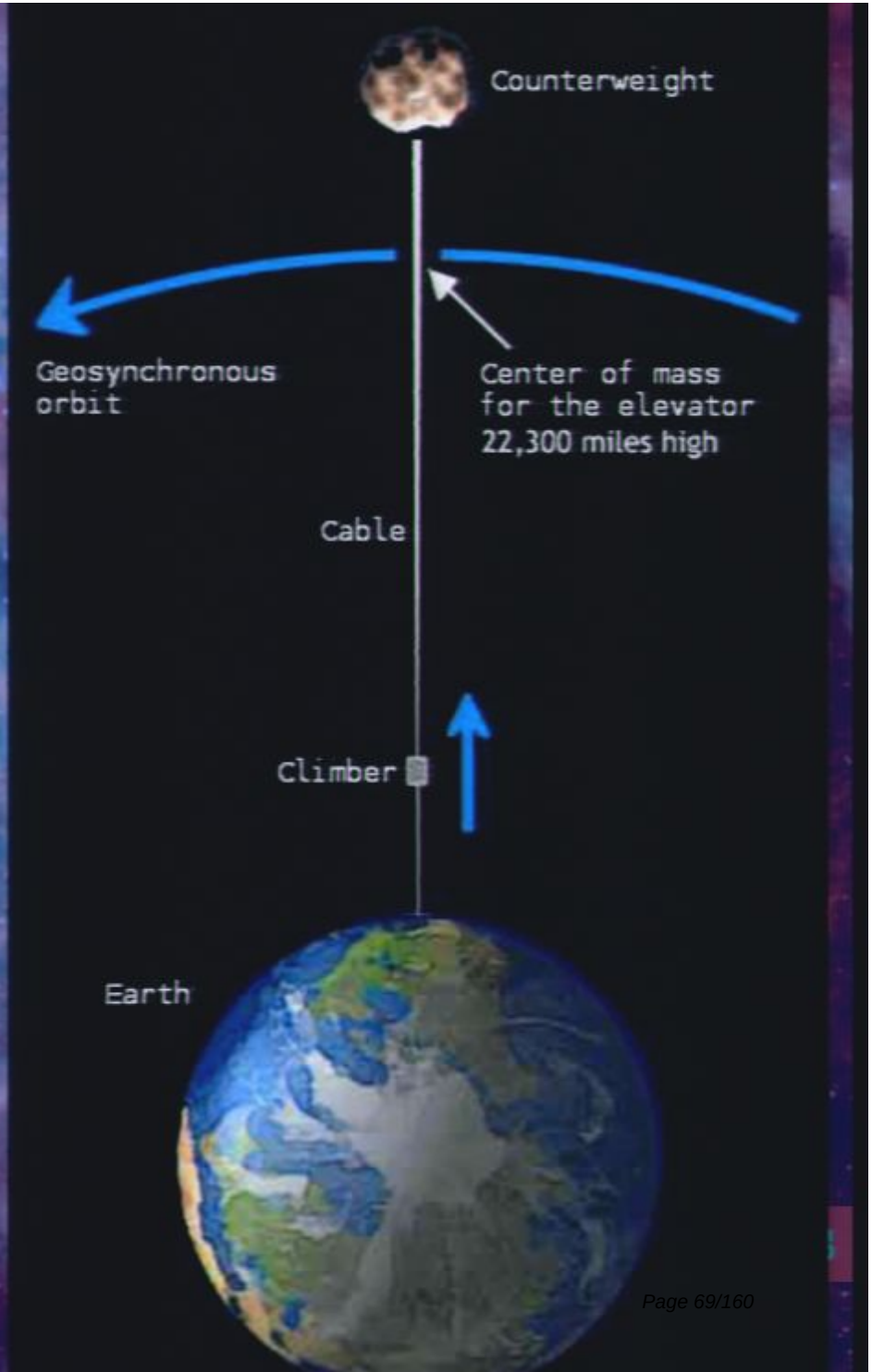

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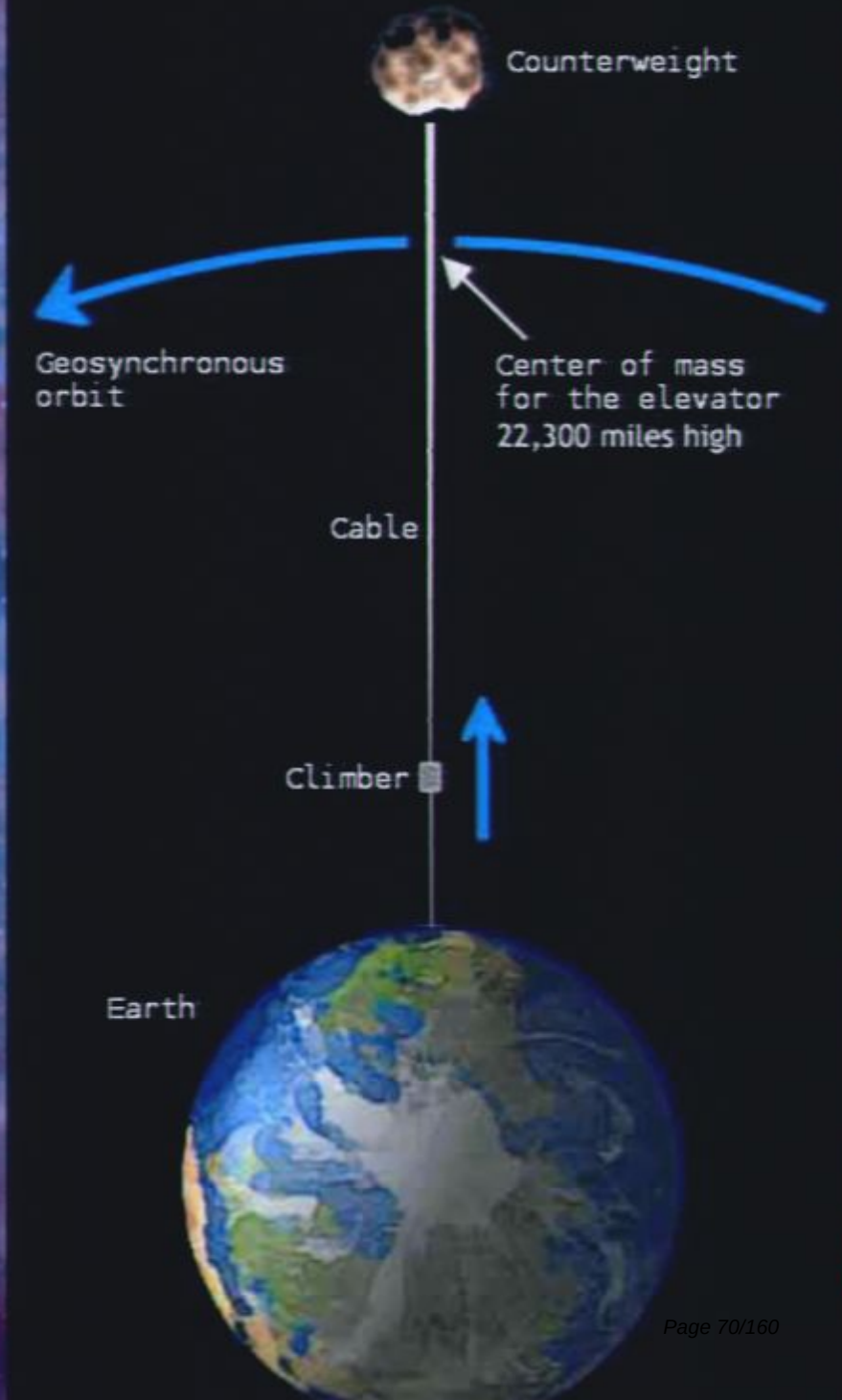
$$\frac{Nm}{kg} = \frac{kg\,m/sec^2\ m}{kg} = (m/sec)^2$$

Steel: 154 kNM/kg = 392 m/sec^2



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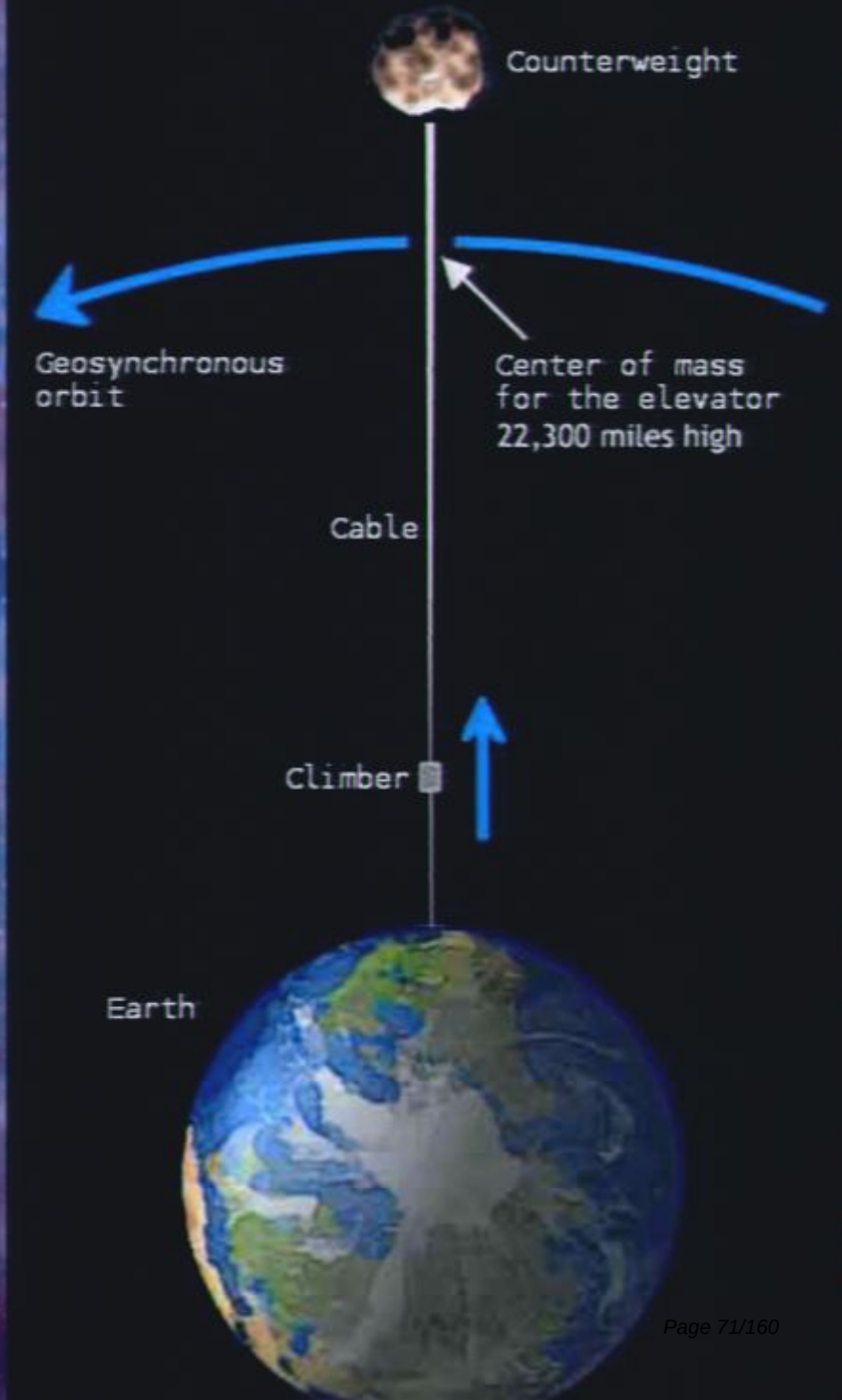
Steel: 154 kNM/kg = 392 $\mathrm{m/sec^2}$

Nano tubes: 48,462 kNm/kg = 7 $\mathrm{km/sec^2}$



Human colonization ...

Perimeter institute, Canada, 7/5/08

Human colonization ...

Our motives: curiosity ...

Perimeter institute, Canada, 7/5/08

Human colonization ...

Our motives: curiosity ...

and expansion drift

Perimeter institute, Canada, 7/5/08

Human colonization ...

Our motives: curiosity ...

and expansion drift

Colonization of the Universe only happens if **affordable**!

Perimeter institute, Canada, 7/5/08

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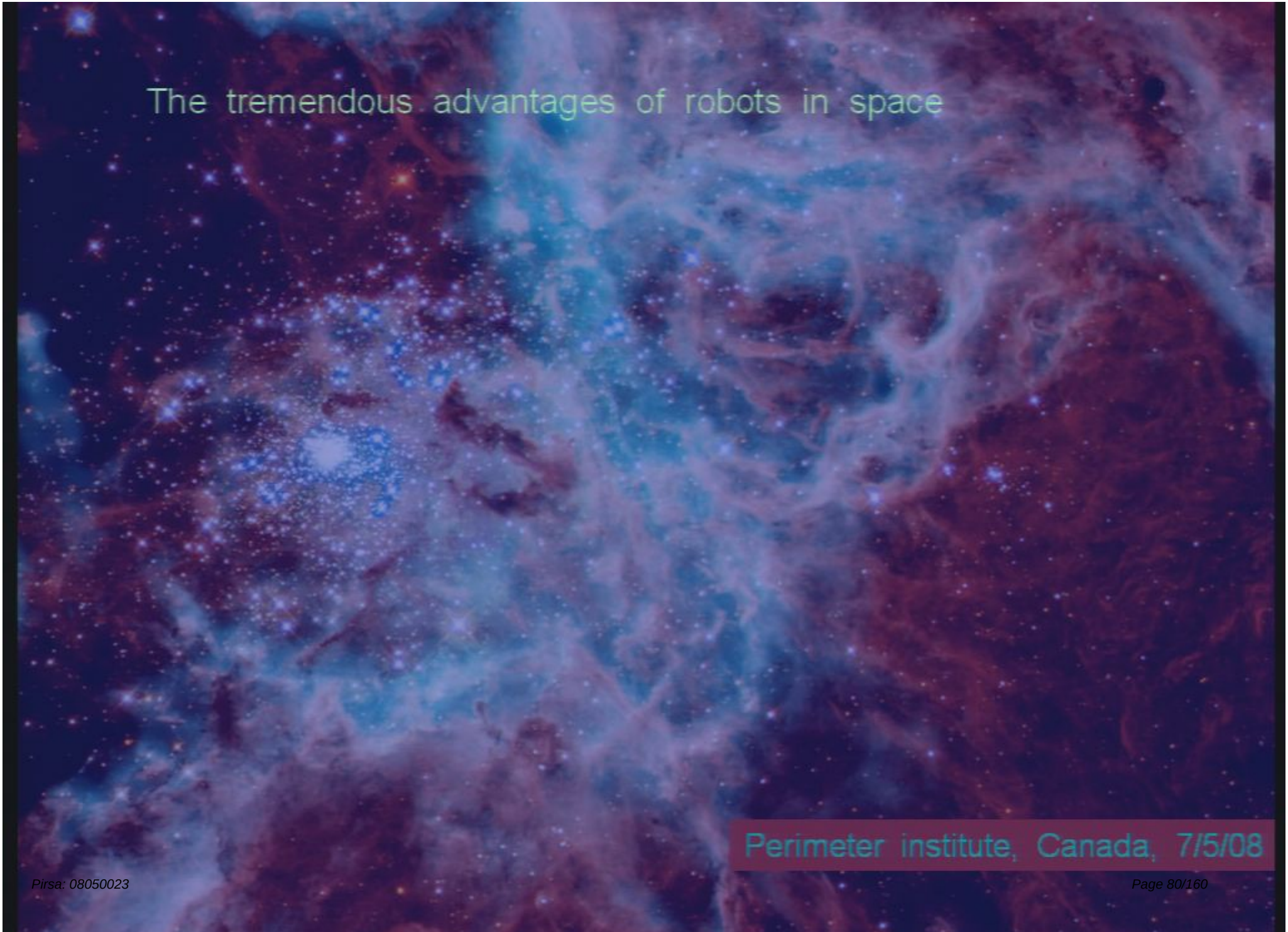
for essential information

the Media

the Internet

To keep fund providers happy

remotely controlled robots


The tremendous advantages of robots in space
Perimeter institute, Canada, 7/5/08

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Information technology

Robots remotely controlled by genuinely intelligent computers
- this does not contradict anything we know

Perimeter institute, Canada, 7/5/08

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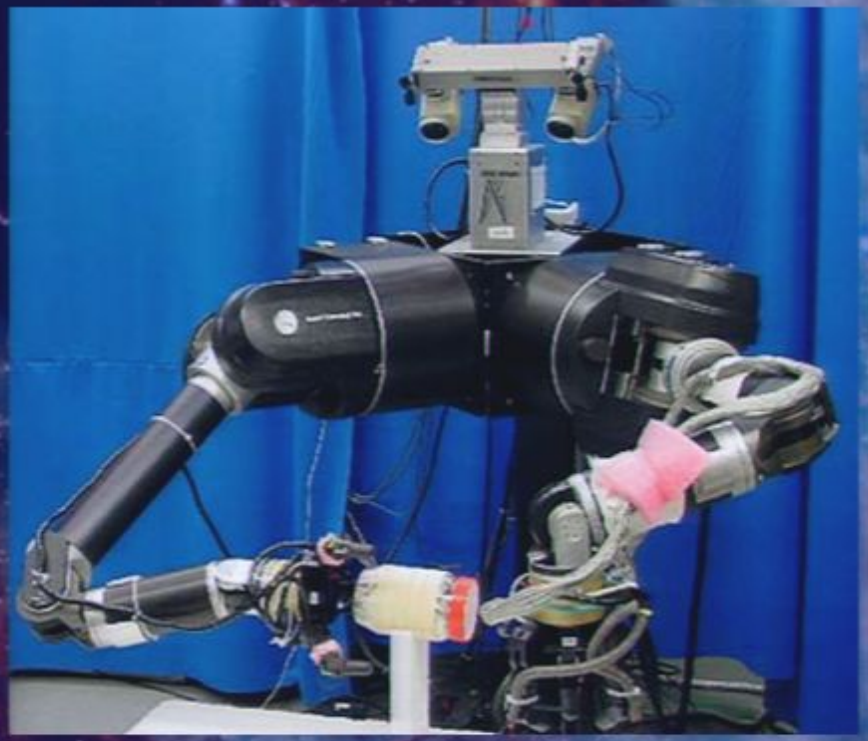

