

Liv i universum

– inte bara spekulationer

Peter Linde

www.peterlinde.net



$$N = R_* * f_s * f_p * n_e * f_l * f_i * f_c * L$$

N = antal civilisationer i Vintergatan med detekterbara signaler

R_* = antal nybildade stjärnor per år

f_p = andel av dessa stjärnor med planetsystem

n_e = antalet planeter per system, lämpliga för liv

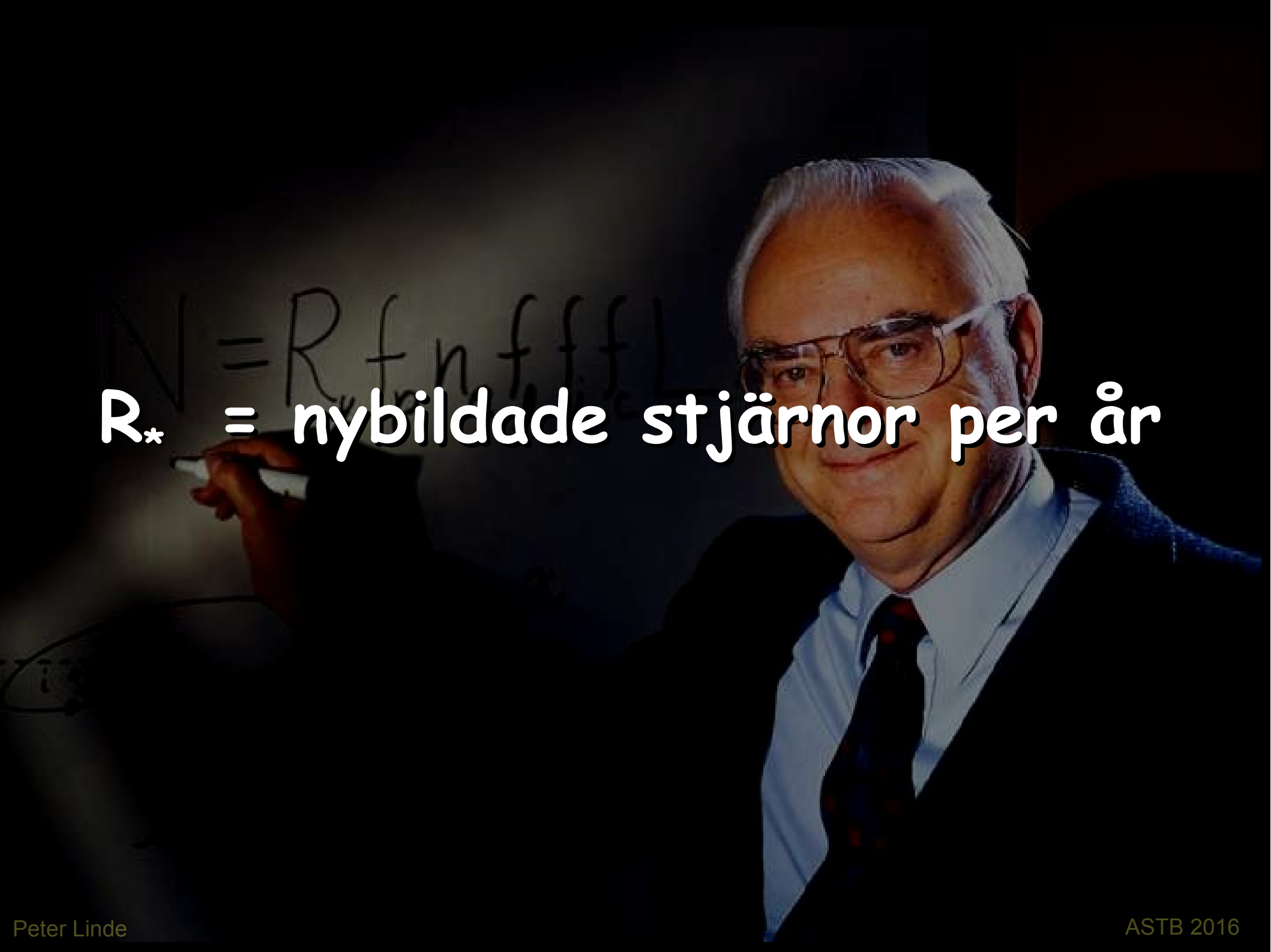
f_l = andelen lämpliga planeter där livet verkligen bildas

f_i = andelen planeter med högt utvecklat liv (civilisationer)