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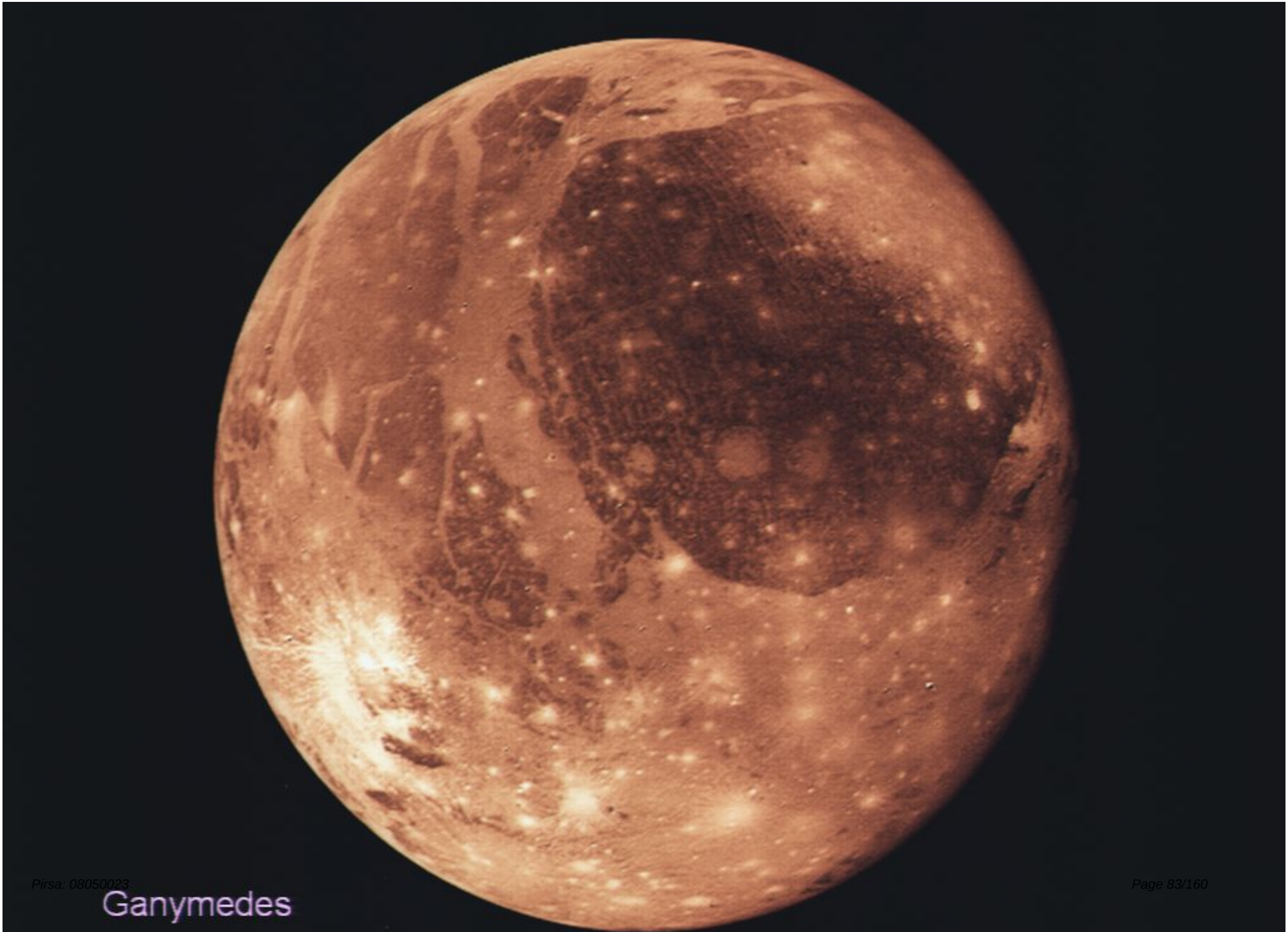
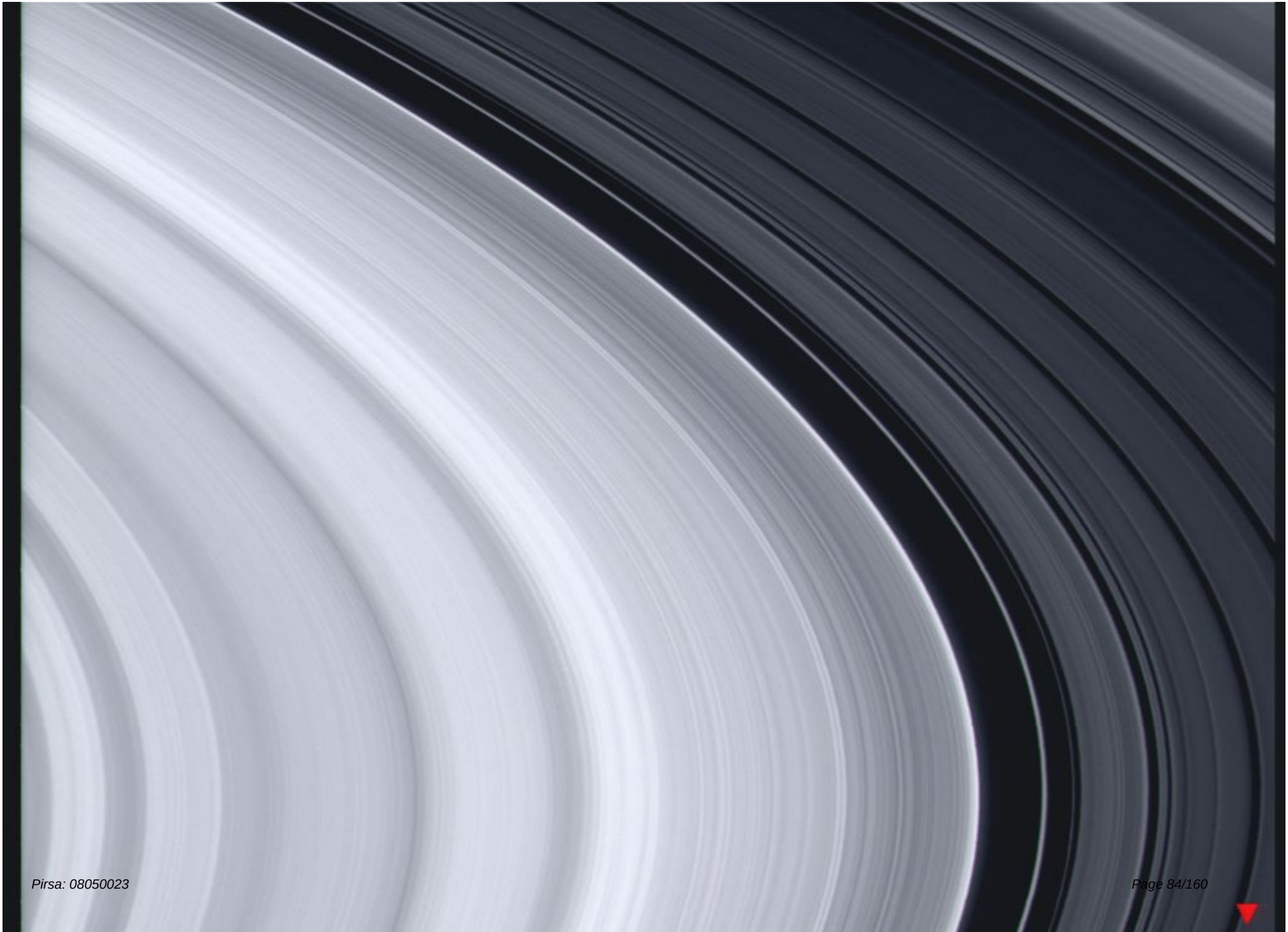
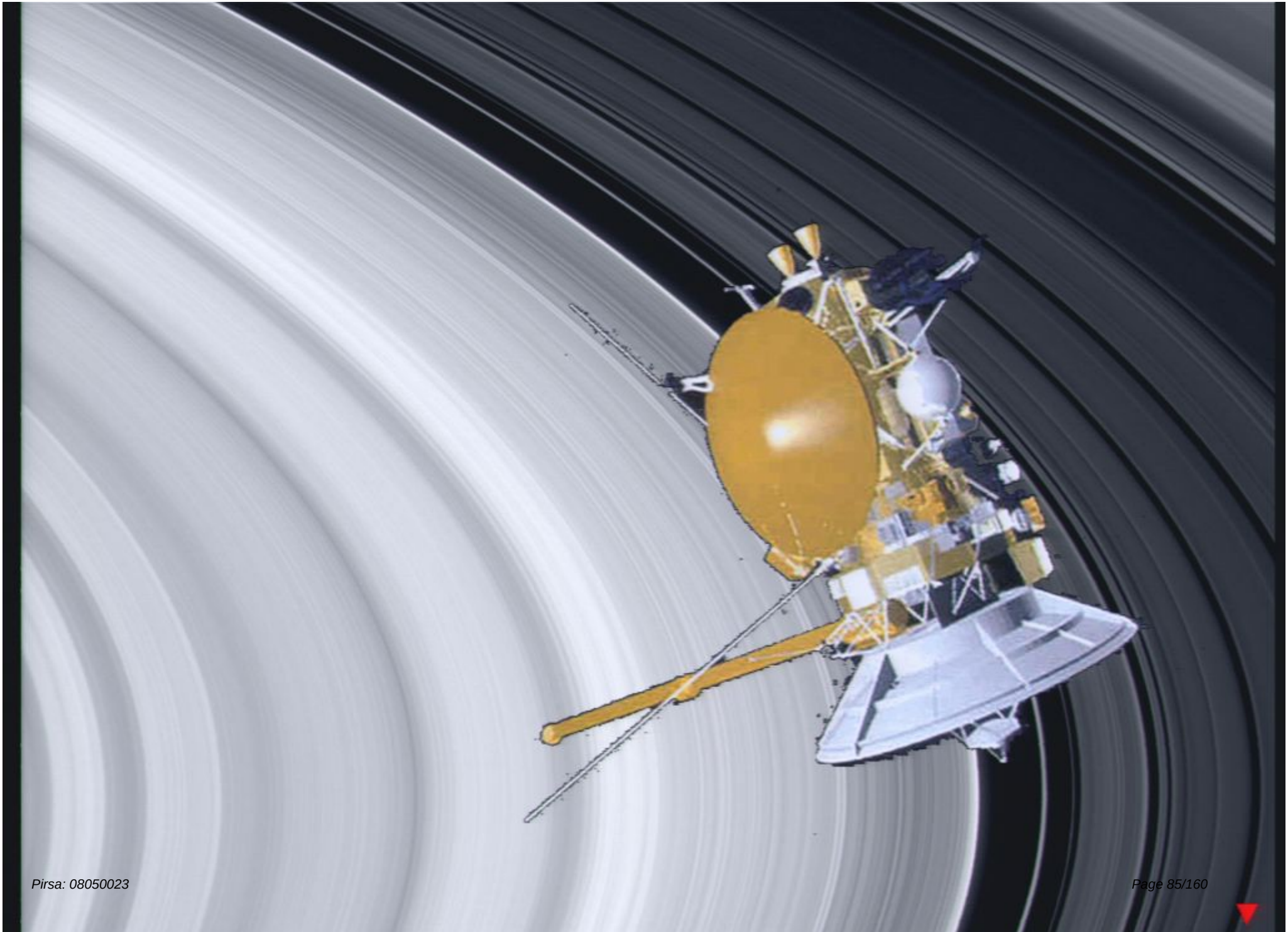
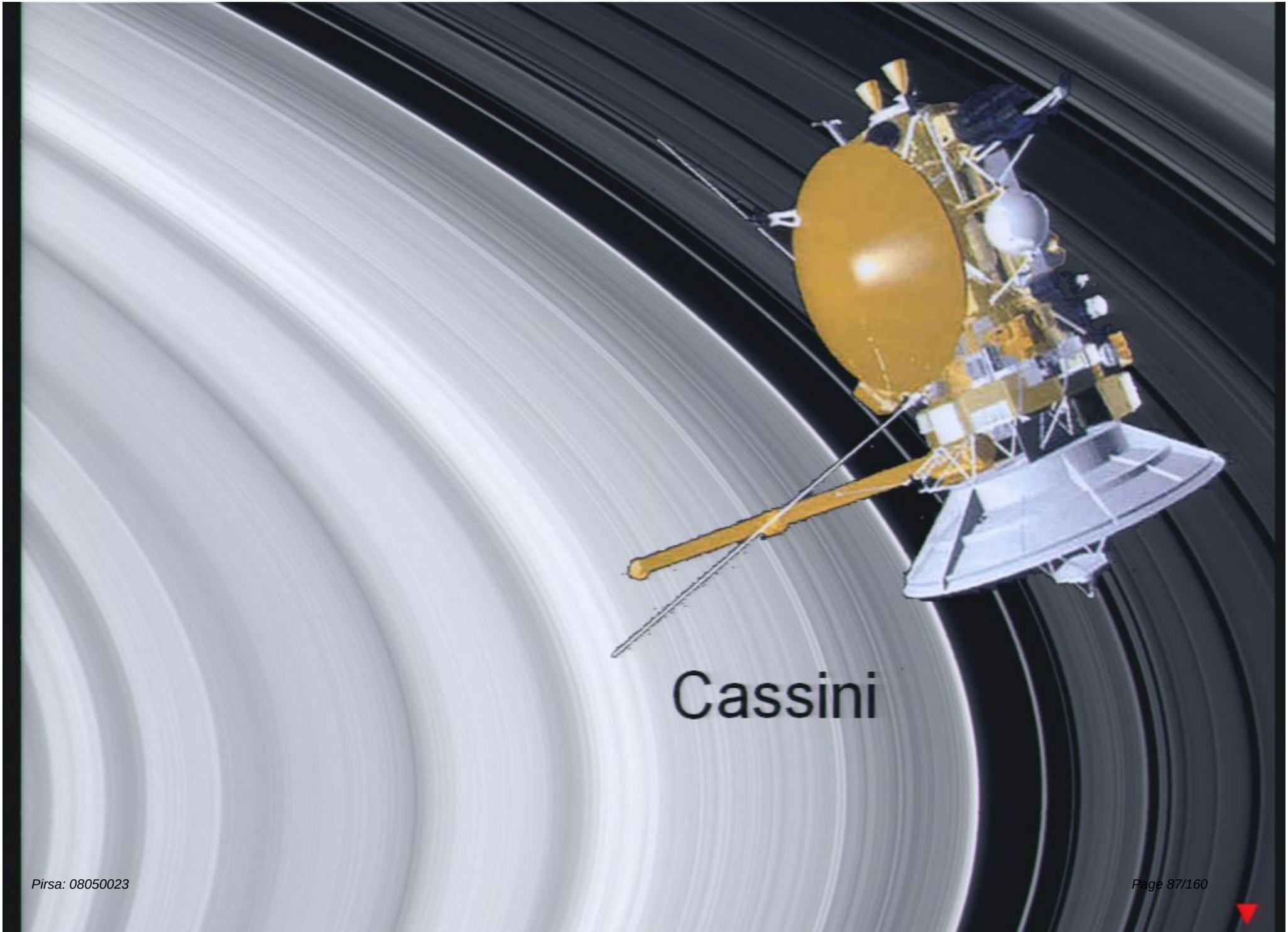


Ganymedes






Cassini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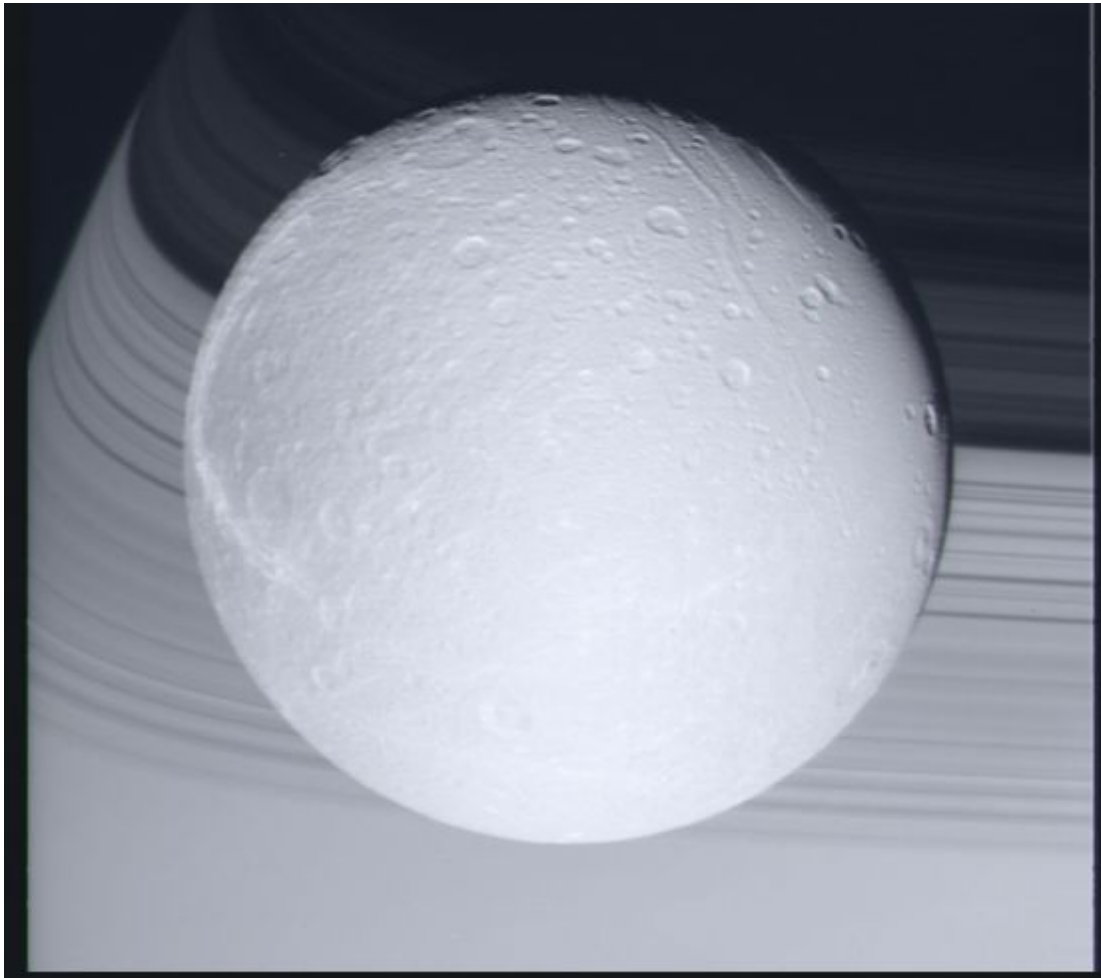
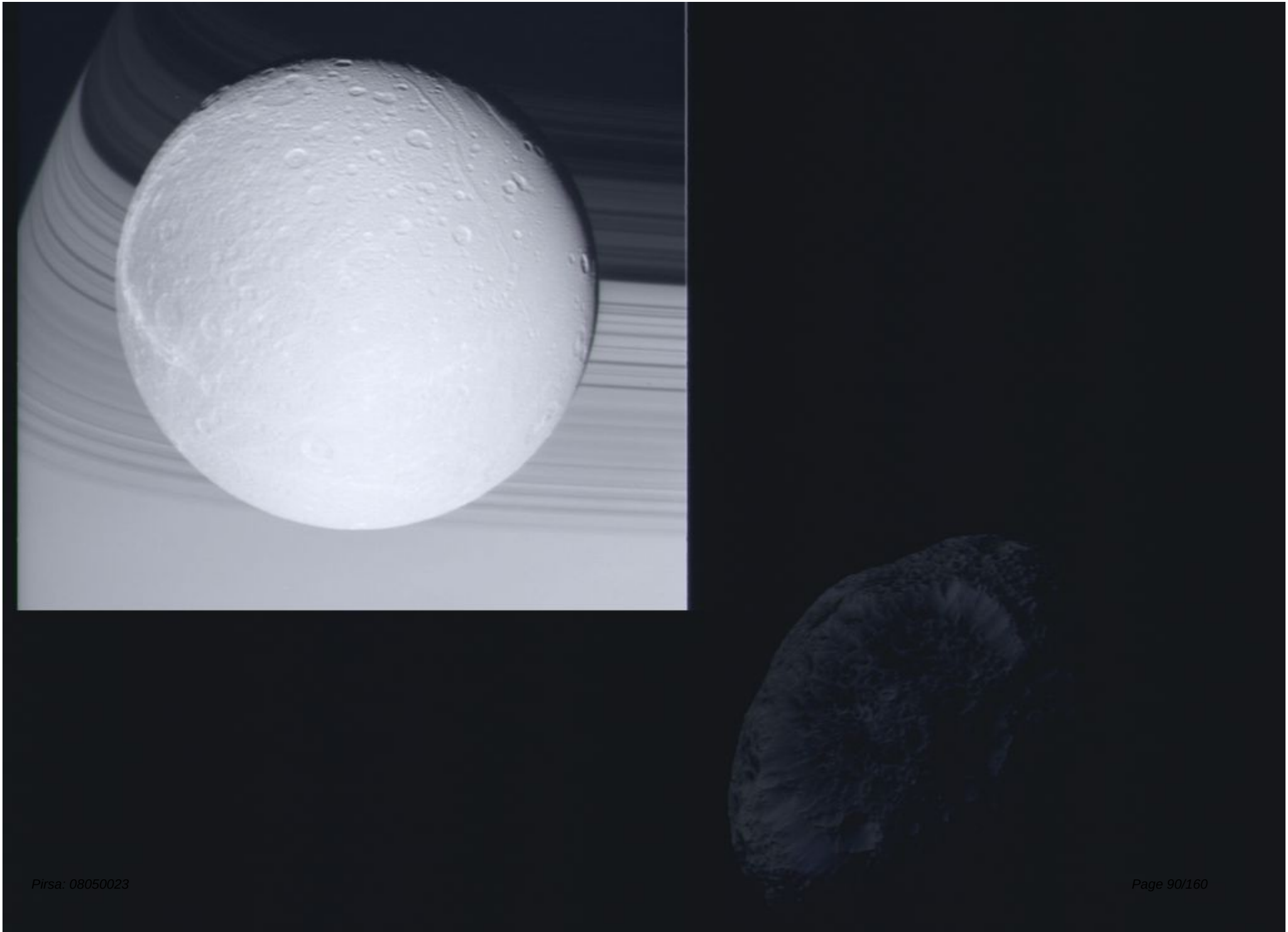
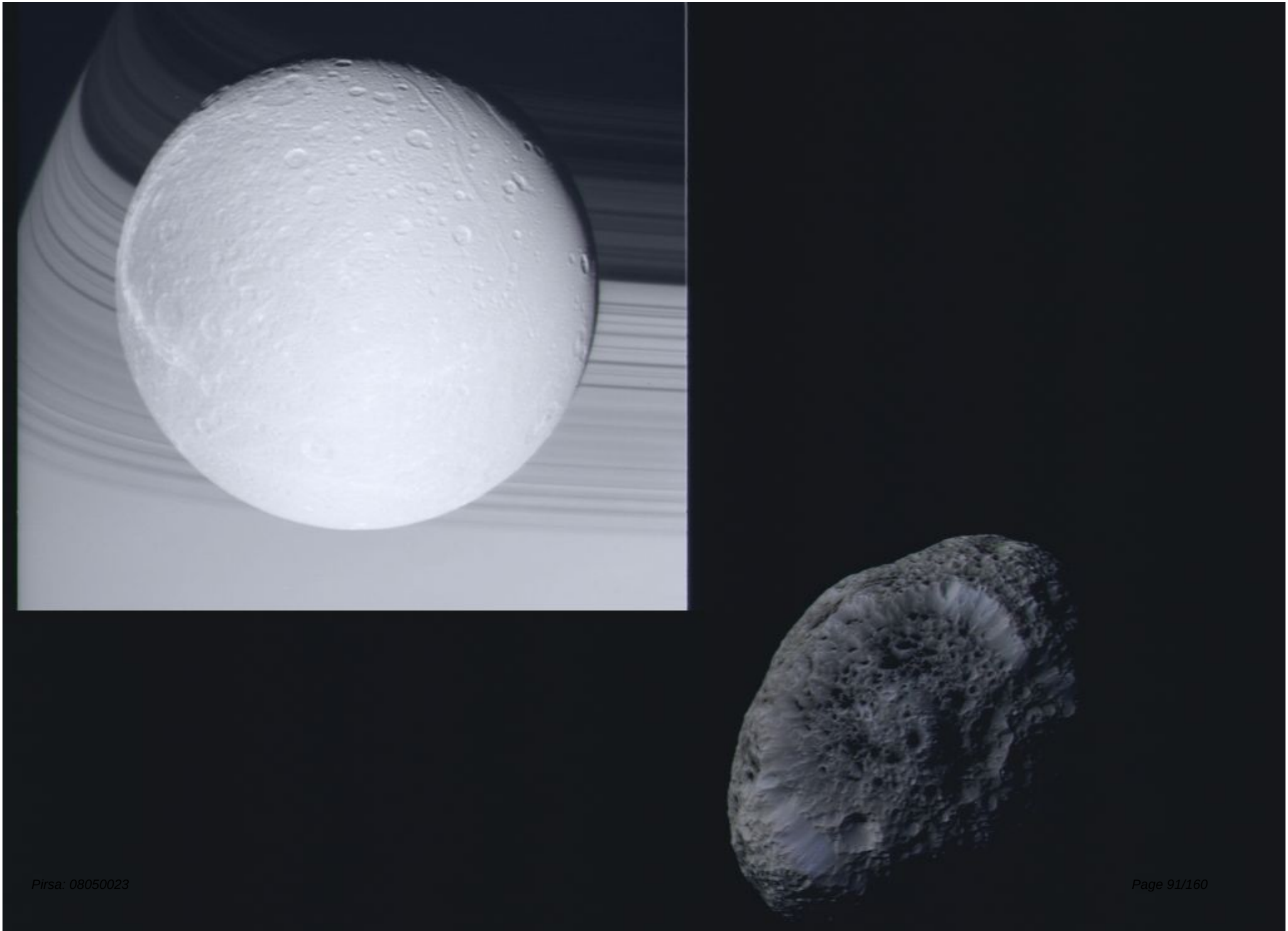
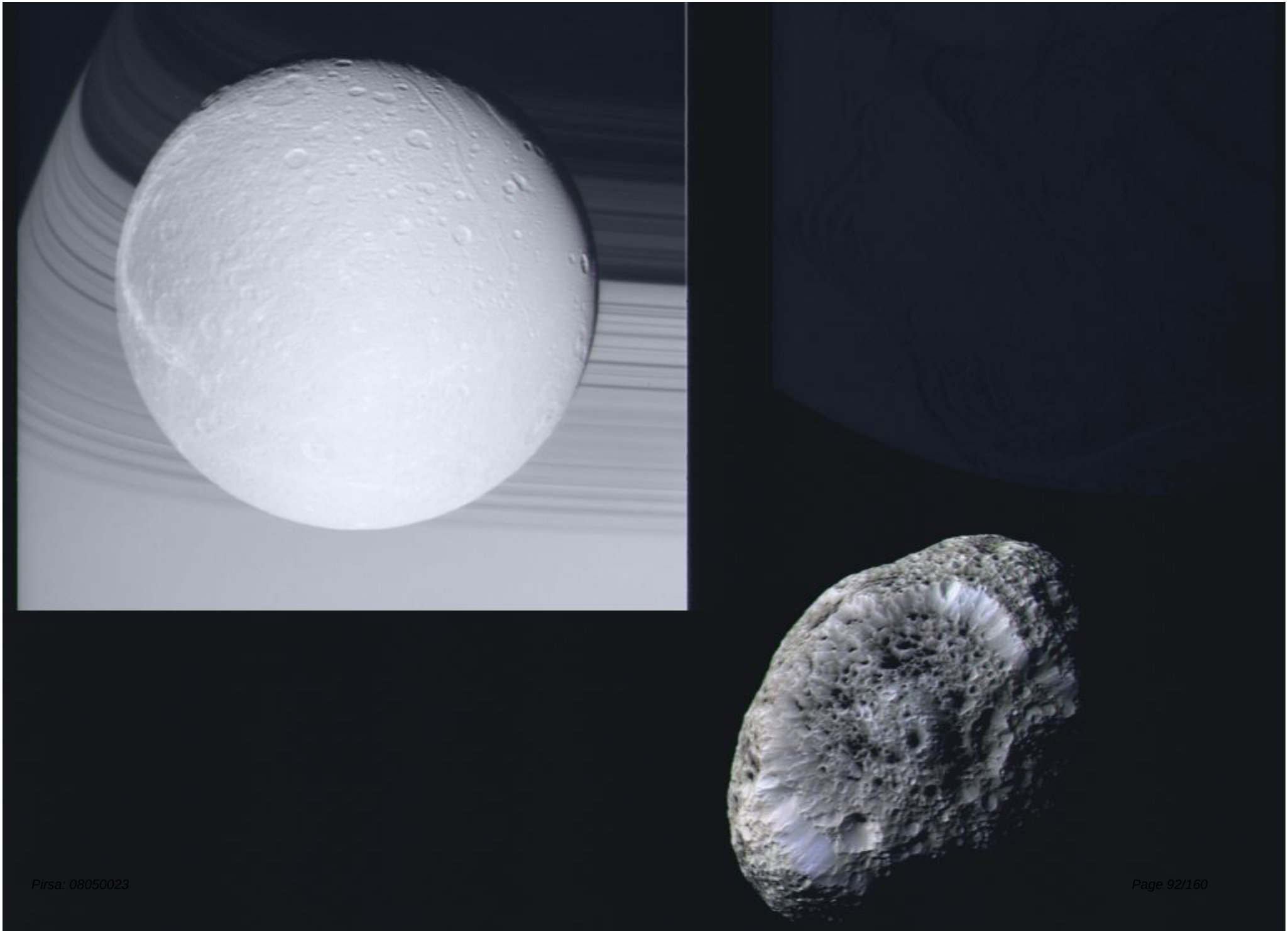
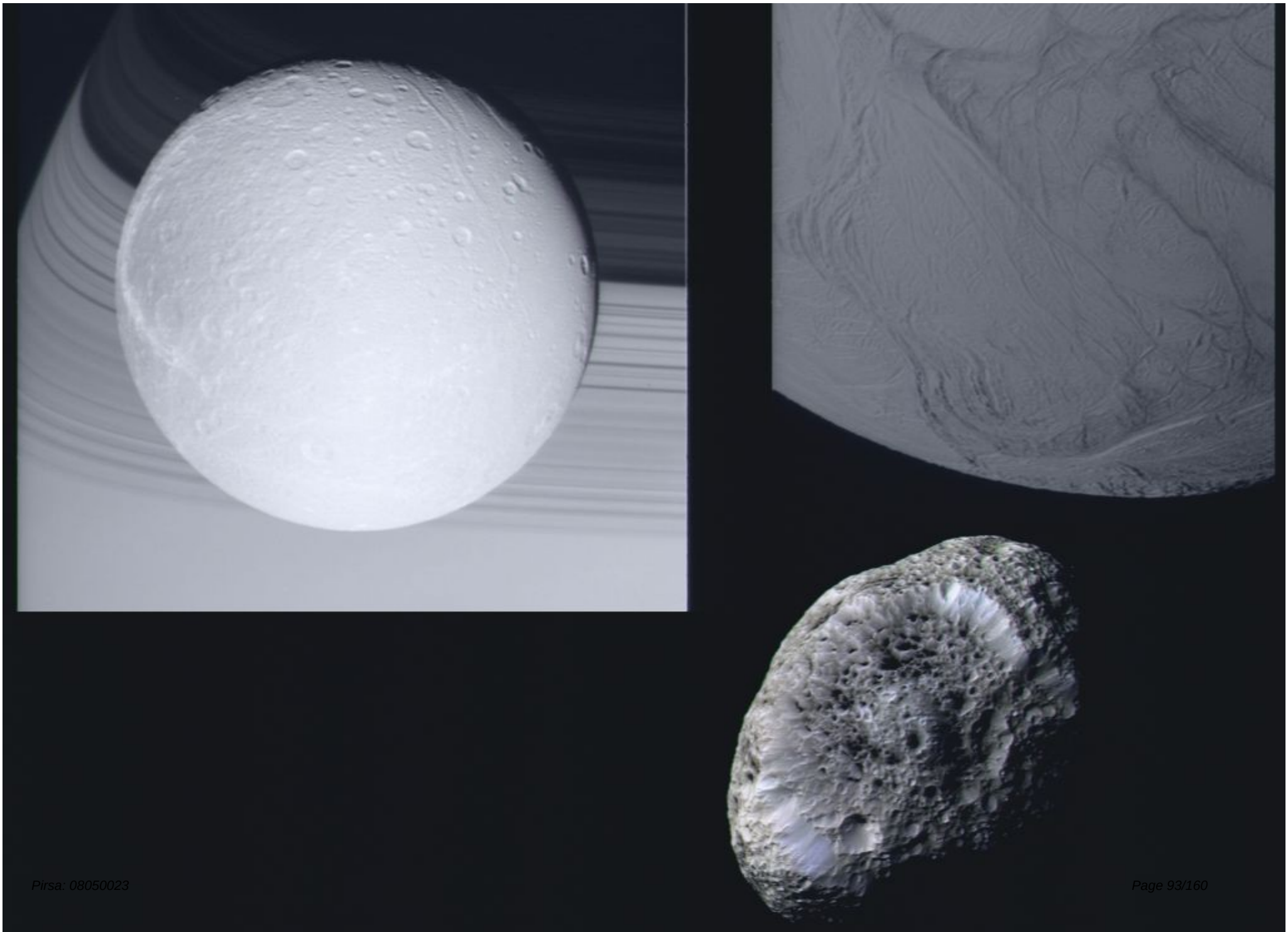
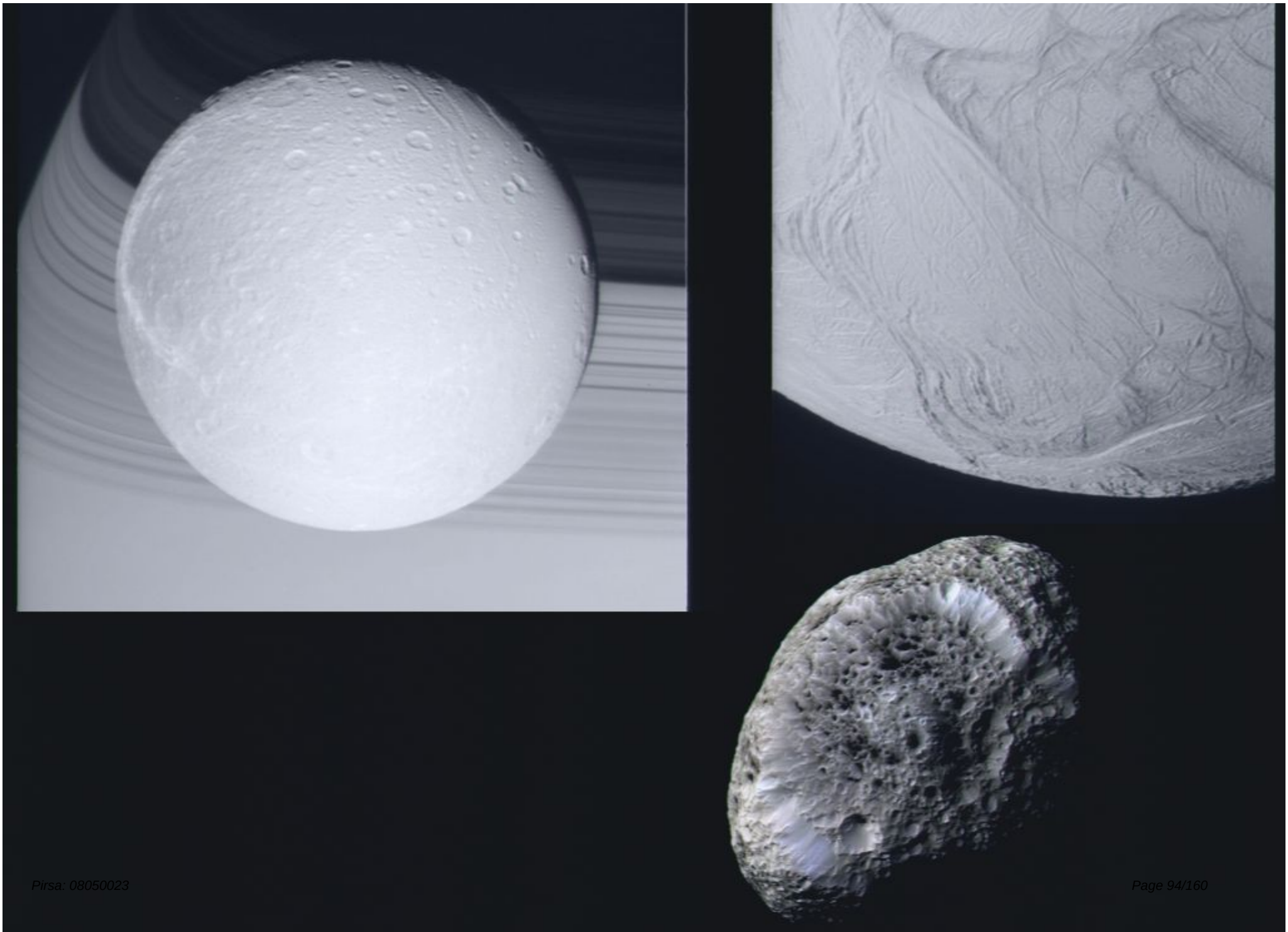