f_c = andelen civilisationer som avger uppfattningsbara signaler

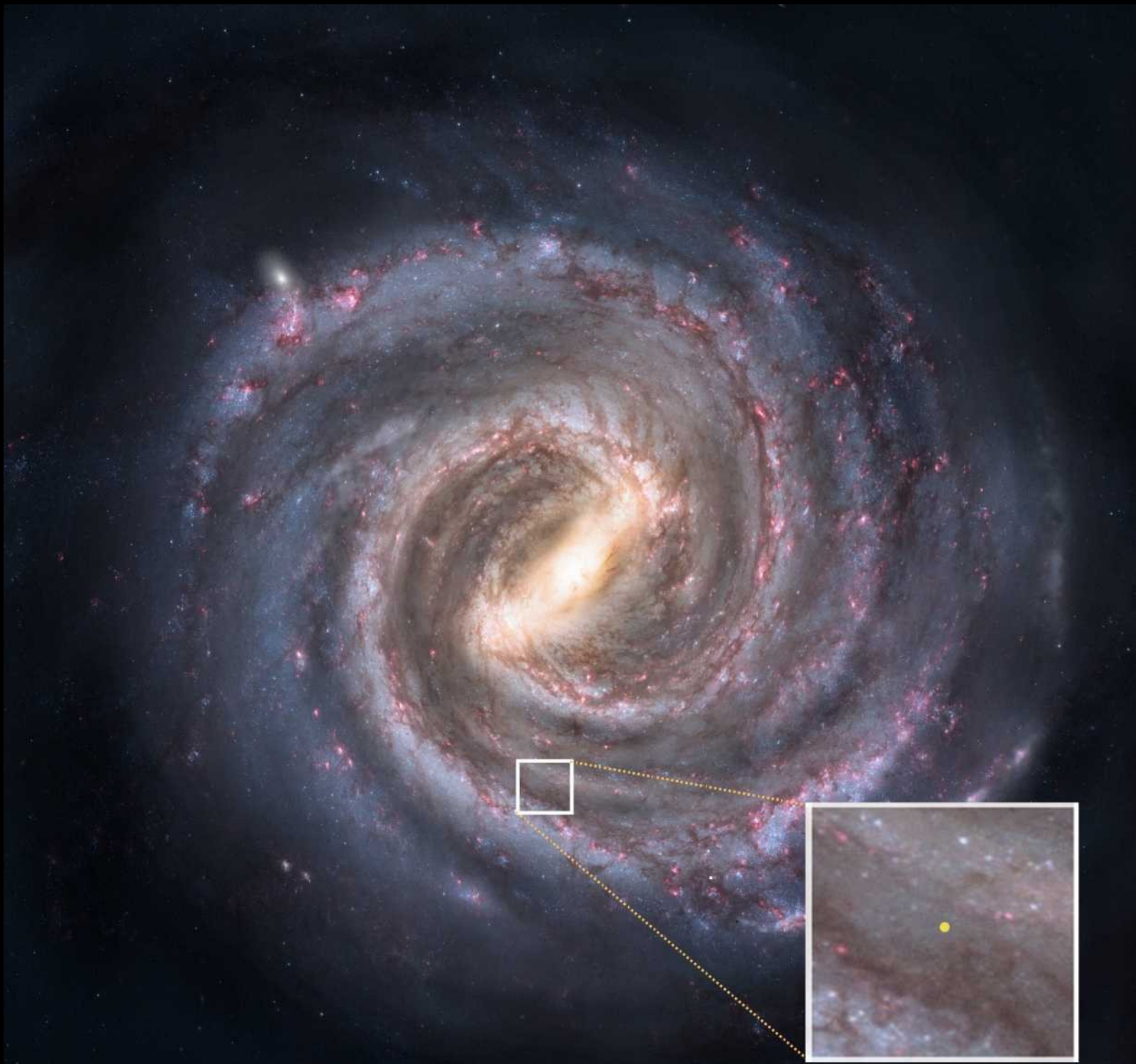
L = medeltiden för hur länge sådana civilisationer existerar

Drakes ekvation

A photograph of Peter Linde, an older man with white hair and glasses, wearing a dark suit, light blue shirt, and dark tie. He is standing in front of a chalkboard, holding a piece of chalk in his right hand. The chalkboard has some faint, handwritten mathematical equations on it. The lighting is dramatic, with a strong light source from the left, casting shadows and highlighting his face and the chalkboard.

R_* = nybildade stjärnor per år





A man with white hair and glasses, wearing a dark suit, light blue shirt, and dark tie, is standing in front of a whiteboard. He is holding a white marker in his right hand and appears to be writing on the board. The whiteboard has some faint, illegible handwriting on it. The background is dark, and the lighting is focused on the man and the whiteboard.

R_* = nybildade stjärnor per år

7

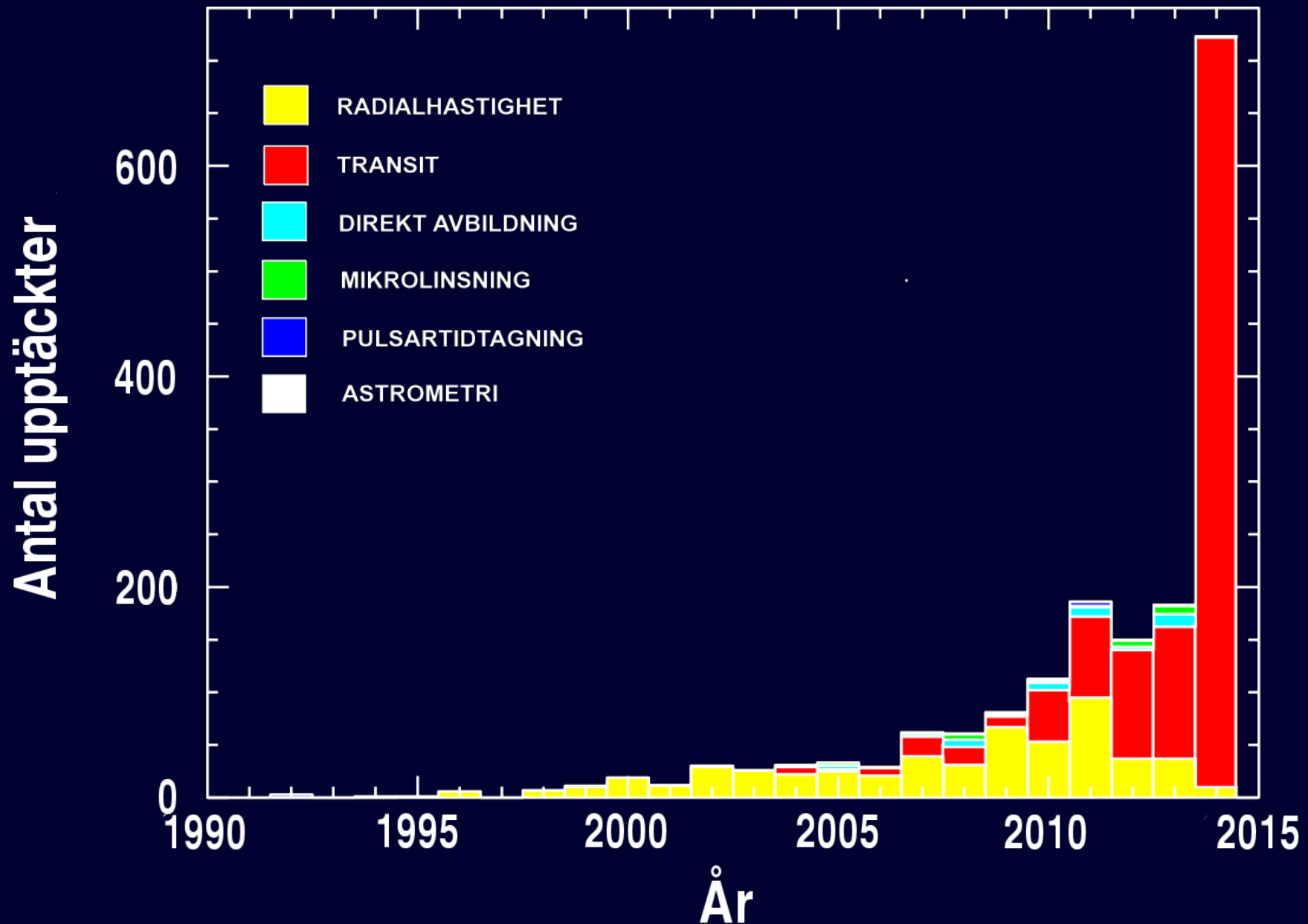
A photograph of Peter Linde, an older man with white hair and glasses, wearing a blue shirt and a dark tie. He is standing in front of a chalkboard, holding a piece of chalk. The chalkboard has some faint, handwritten mathematical formulas on it. The text is overlaid on the image in a large, white, sans-serif font.