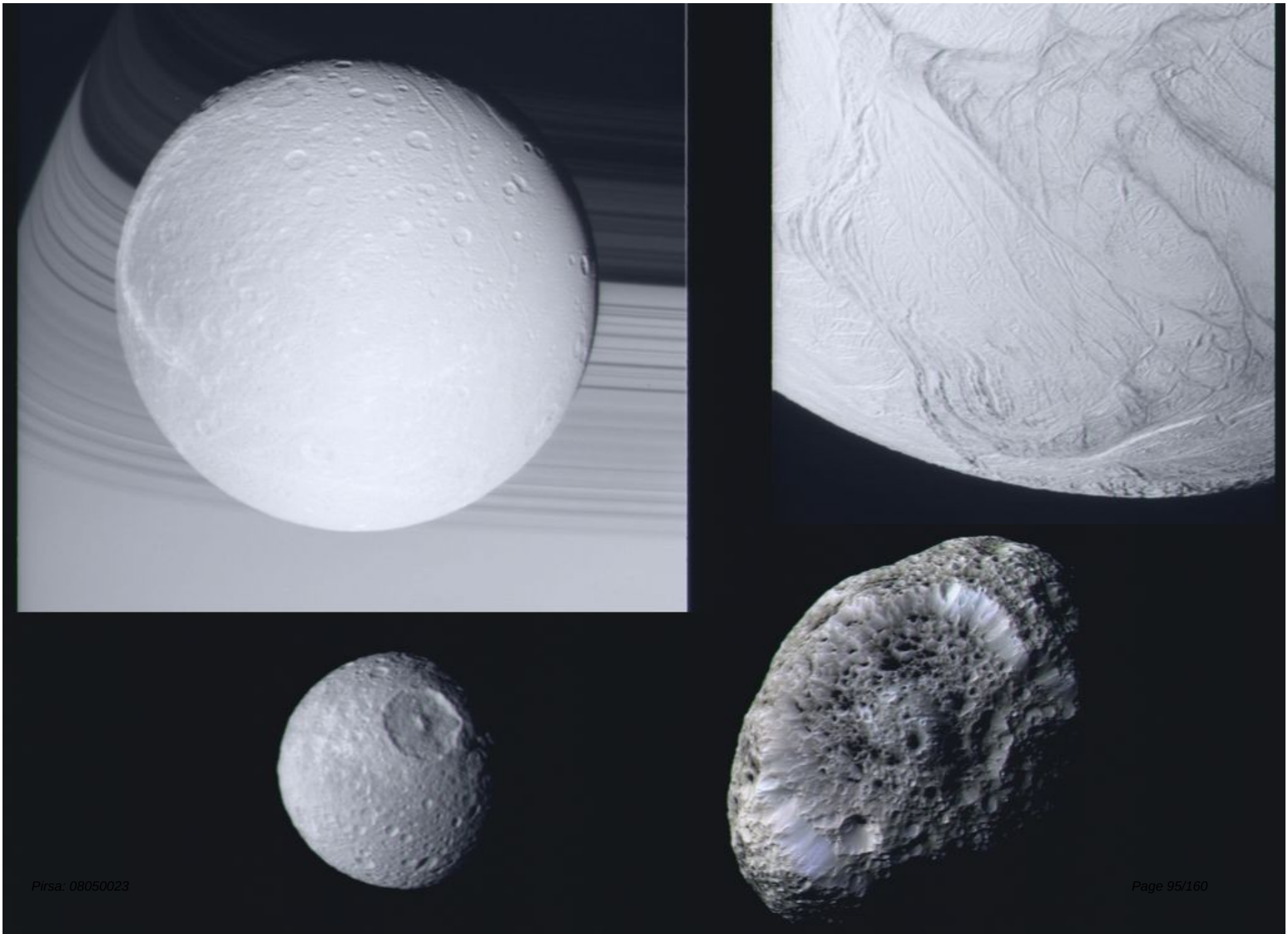


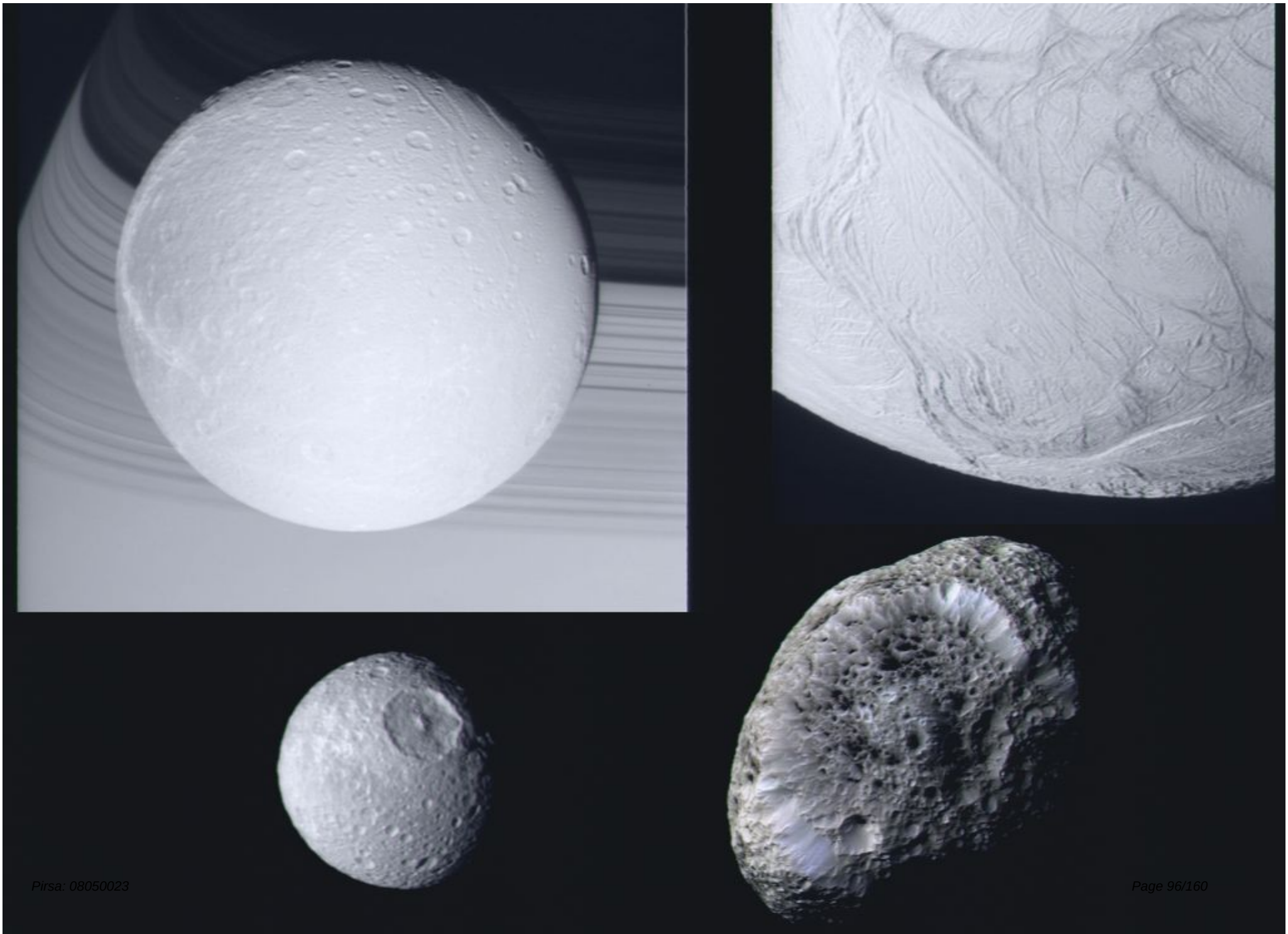




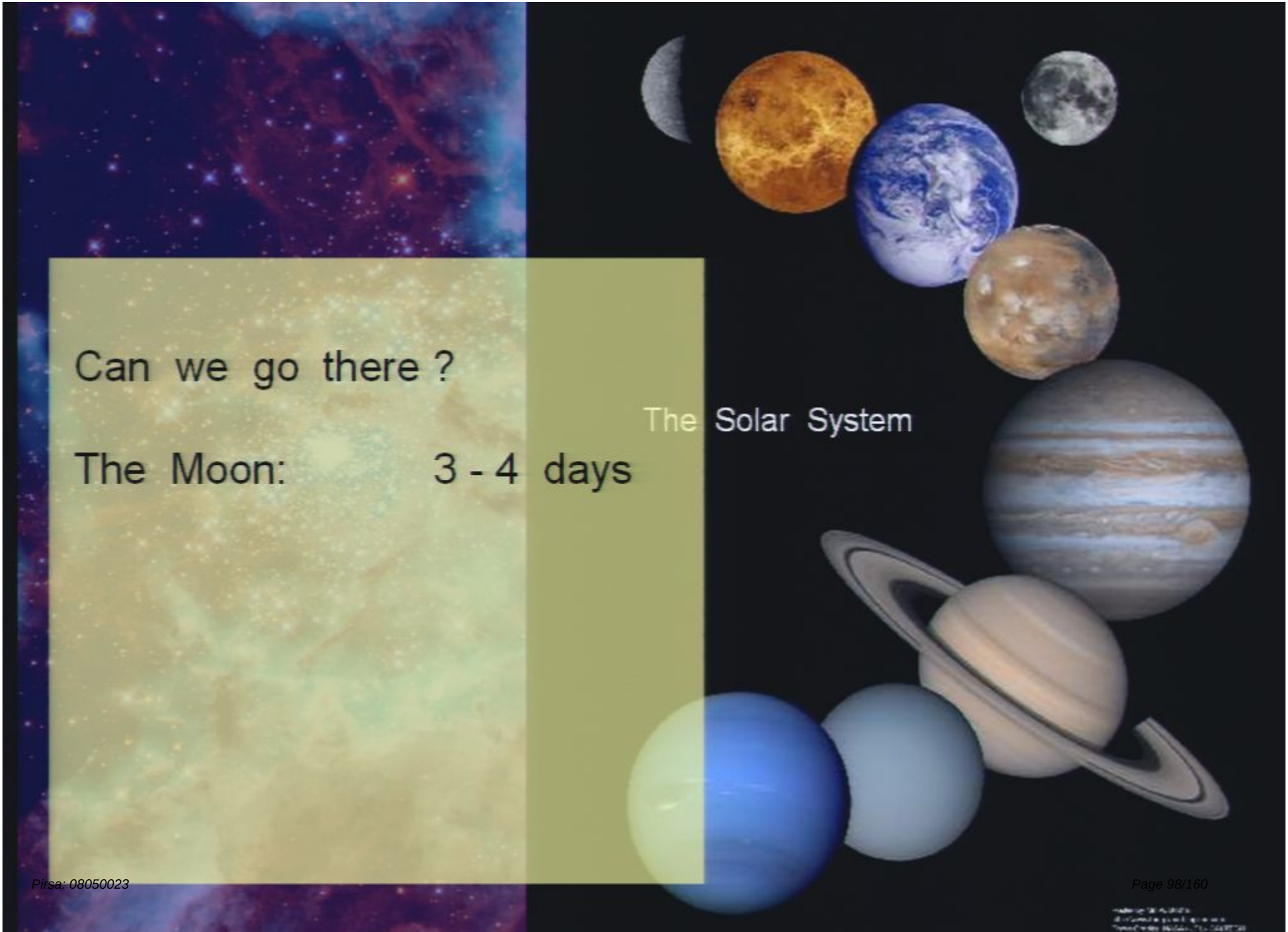


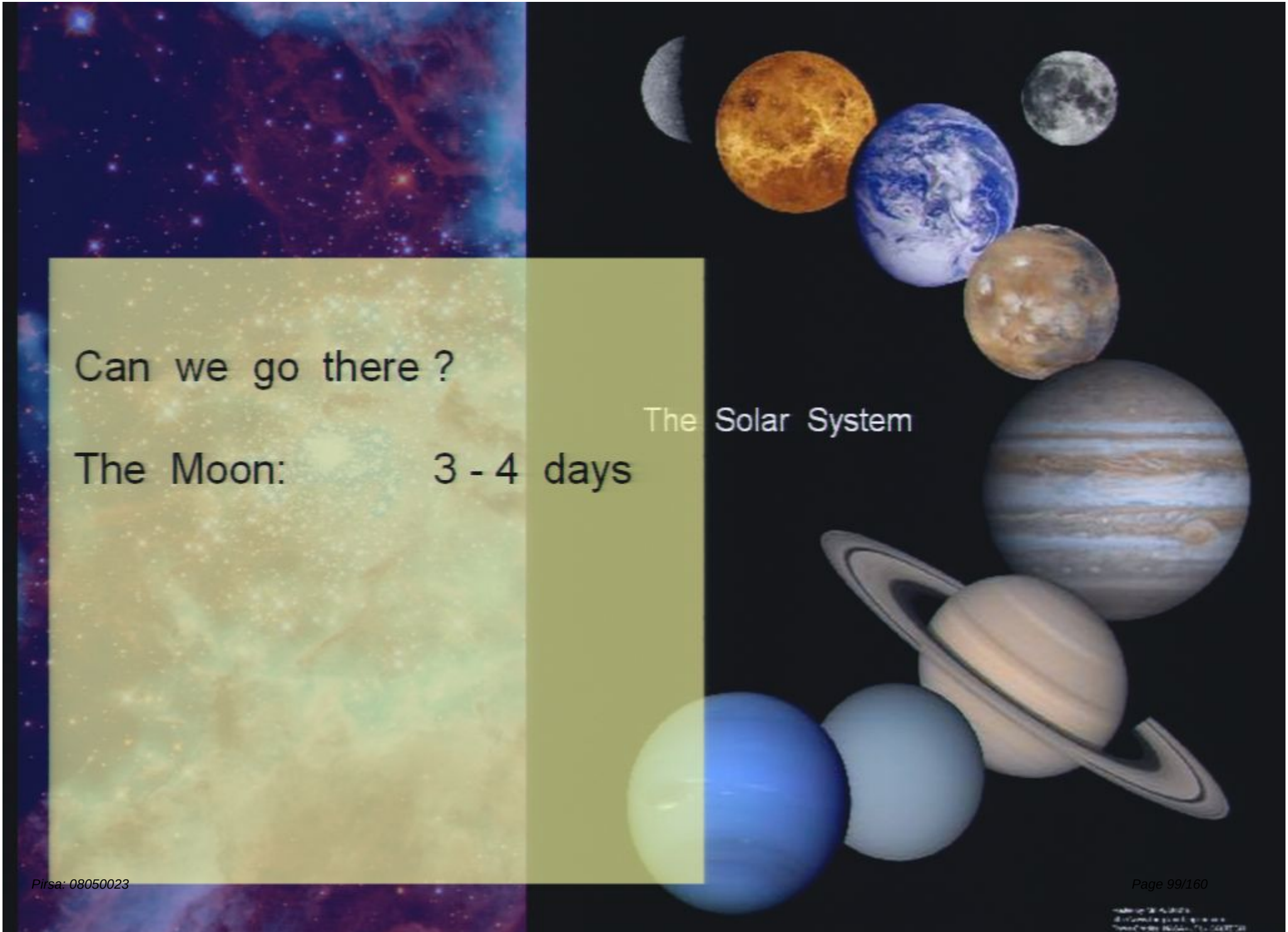







The Solar System


Can we go there ?
The Moon: 3 - 4 days
The Solar System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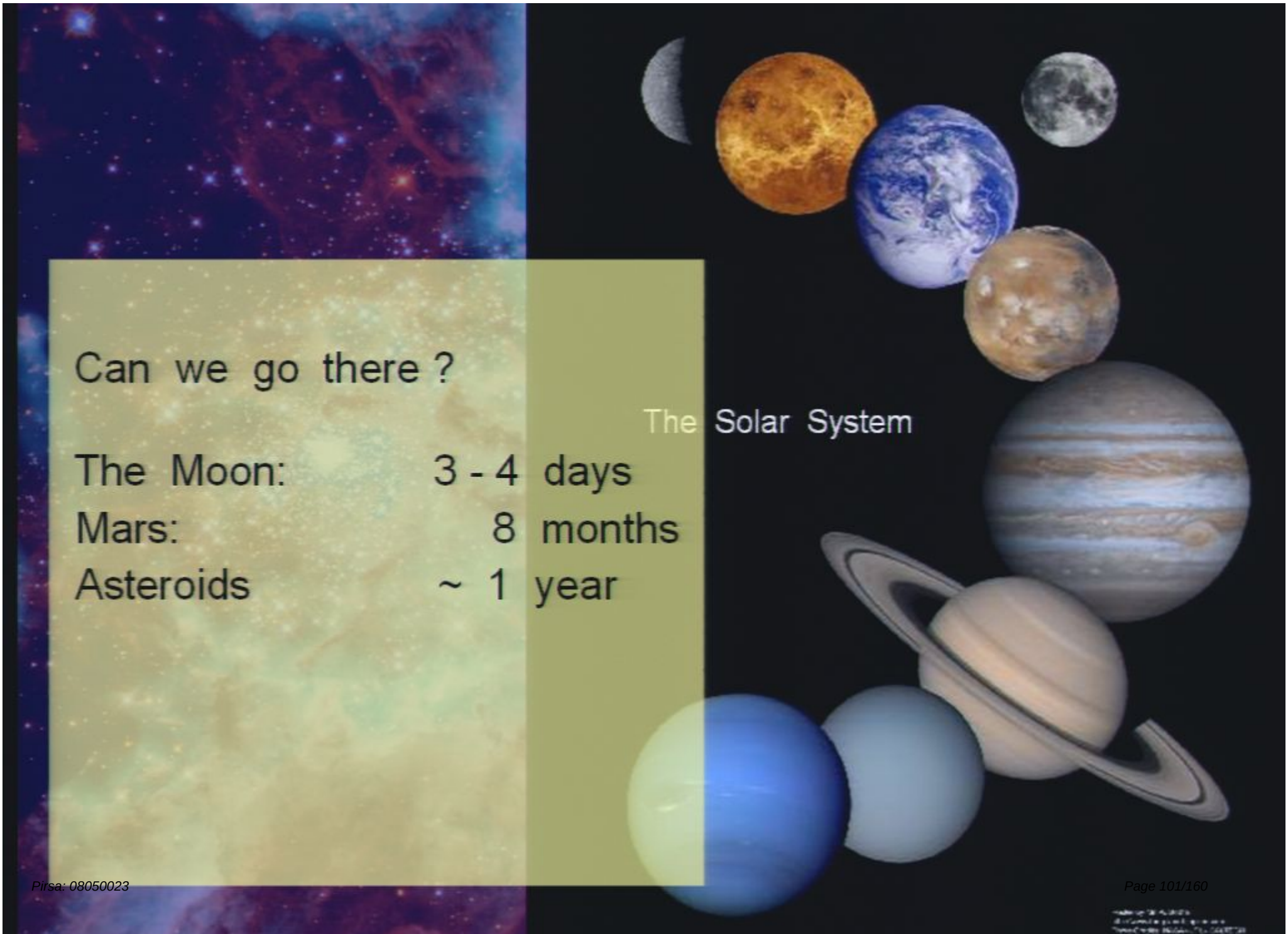
The Moon: 3 - 4 days
Mars: 8 months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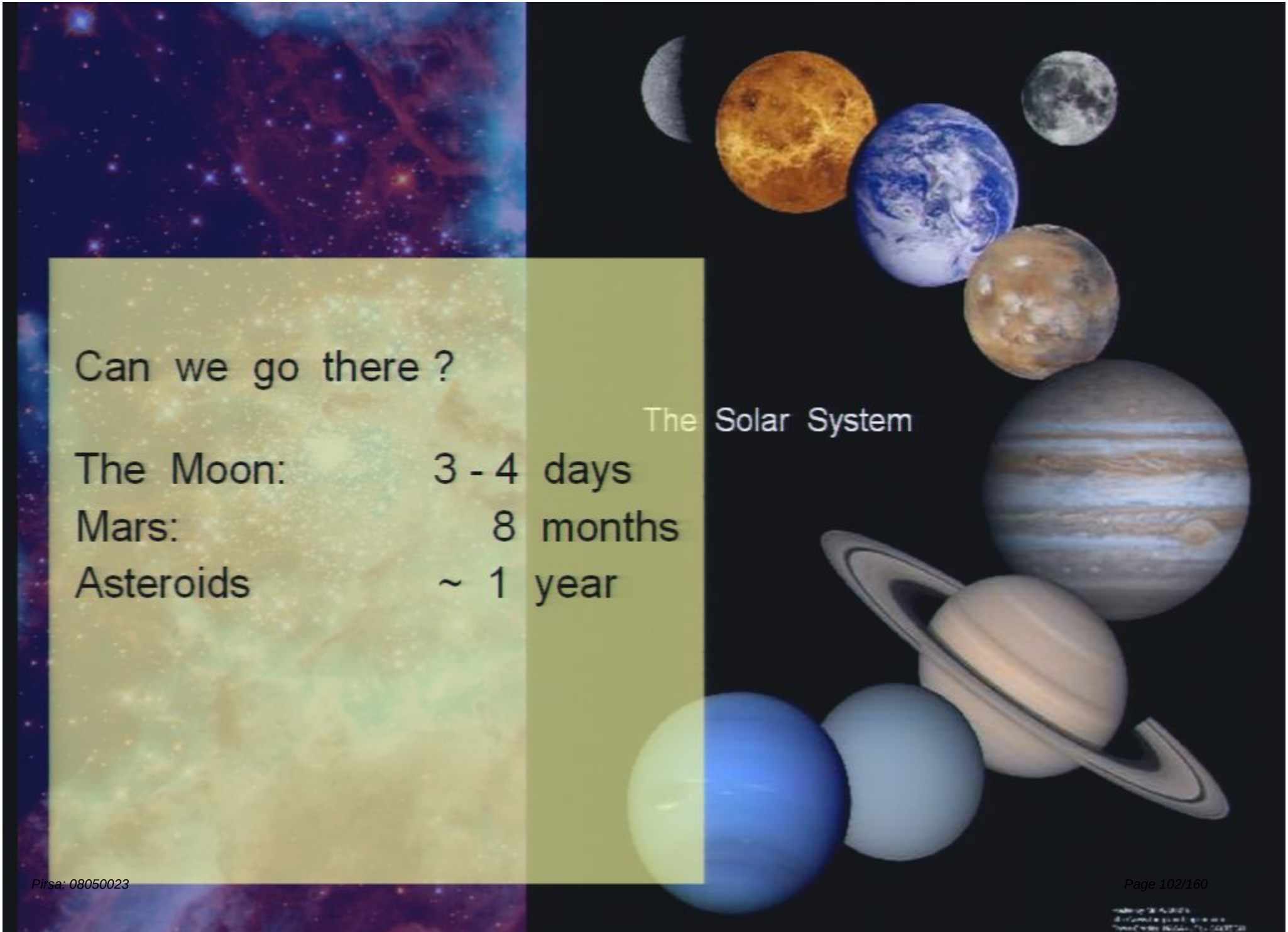
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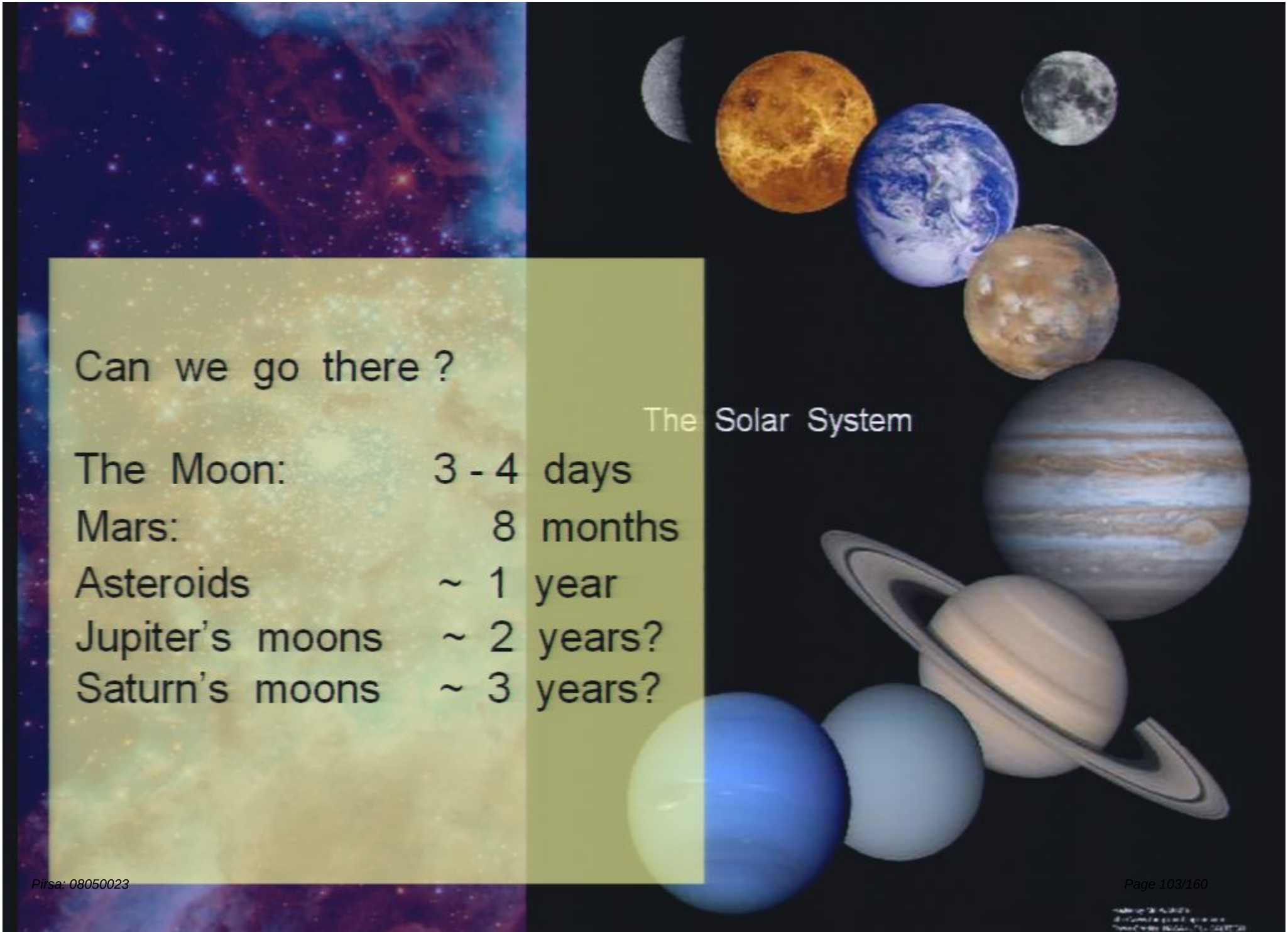
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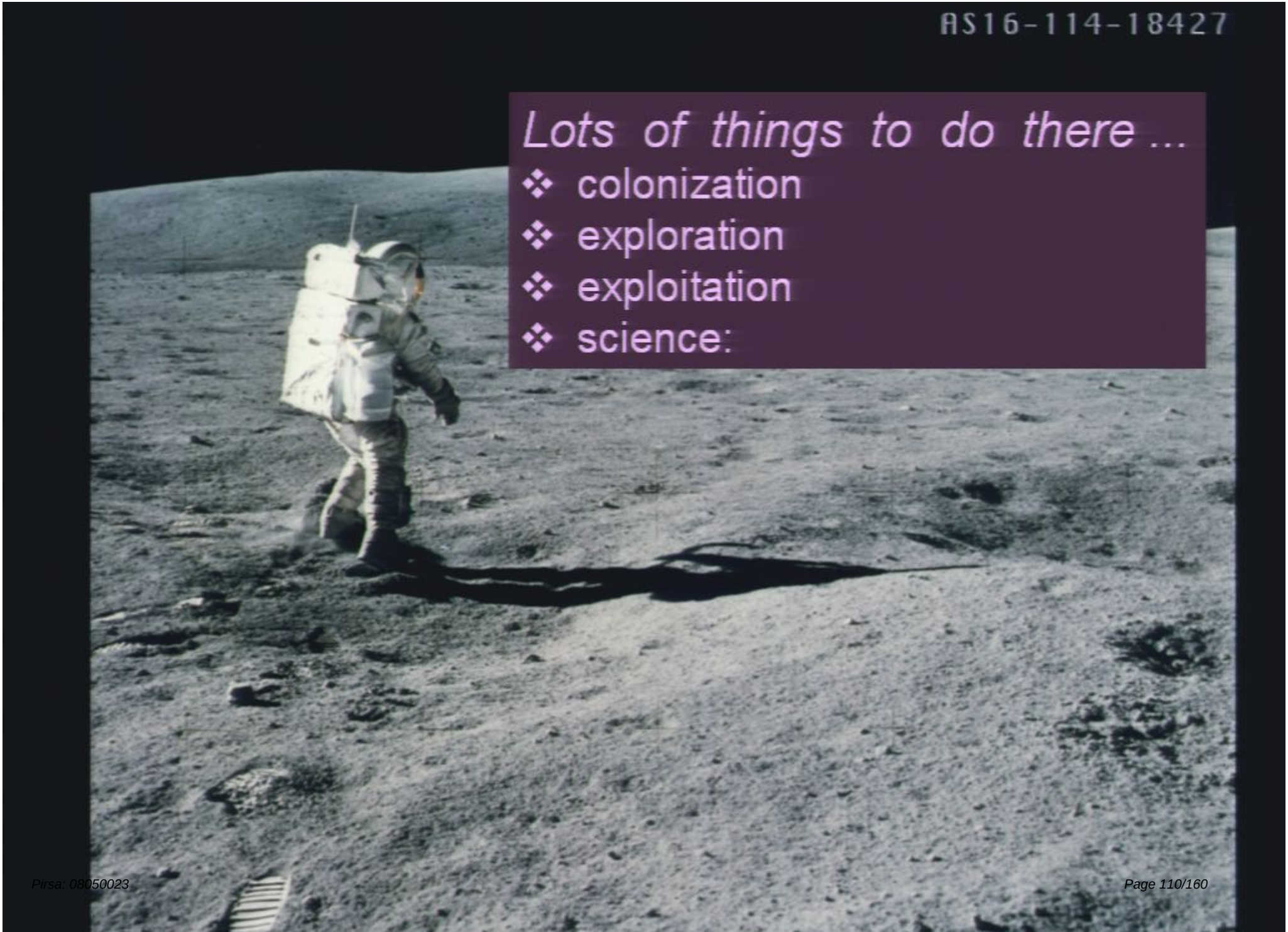
Pluto and beyond ?

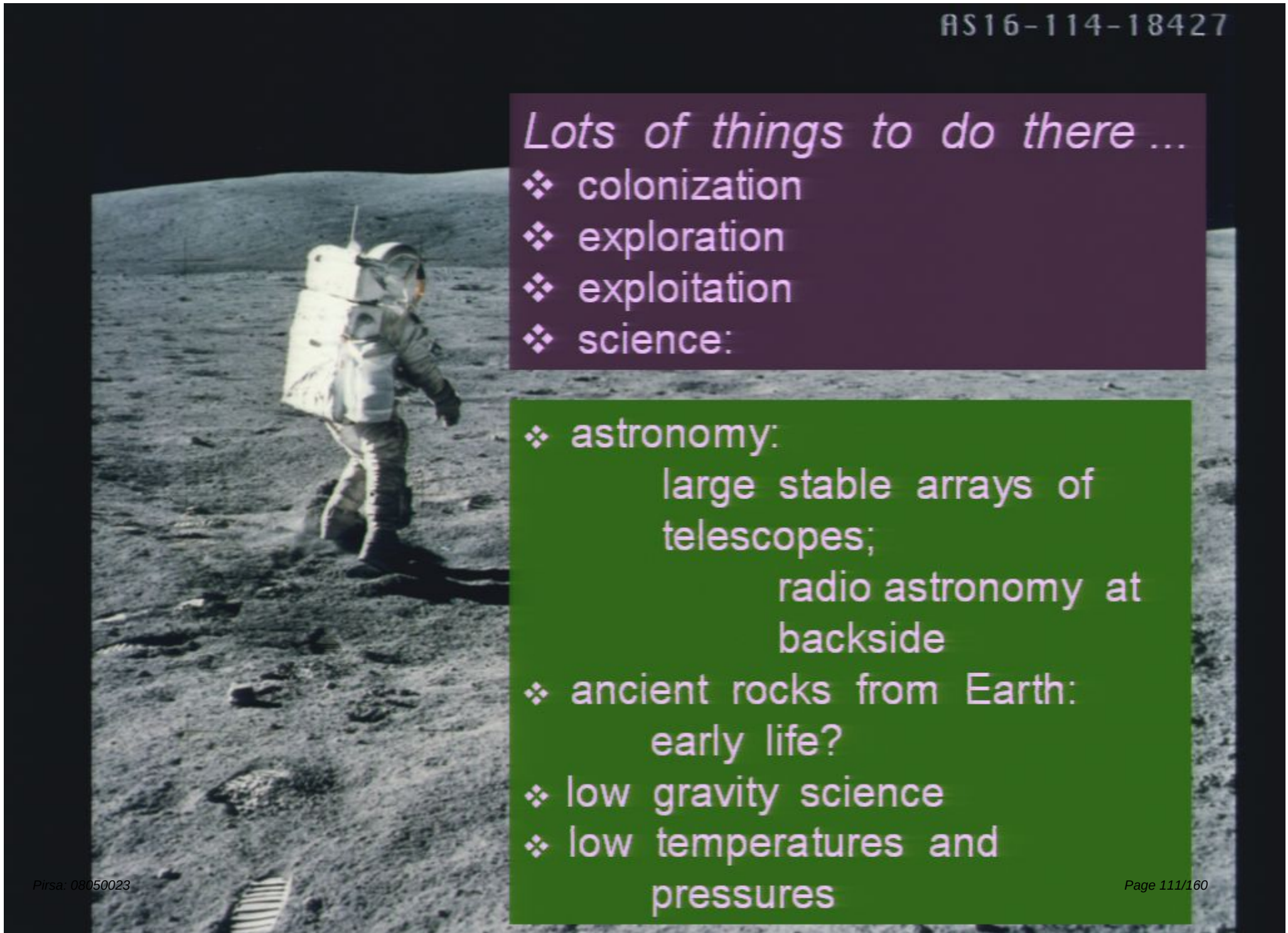

a SCENARIO
Perimeter institute, Canada, 7/5/08


Our first aim: the MOON


AS16-114-18427


AS16-114-18427


AS16-114-18427
Lots of things to do there ...
colonization
exploration
exploitation
science: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Lots of things to do there ...
❖ colonization
❖ exploration
❖ exploitation
❖ science:
❖ astronomy:
large stable arrays of telescopes;
radio astronomy at backside
❖ ancient rocks from Earth:
early life?
❖ low gravity science
❖ low temperatures and pressures


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Colonization Step One :

Simpler **smaller** versions of this type of robots on wheels, equiped with tools, camera's / webcams !

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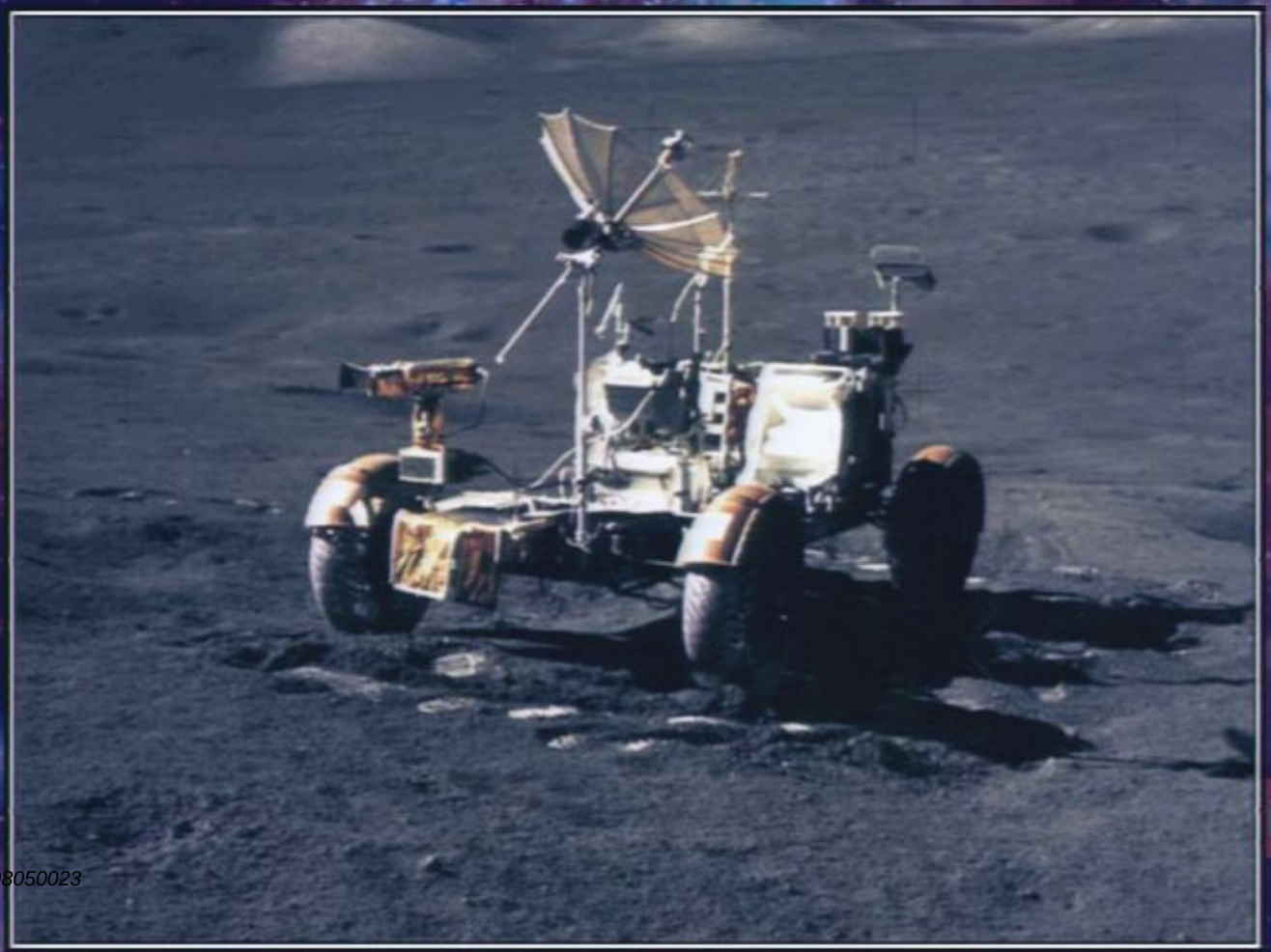

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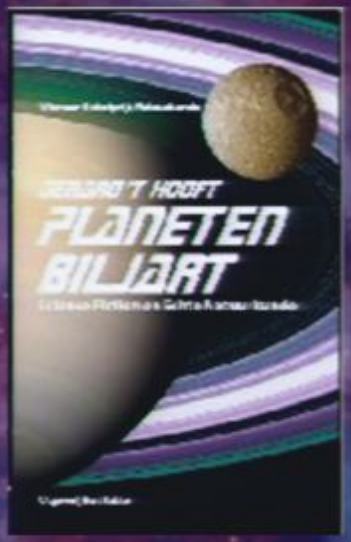

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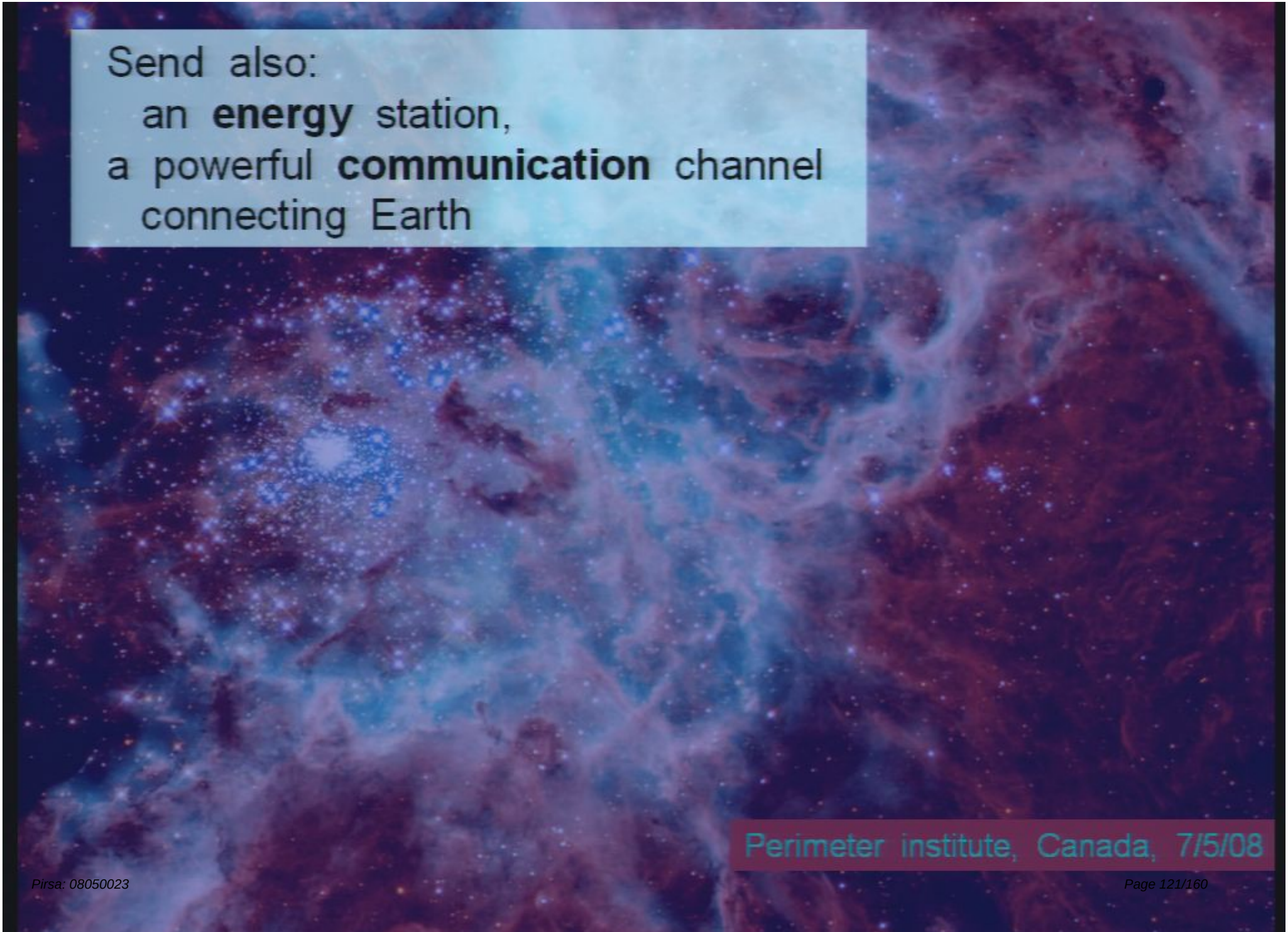
institute Canada 7/5/08


Send also:
an **energy** station,
a powerful **communication** channel
connecting Earth
Perimeter institute, Canada, 7/5/08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Cambots are vulnerable and difficult - **3 seconds signal delay !** Required: *Cambot driving licence*
And: you can earn your money back ... !

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the first lunar colony

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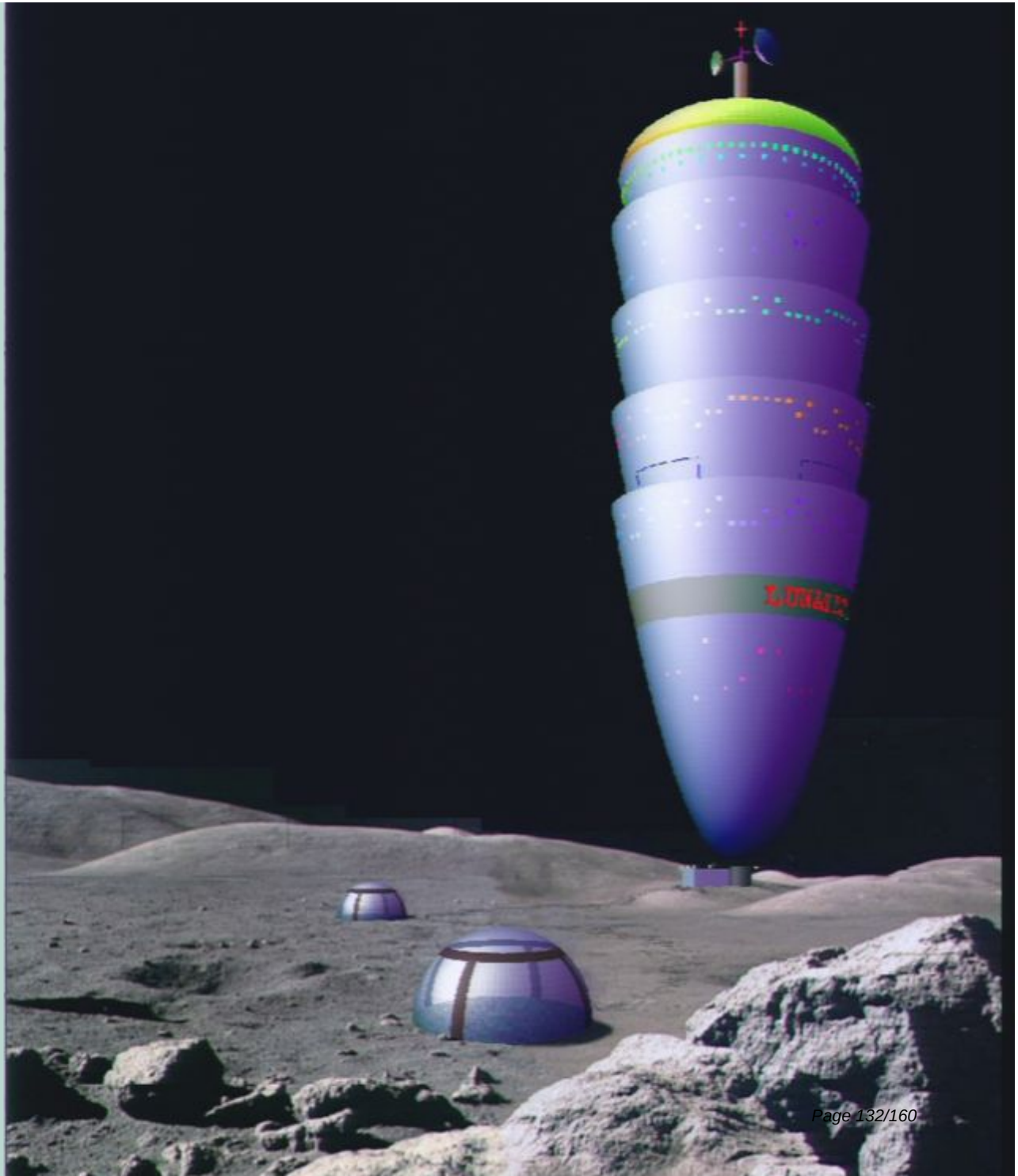
The **Lunar hotel**