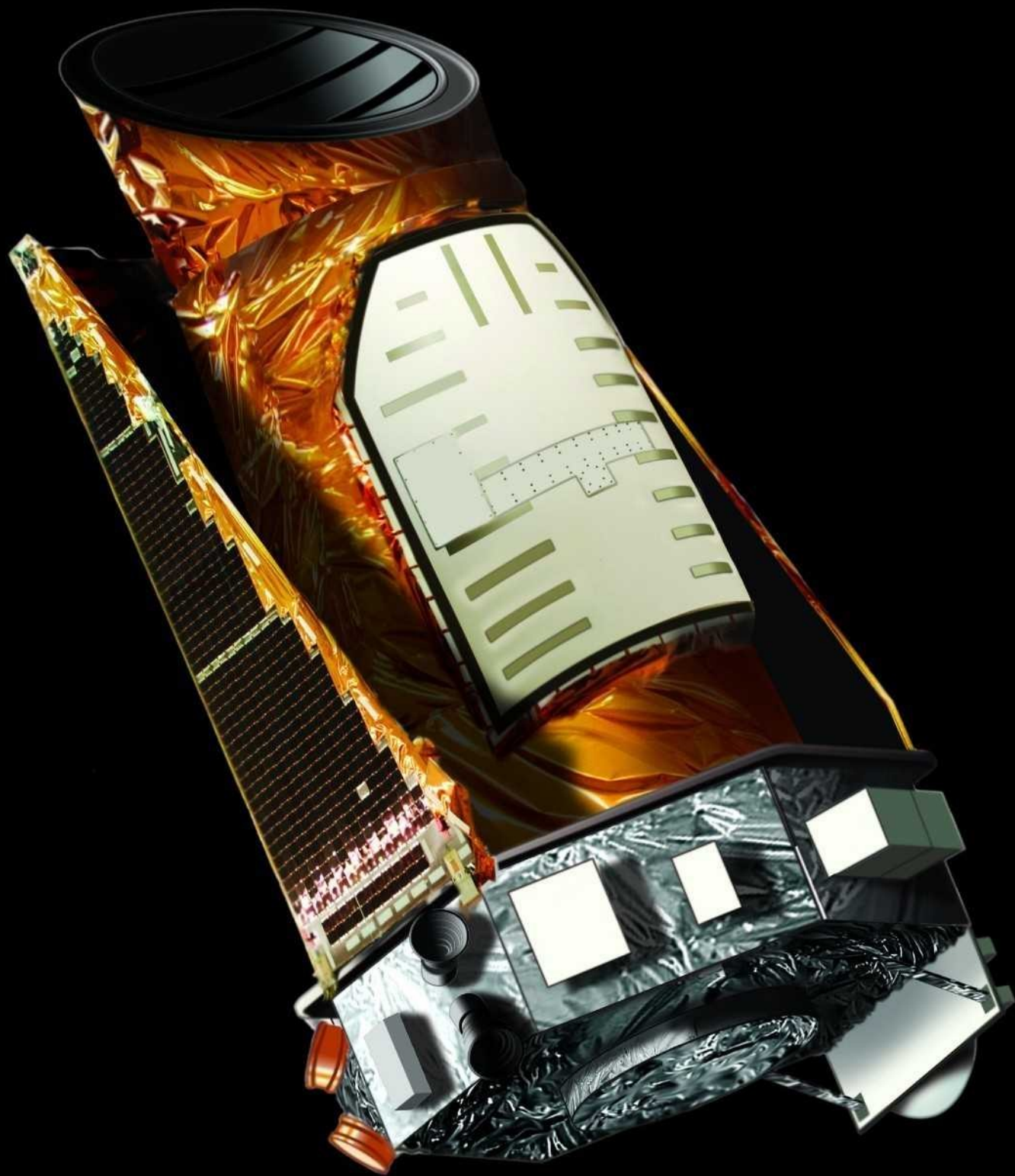
$f_p =$ andel av dessa stjärnor
med planetsystem



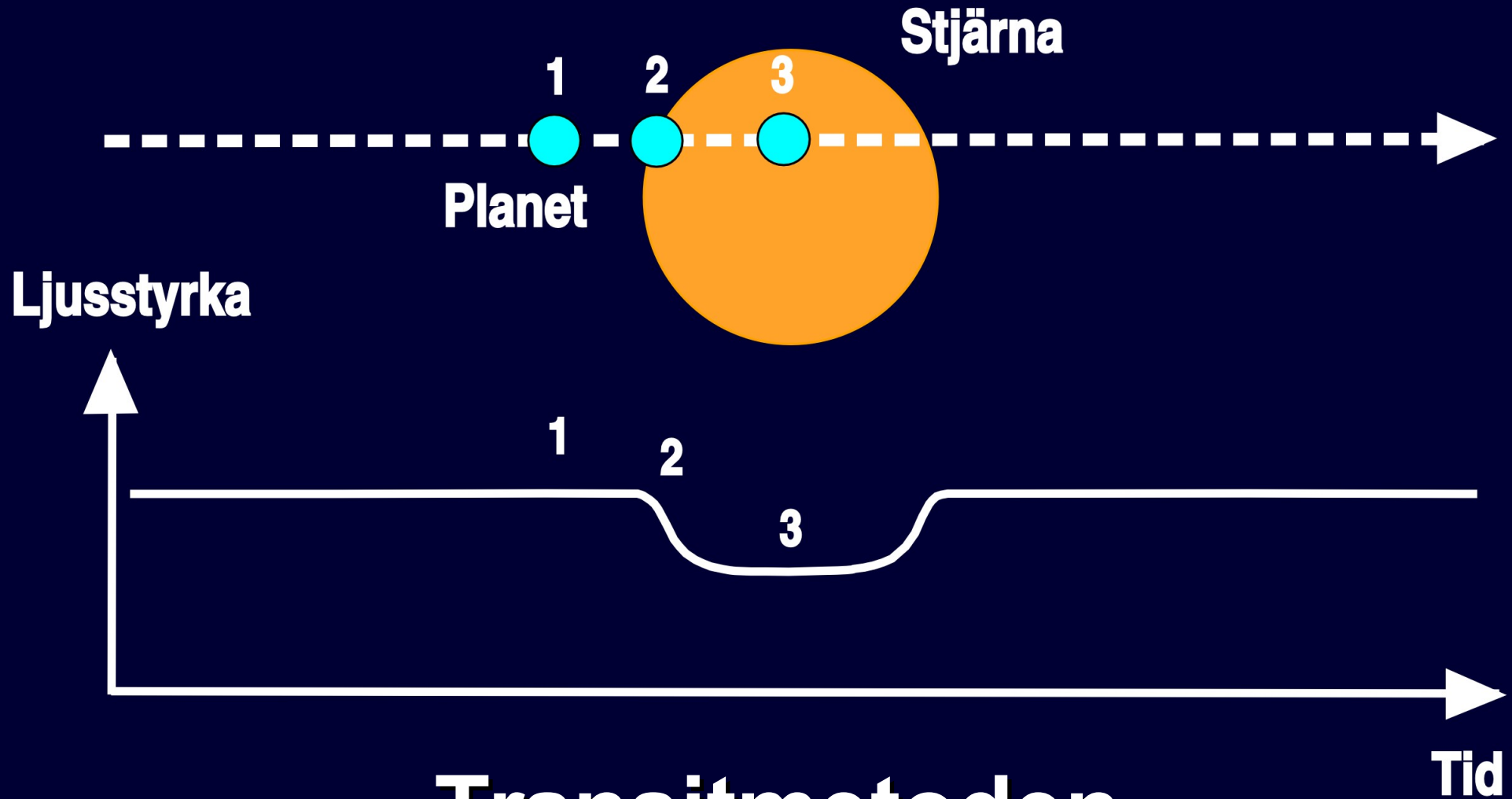
Exoplaneter!

Dagsnotering: 3575 st

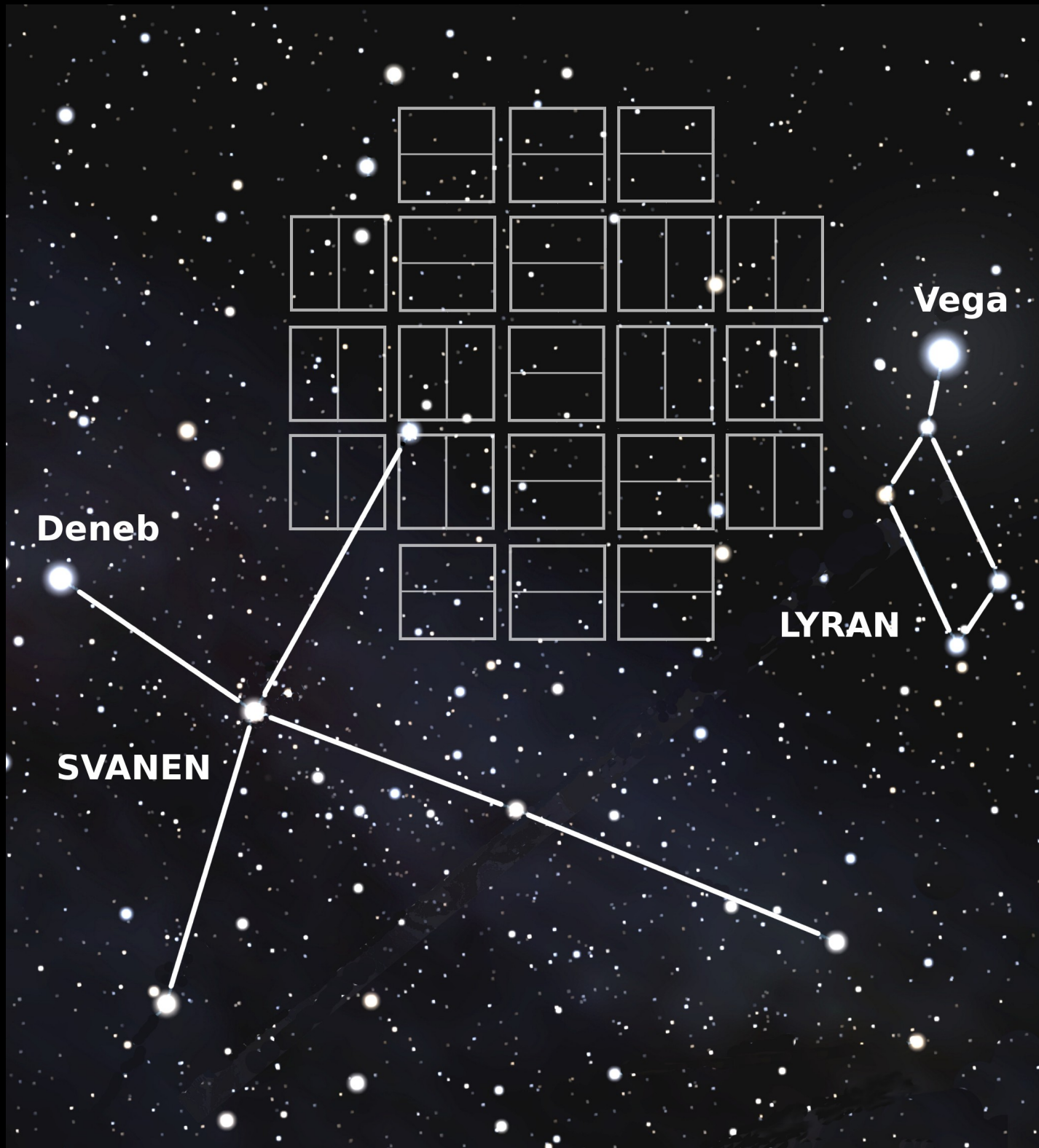




Hur upptäcker man en exoplanet?