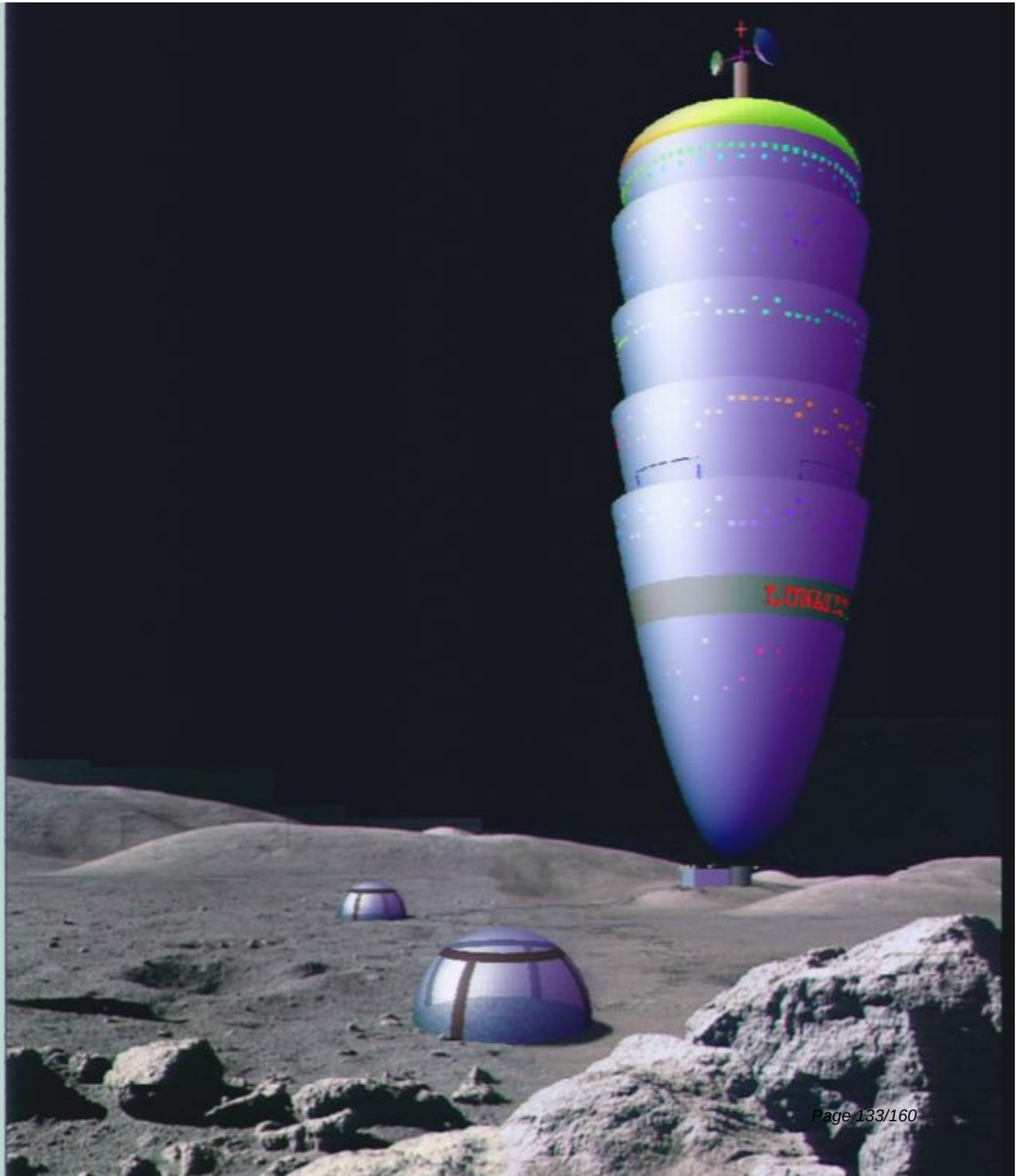


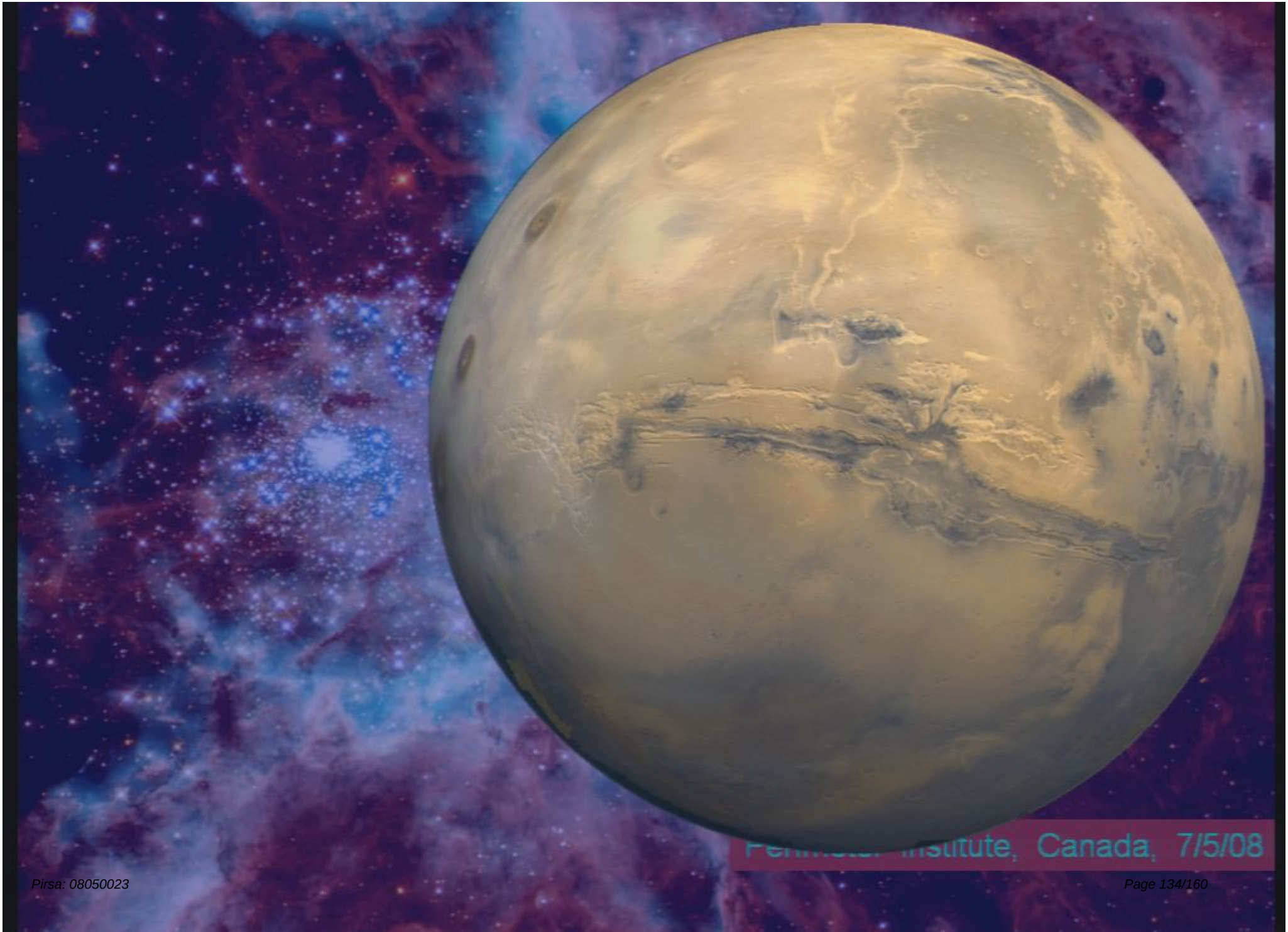
The **Lunar hotel**

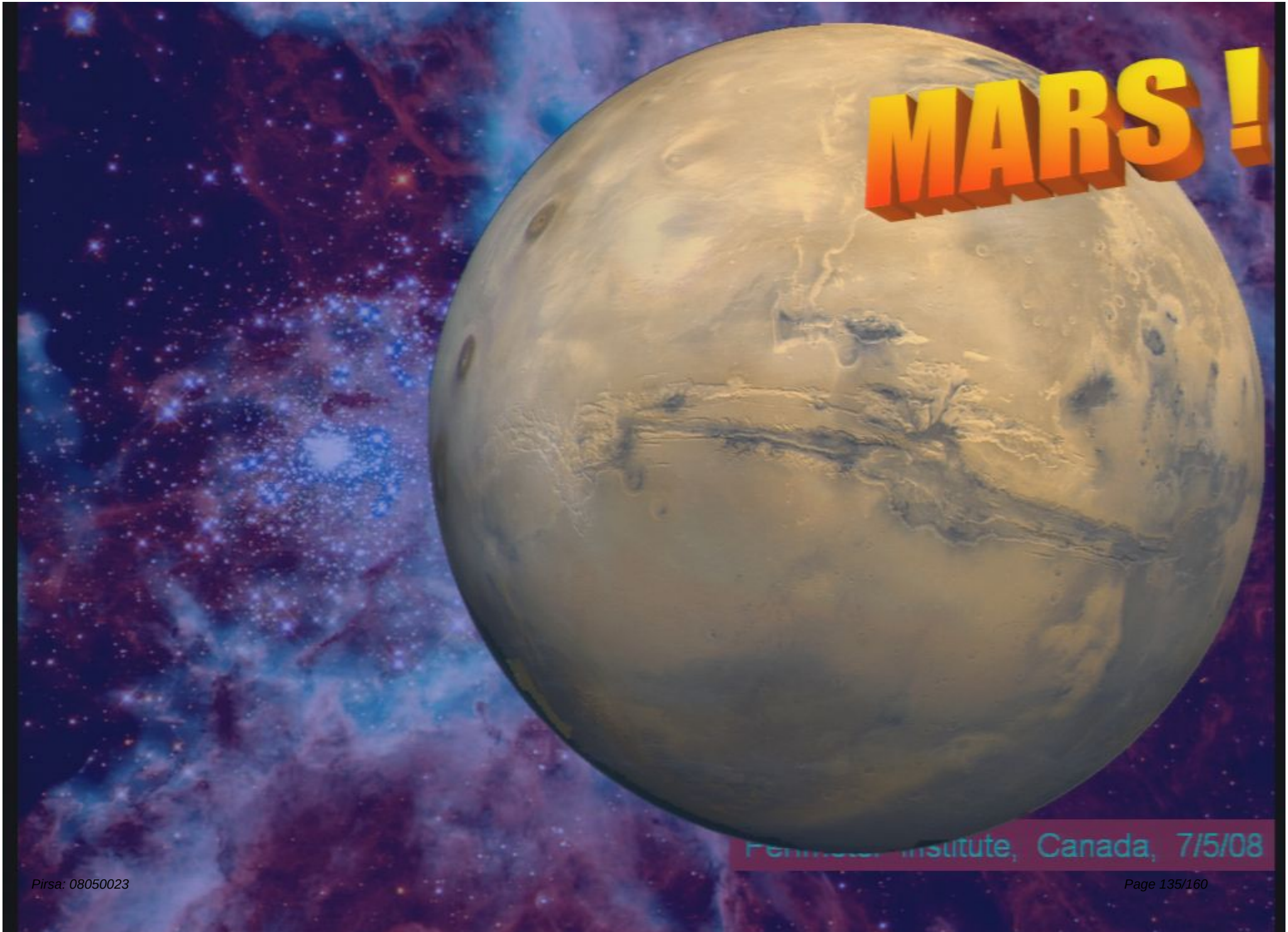
The first colonies all and under ground ...

Glass can be made on any planet

Ice is also a magnificent building material




Perimeter Institute, Canada, 7/5/08


MARS !
Perimeter Institute, Canada, 7/5/08


John von Neumann:
Robots can reproduce themselves.
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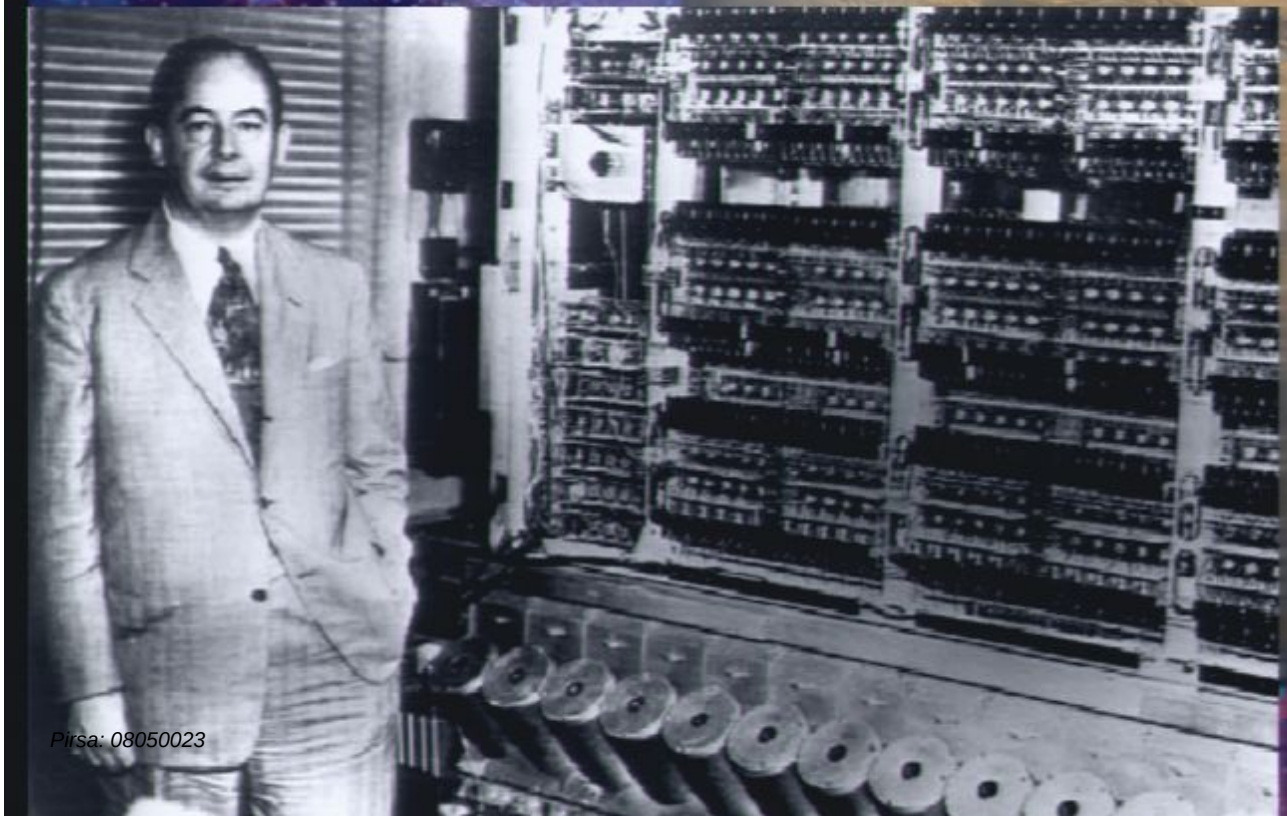

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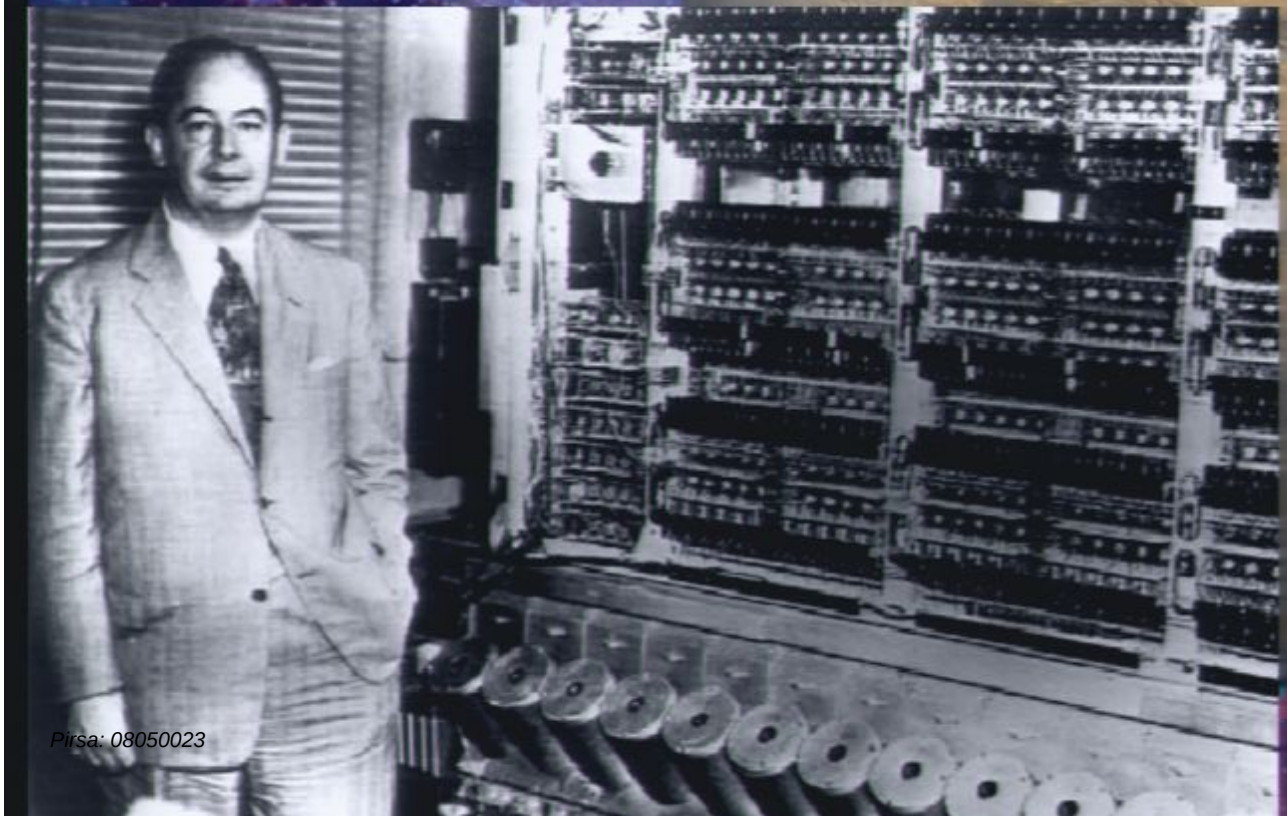

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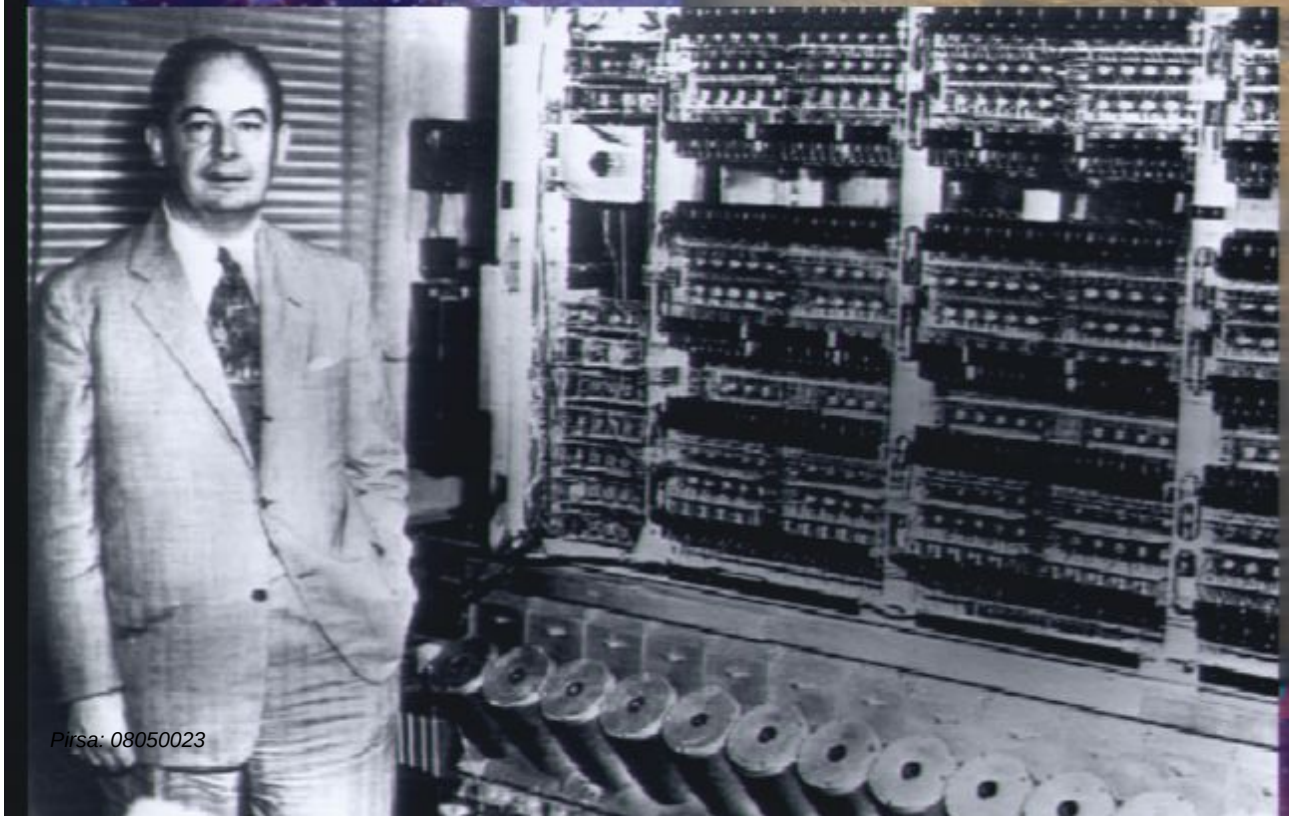

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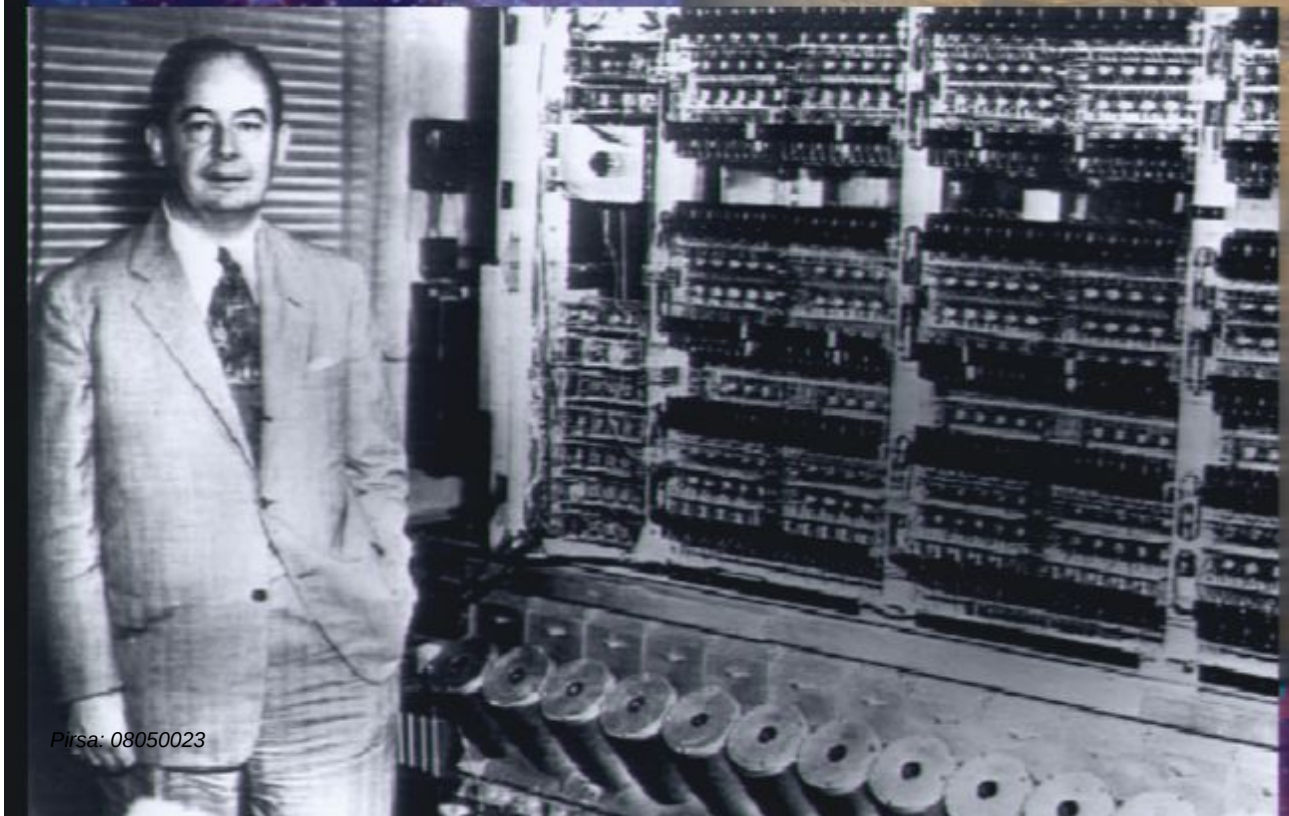

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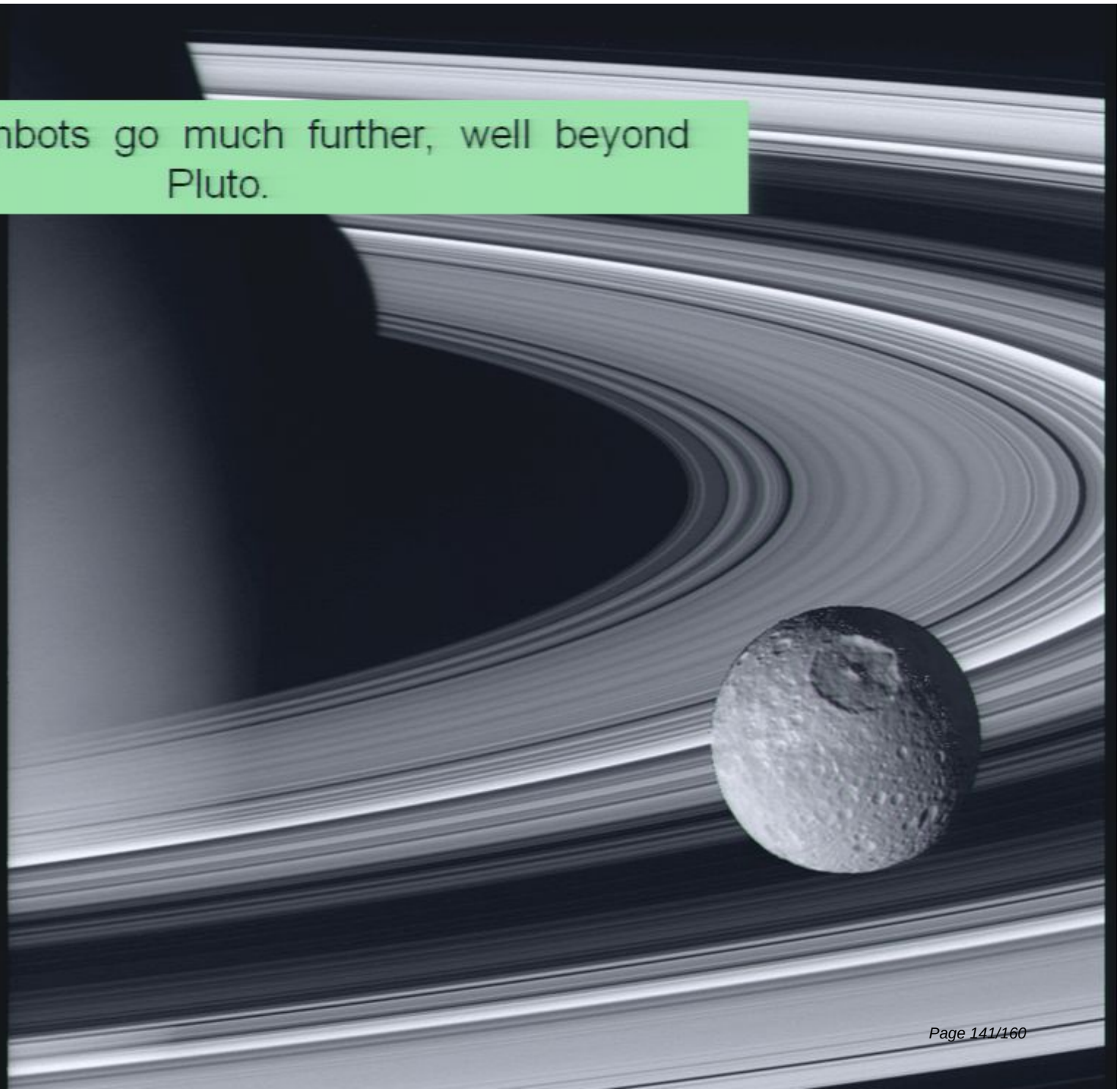
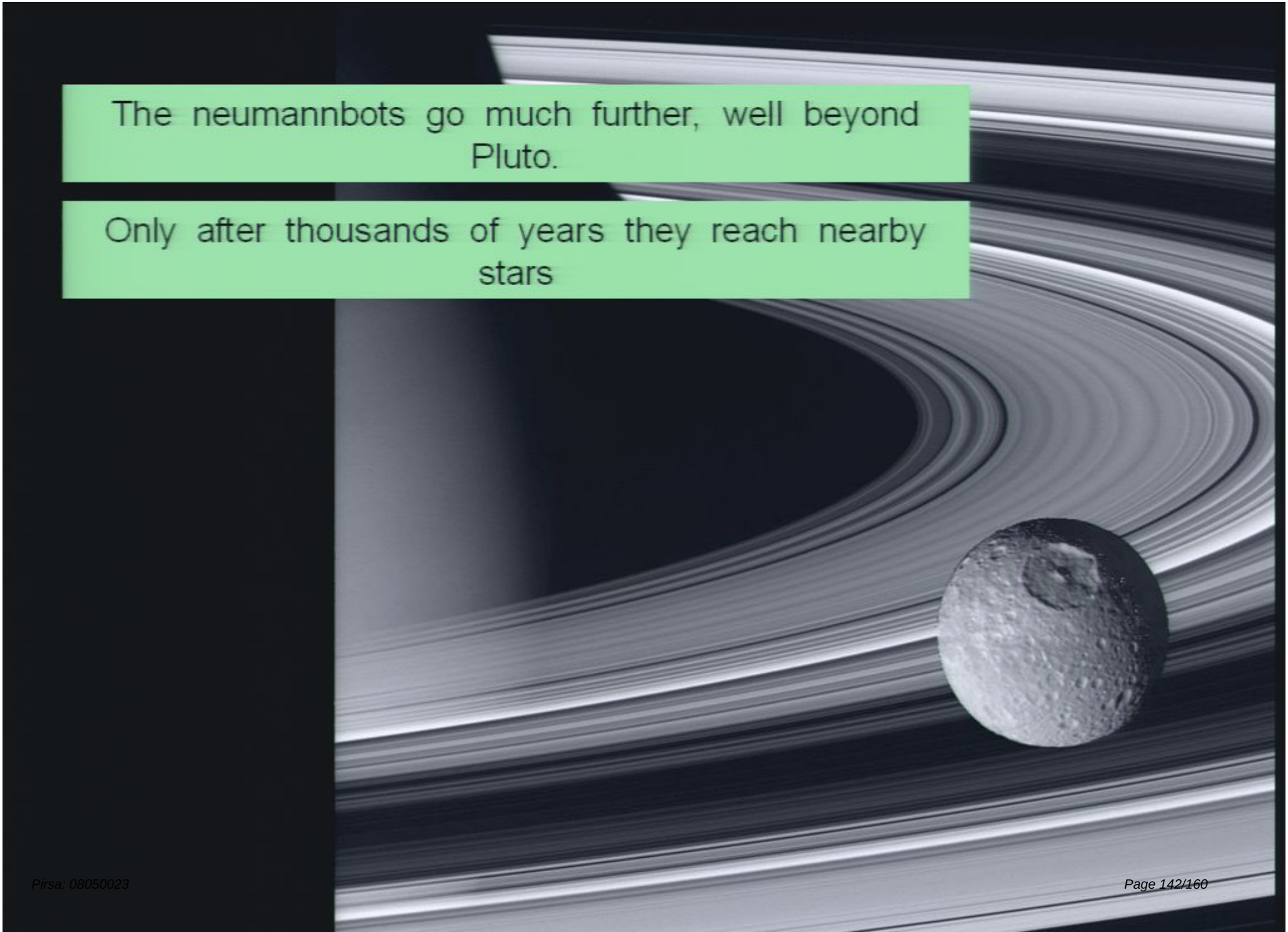
Neumannbots

Institute, Canada, 7/5/08

The neumannbots go much further, well beyond Pluto.

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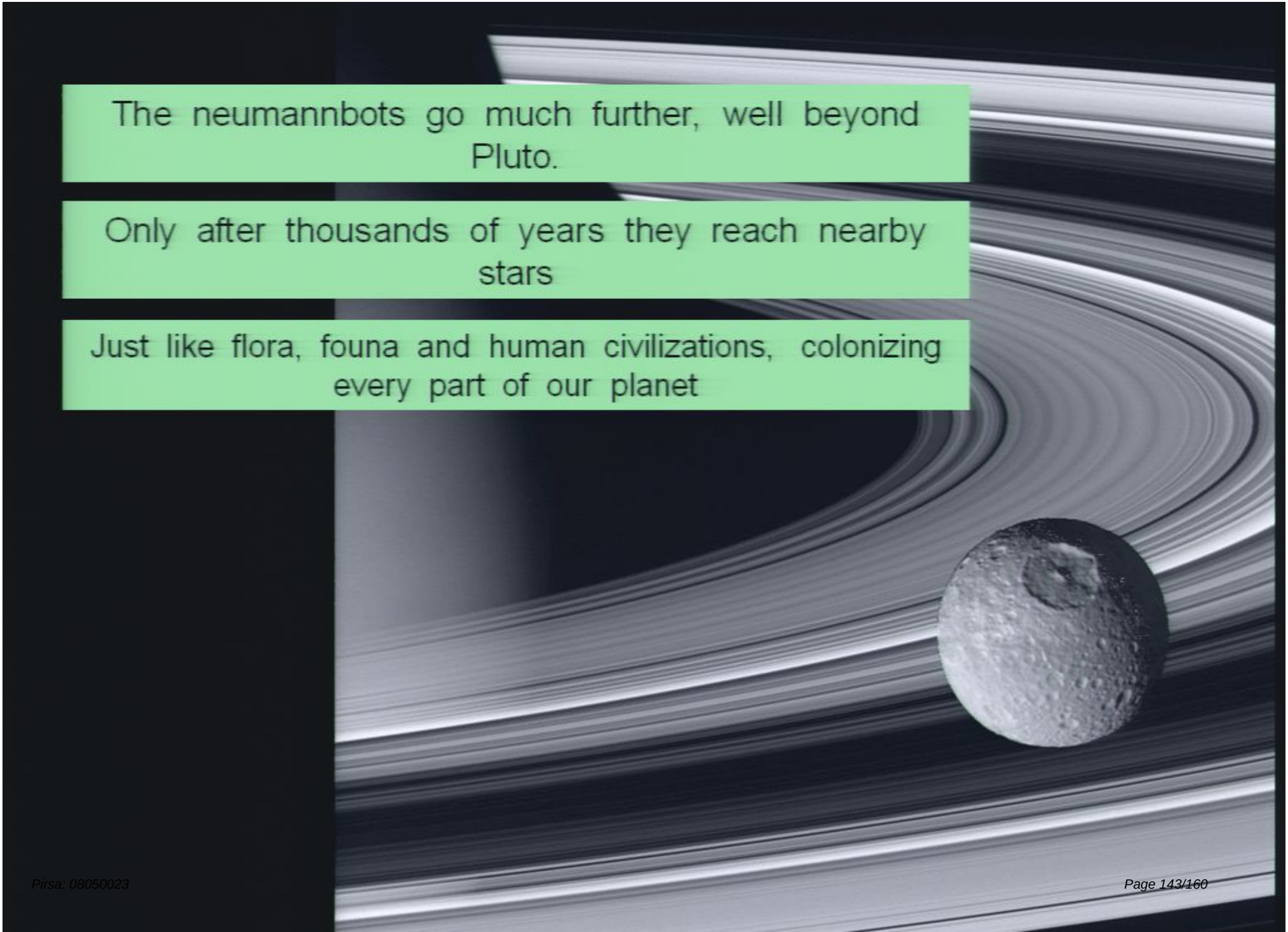
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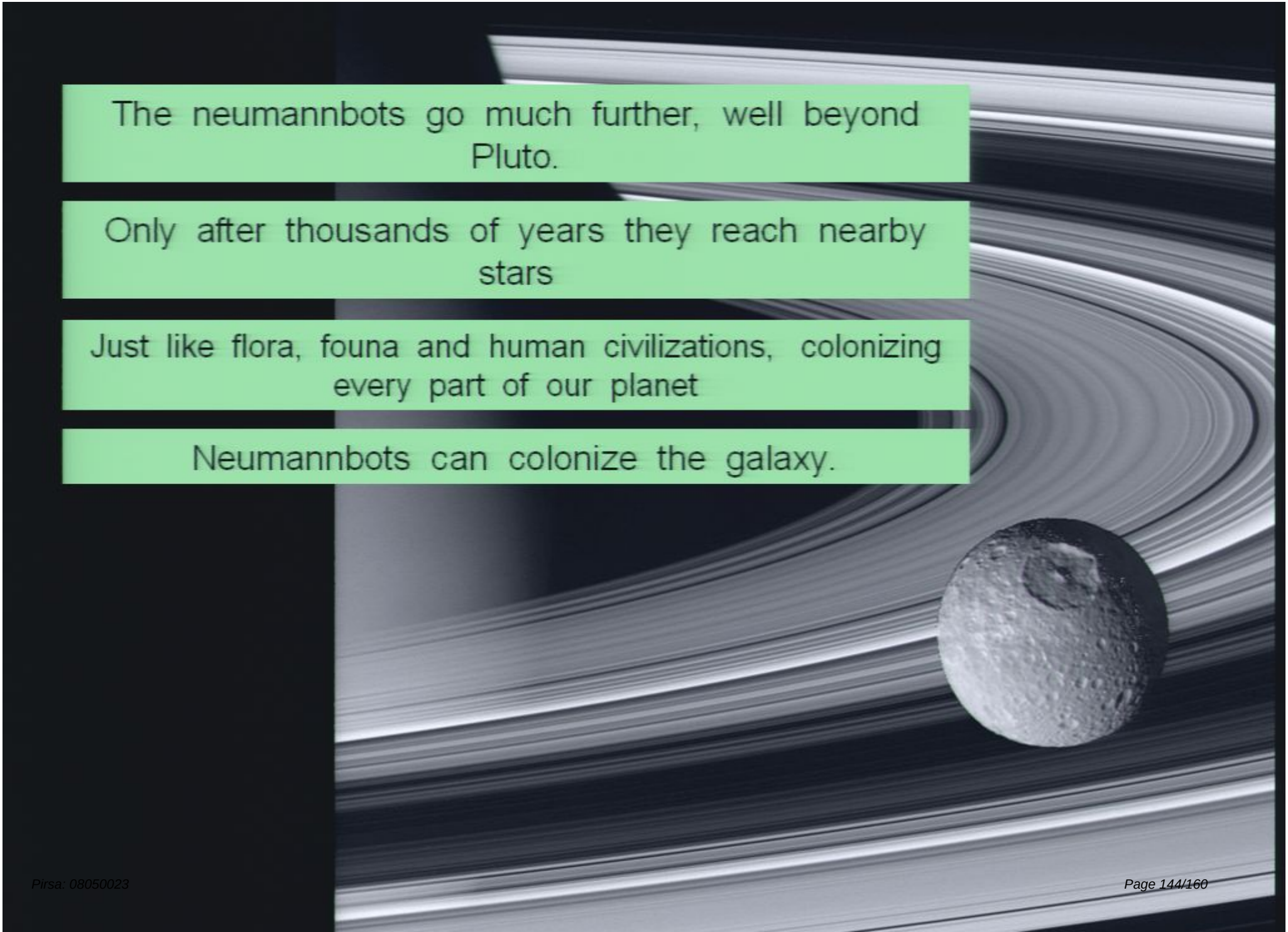
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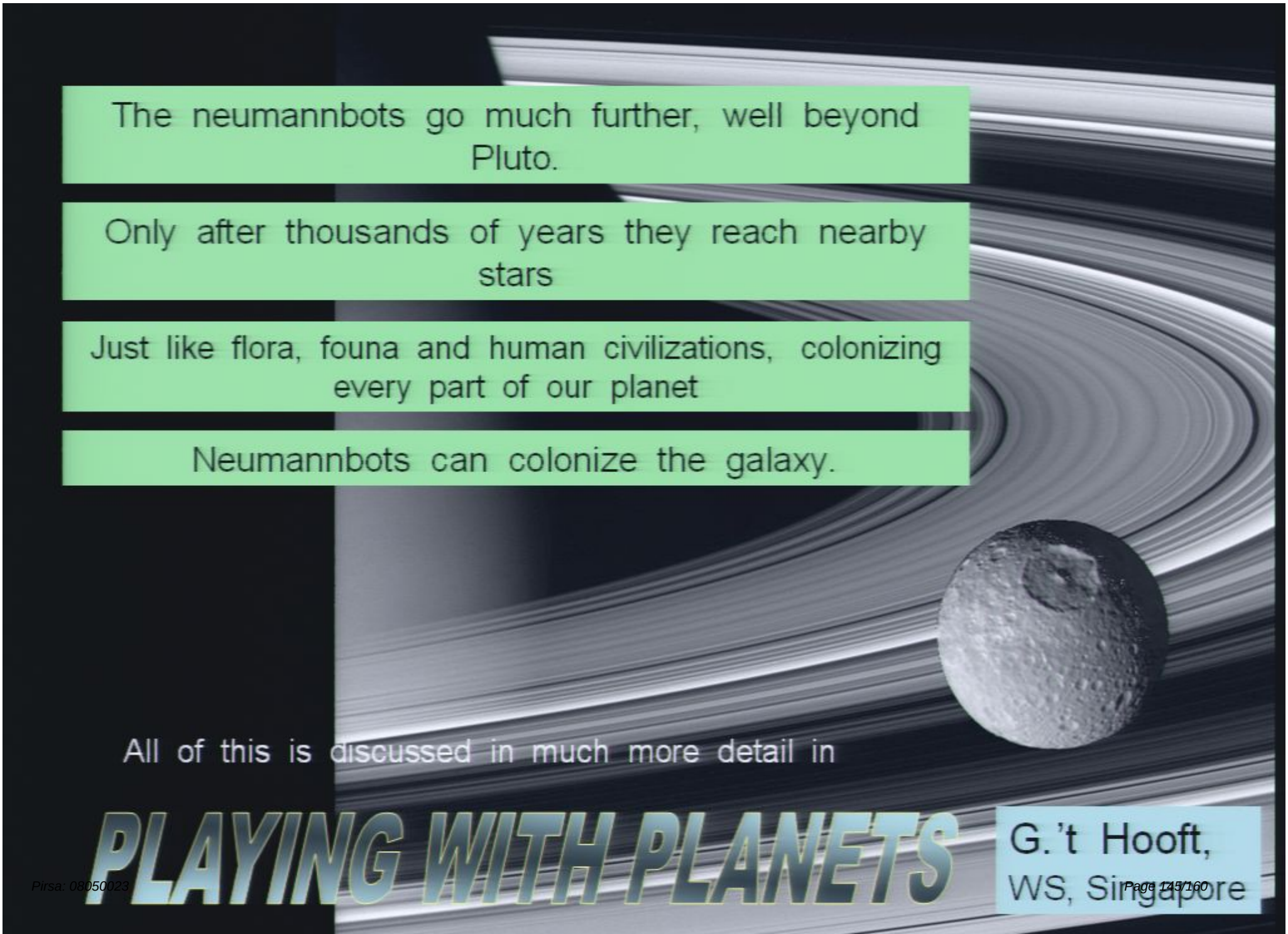
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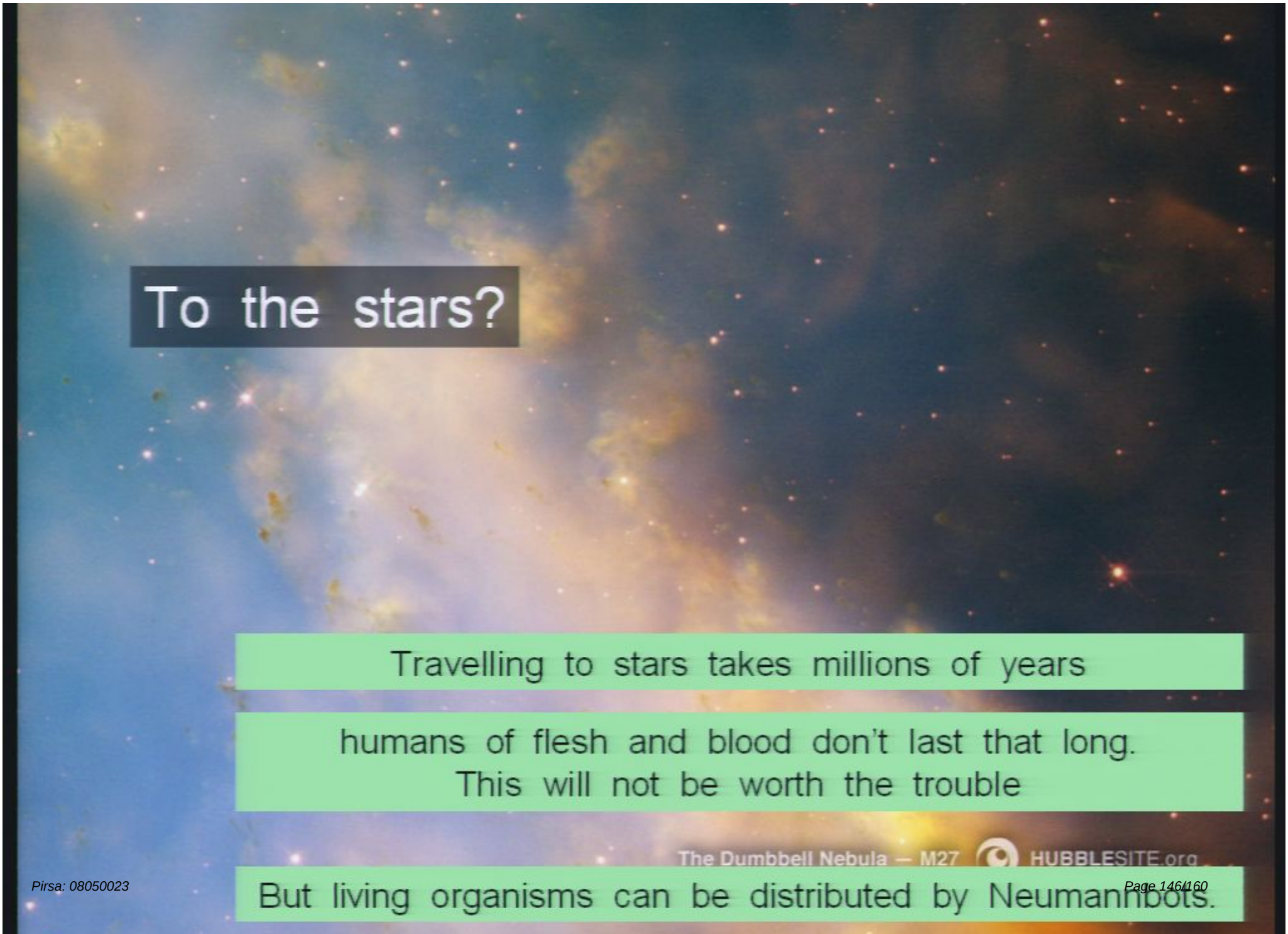
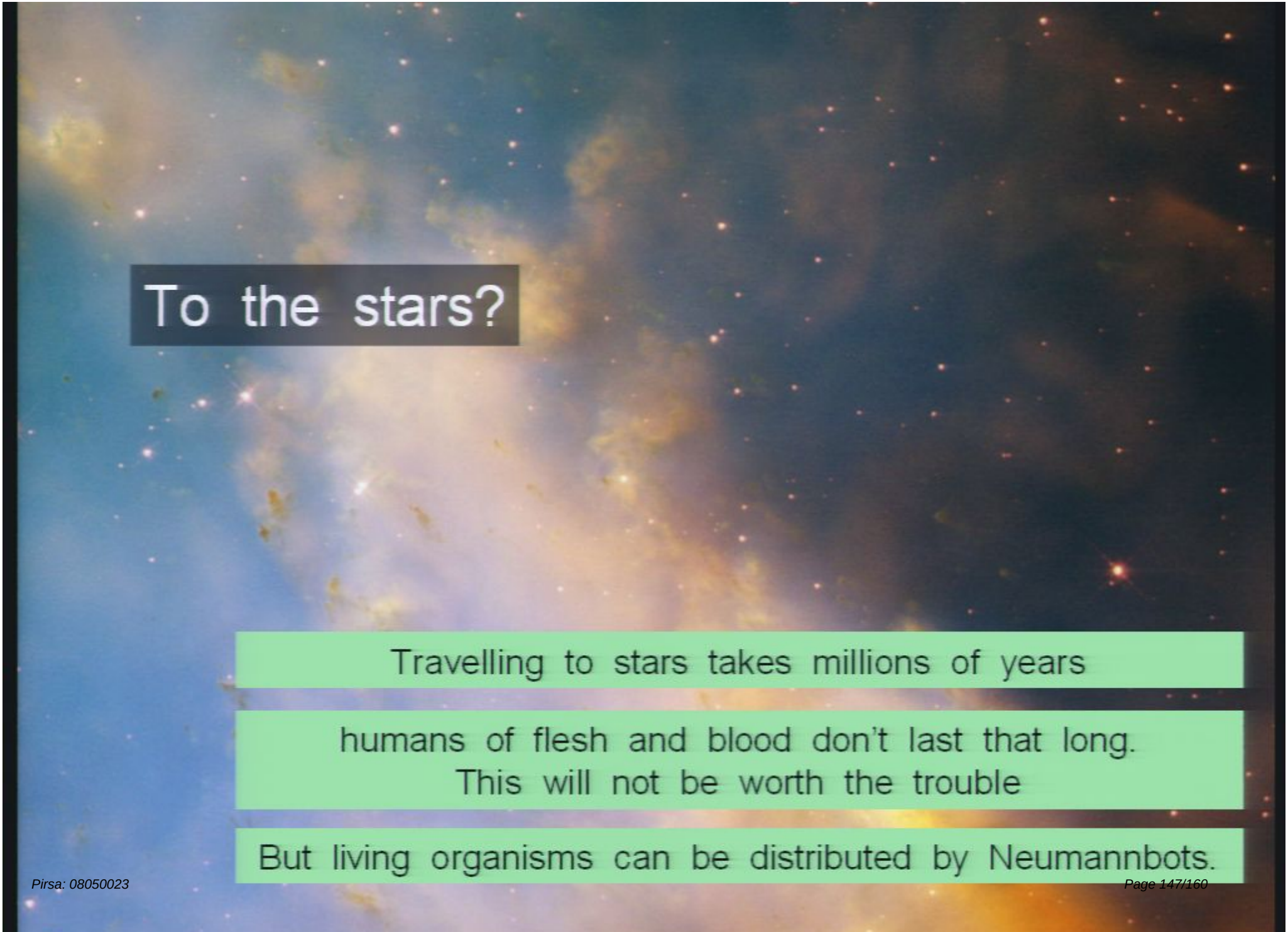
All of this is discussed in much more detail in
PLAYING WITH PLANETS
G.'t Hooft,
WS, Singapore