Transitmetoden

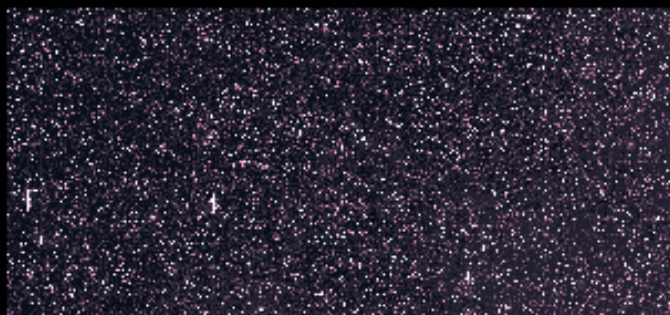
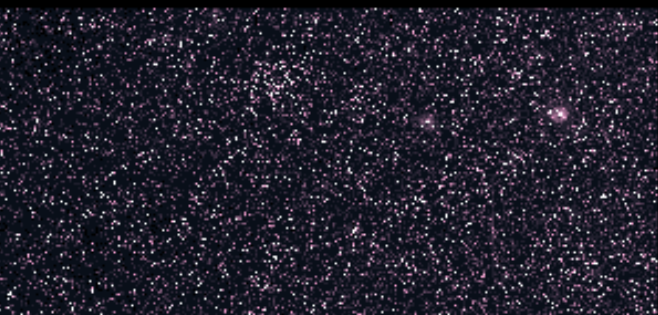
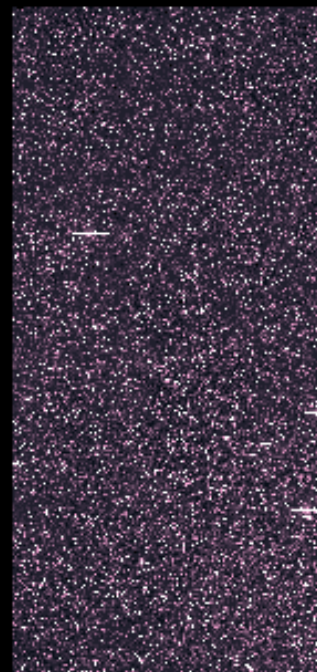
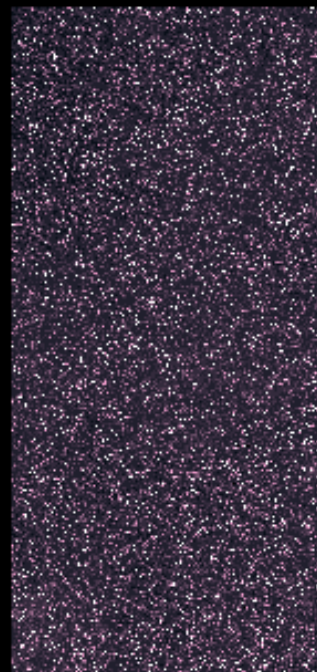
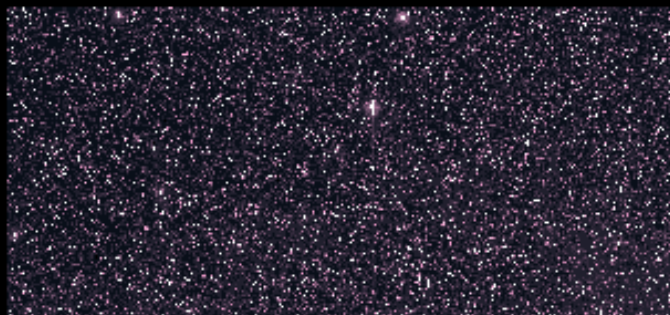
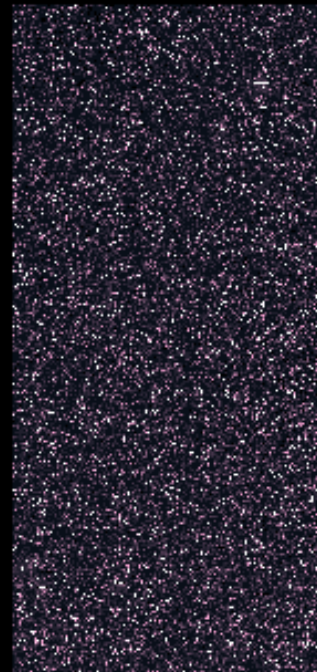
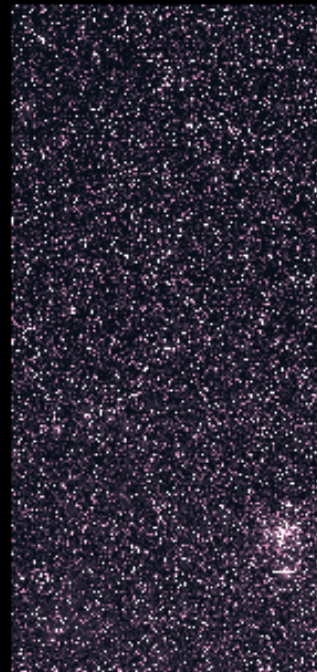
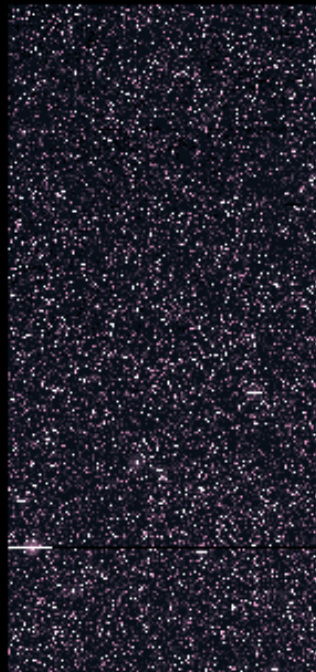
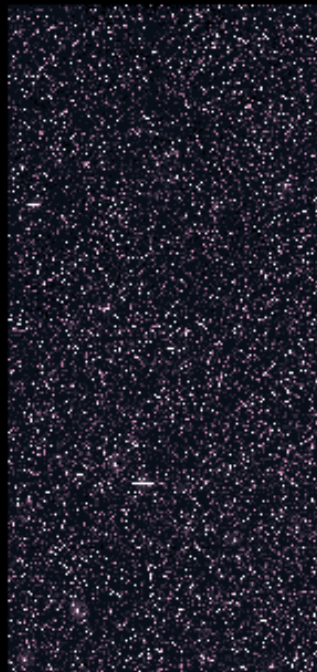
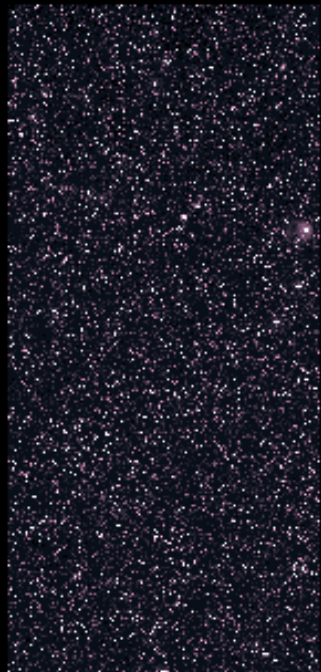