To the stars?
Travelling to stars takes millions of years
humans of flesh and blood don't last that long.
This will not be worth the trouble
The Dumbbell Nebula — M27
HUBBLESITE.org
But living organisms can be distributed by Neumannbots.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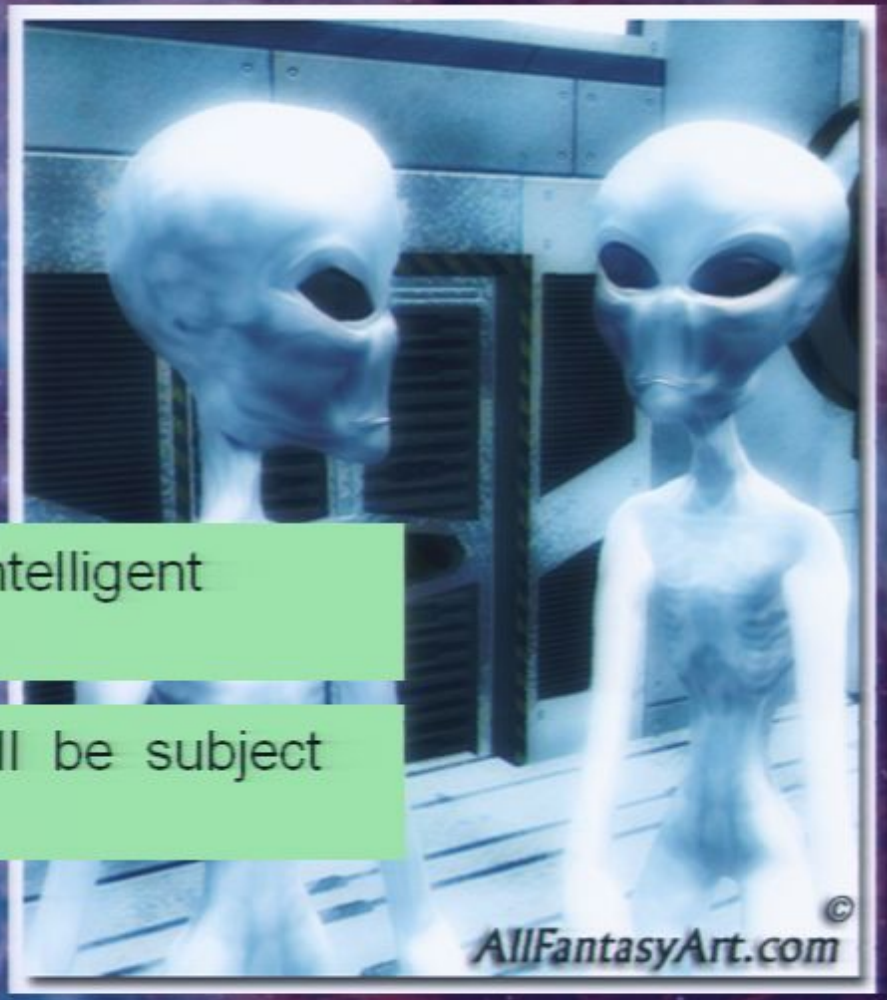

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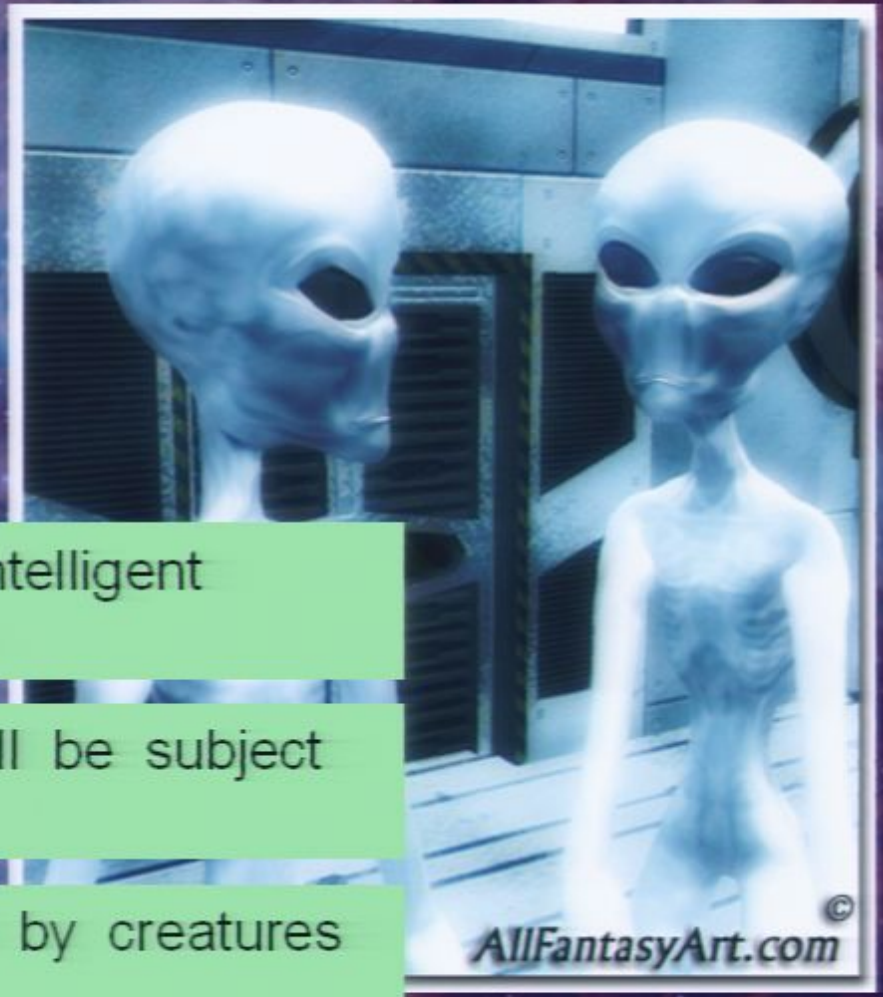
if these creatures exist at all, they will be subject to the same limitations

Perimeter institute, Canada, 7/5/08



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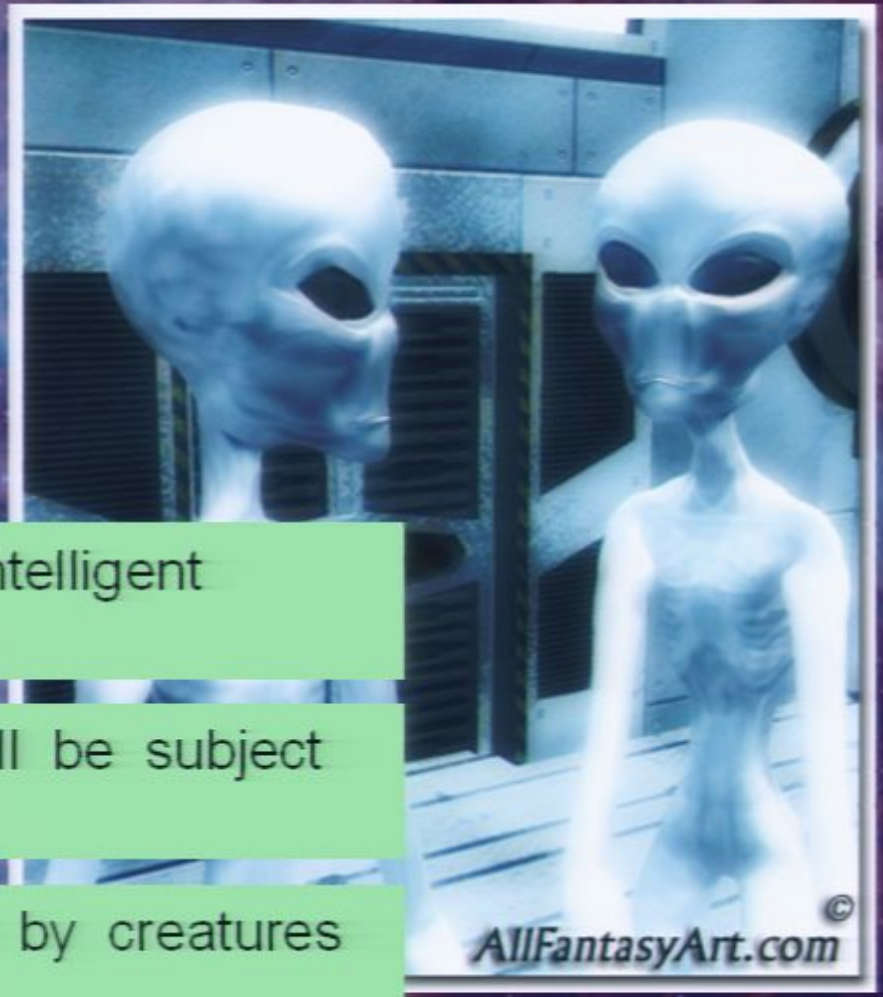
if these creatures exist at all, they will be subject to the same limitations

therefore, we should not expect visits by creatures of flesh and blood



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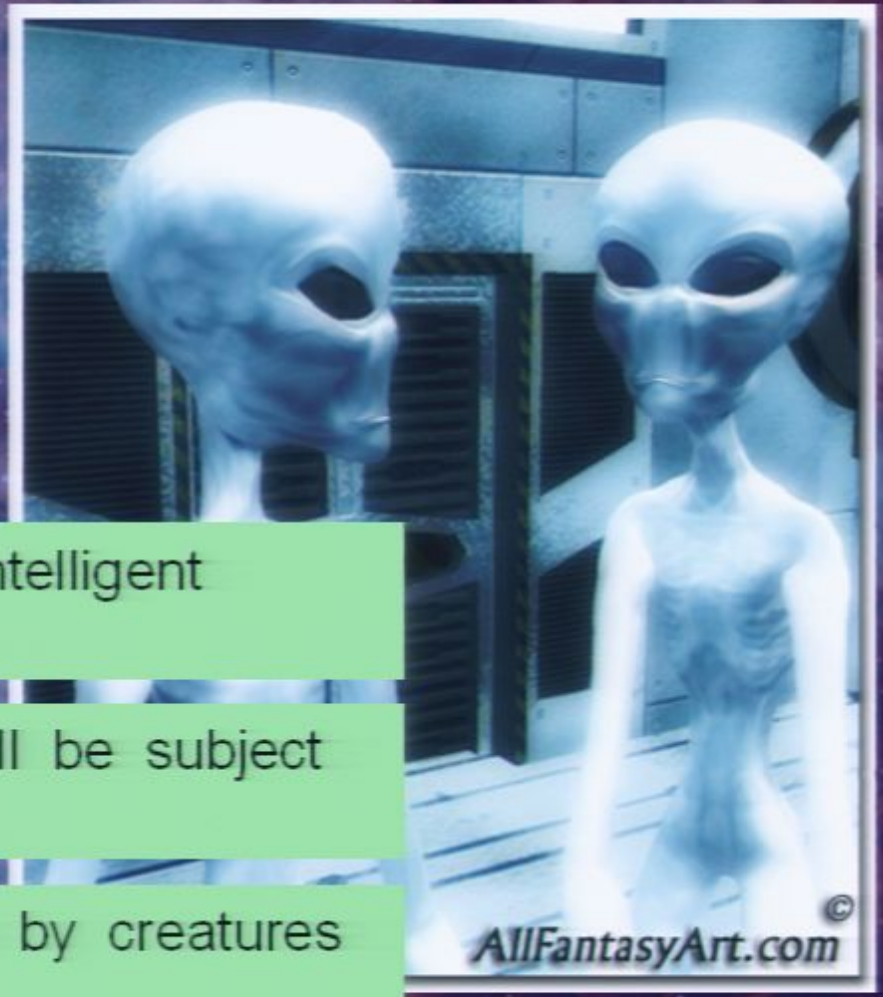

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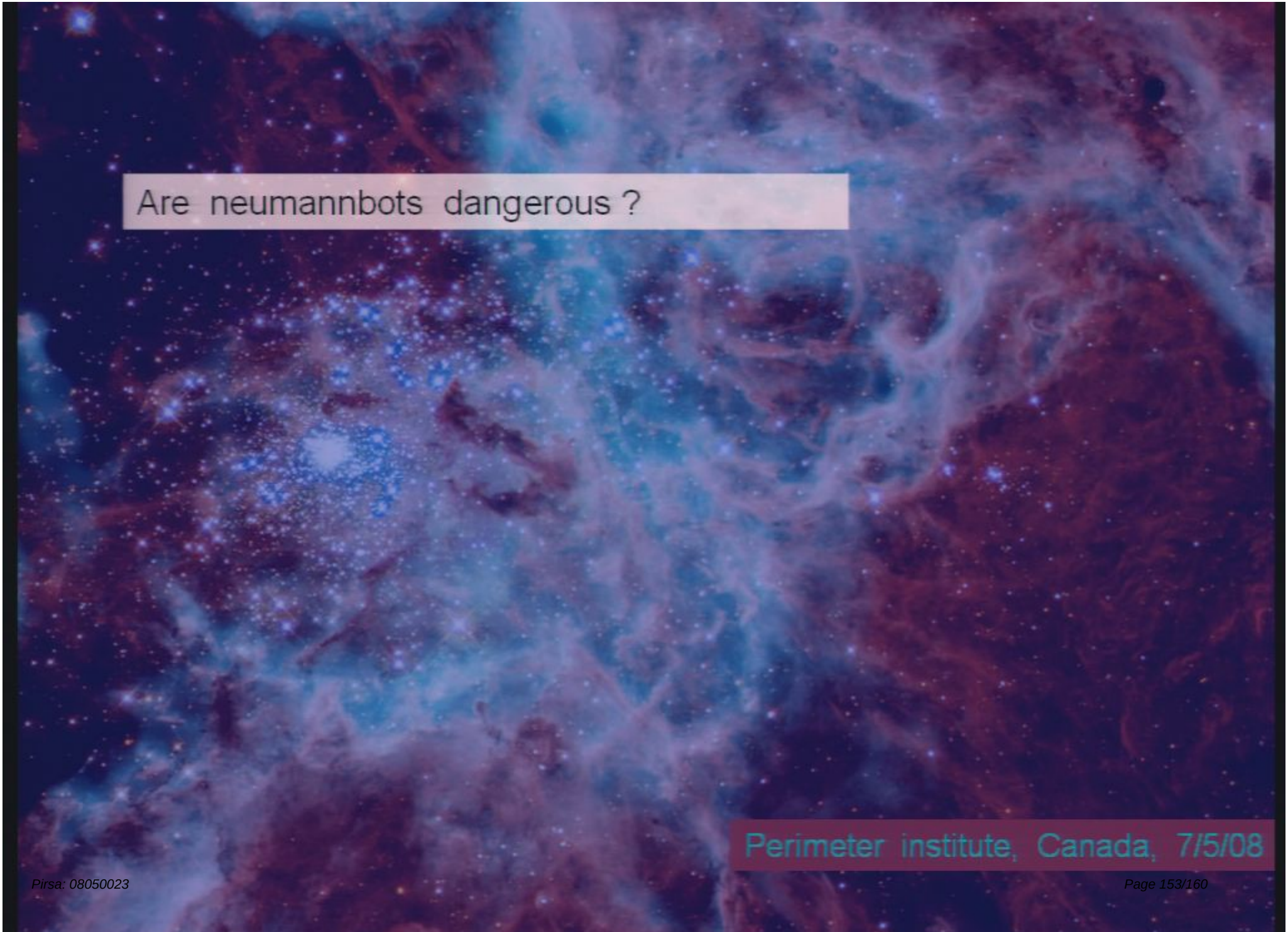
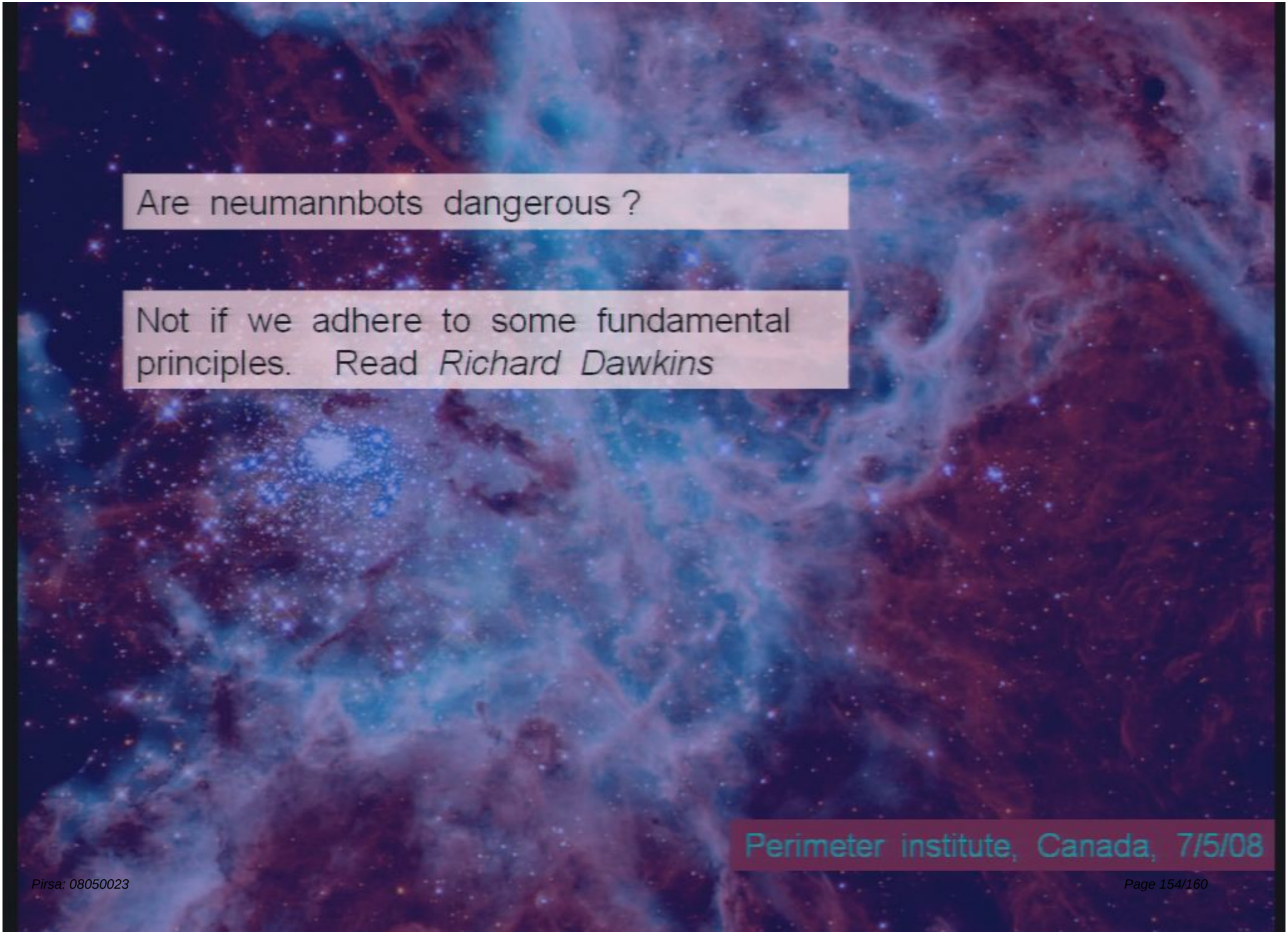

Are neumannbots dangerous ?
Perimeter institute, Canada, 7/5/08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Then all neumannbots will be genetically identical. They behave like termites. The "queen" stays on Earth.


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THE END
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