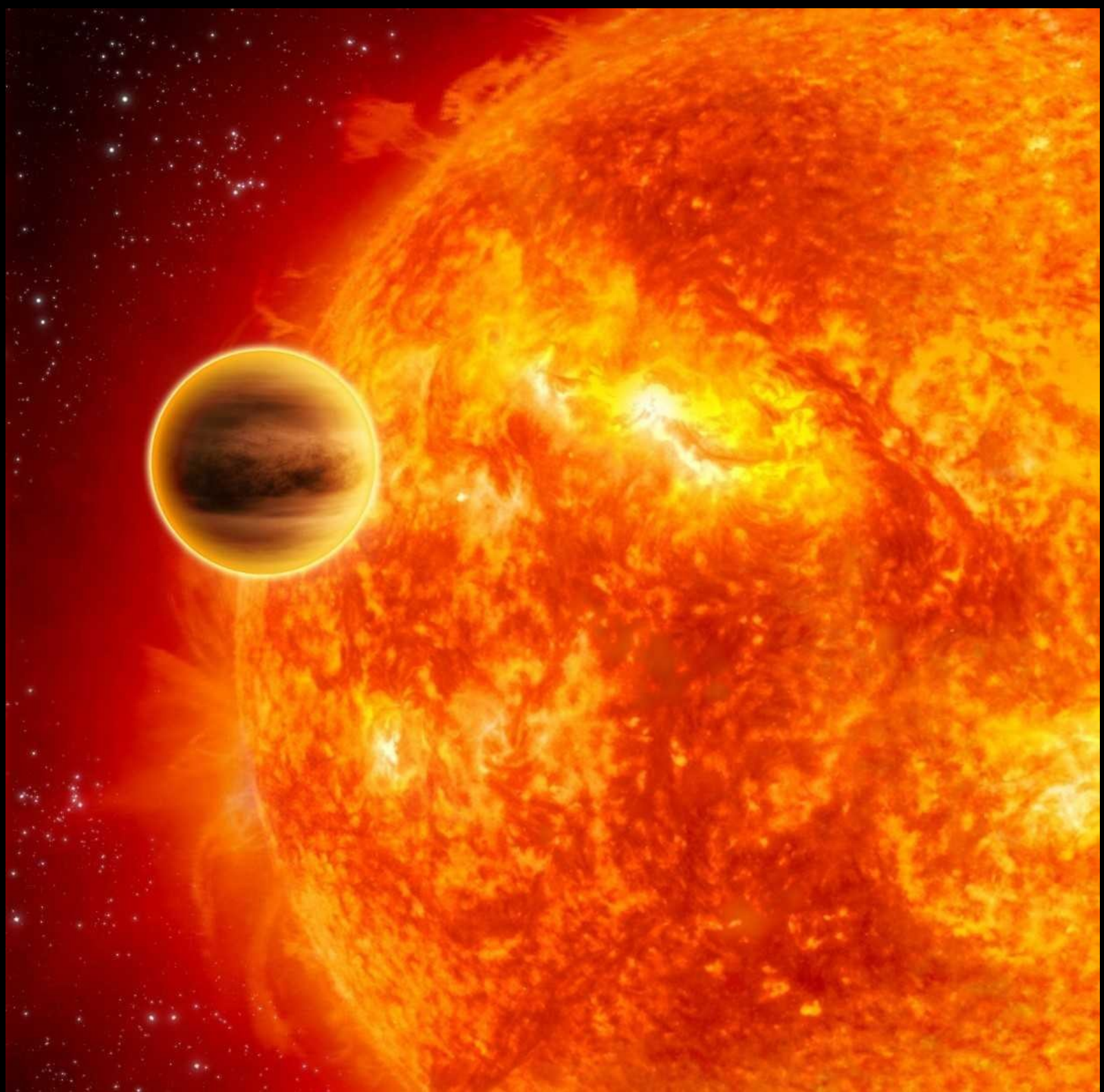
Deneb

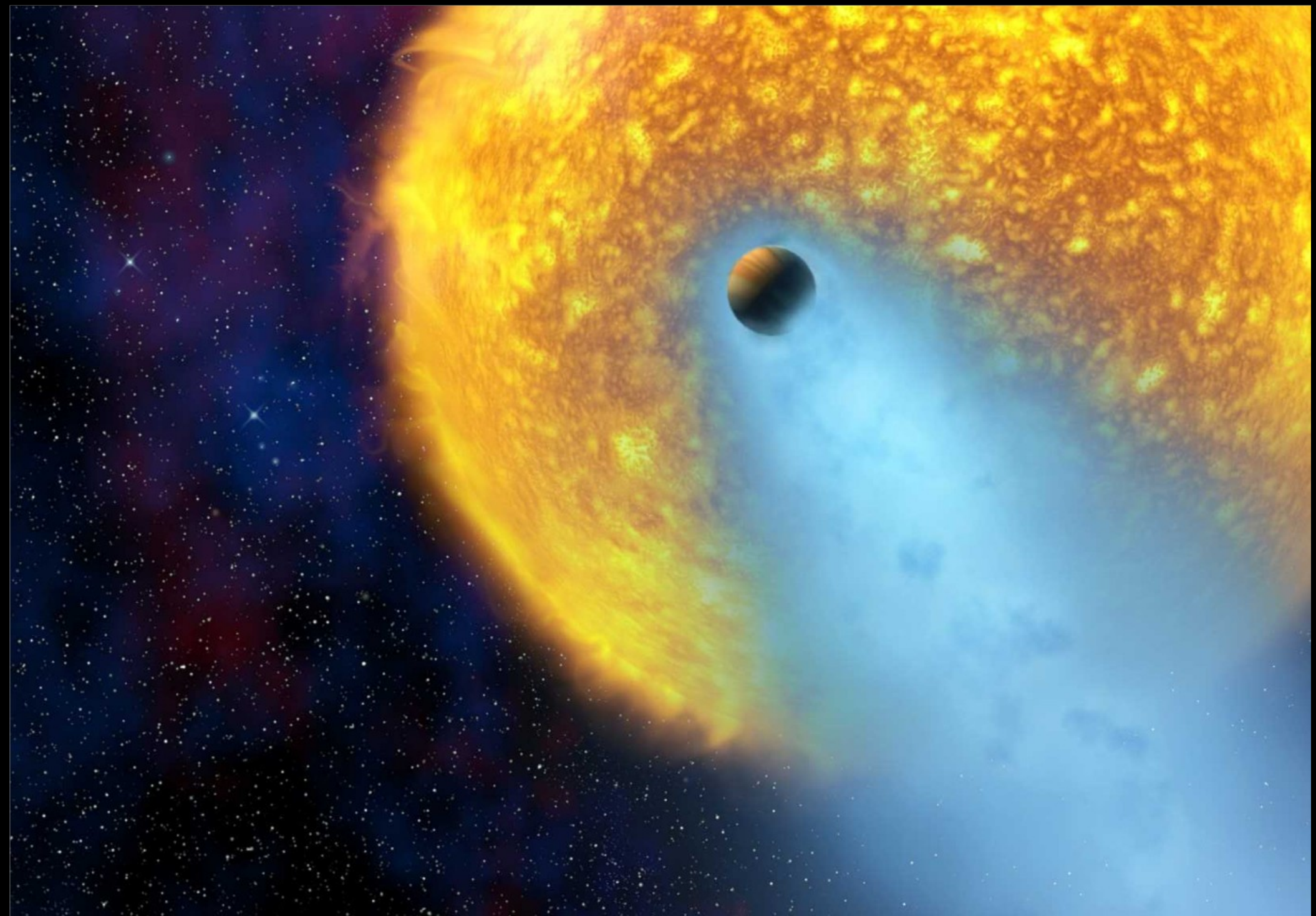
Vega

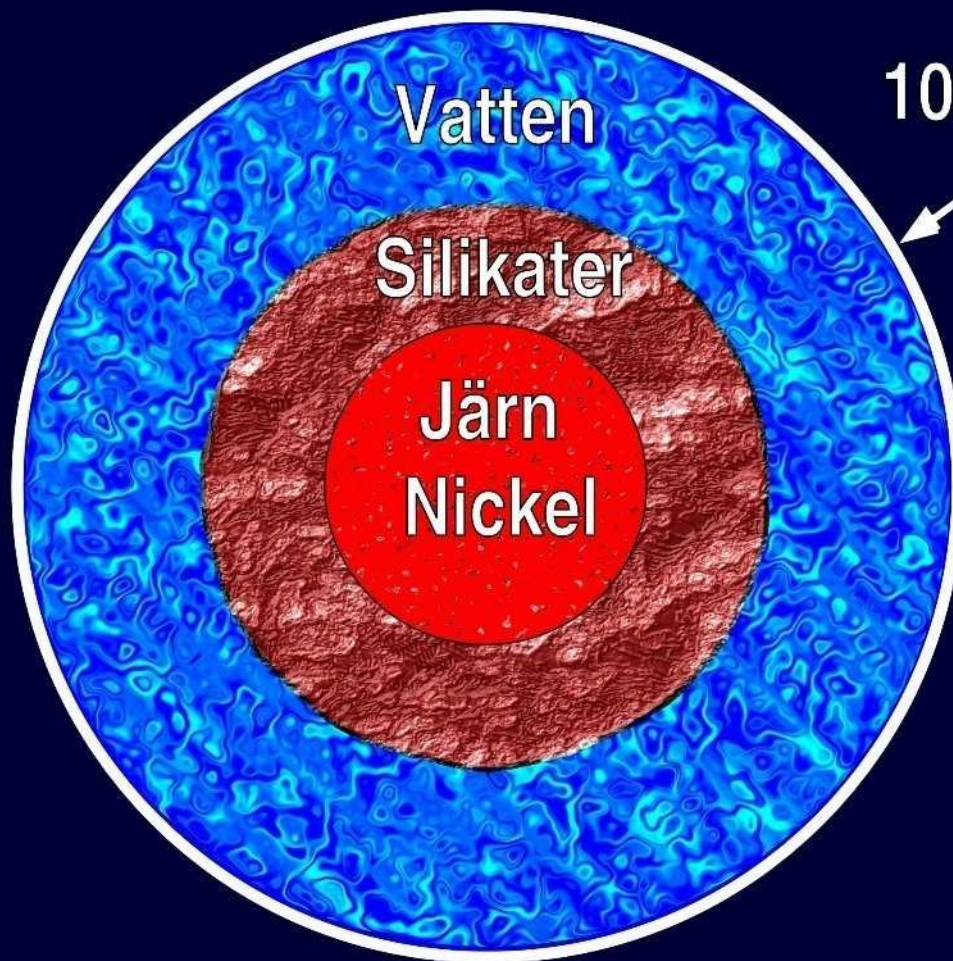
LYRAN

SVANEN

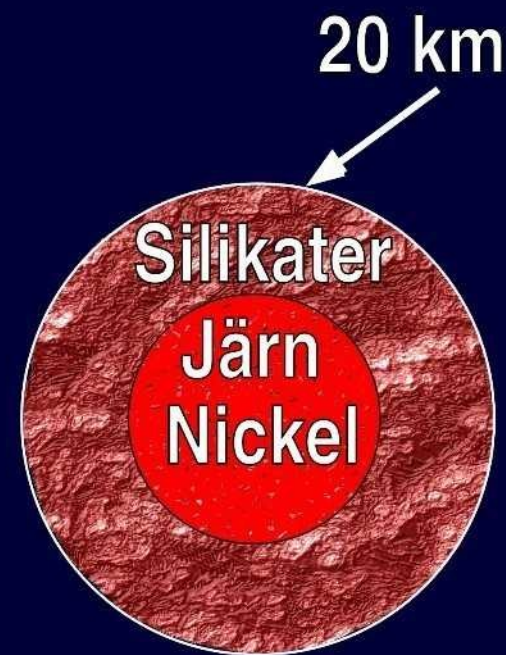








VATTENPLANET



JORDEN











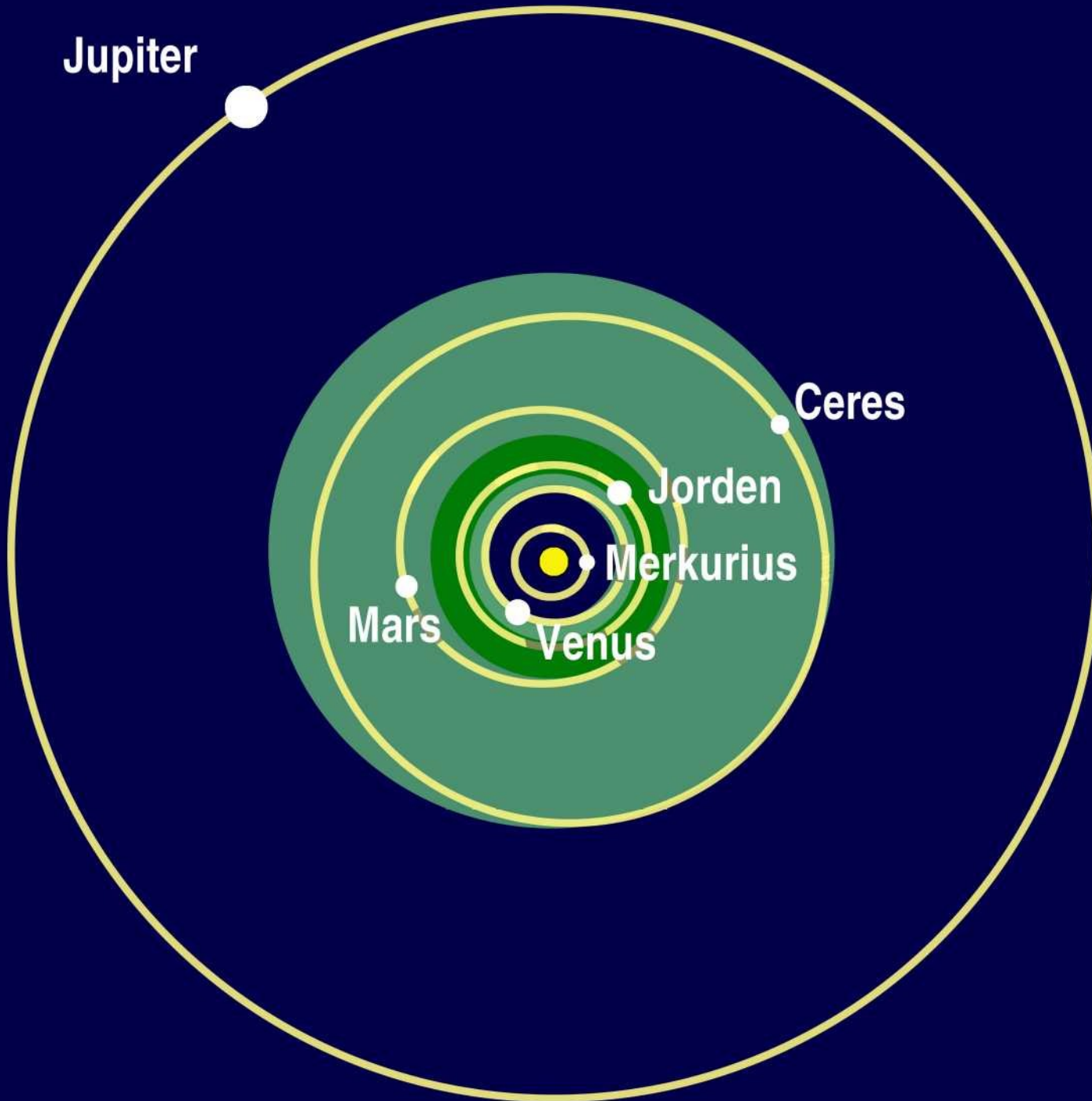
A man with white hair and glasses, wearing a dark suit, light blue shirt, and dark tie, is standing in front of a whiteboard. He is holding a white marker in his right hand. The whiteboard has some faint mathematical equations written on it, including $N = R \times f_p \times f_e \times f_c$. The background is dark, and the lighting is focused on the man and the whiteboard.

$f_p =$ andel stjärnor
med planetsystem

0.5

A photograph of Peter Linde, an older man with white hair and glasses, wearing a dark suit, light blue shirt, and dark tie. He is holding a white marker and writing on a whiteboard. The whiteboard has some faint, illegible handwriting on it. The background is dark.

$n_e =$ antalet beboeliga
planeter per stjärna



Jupiter

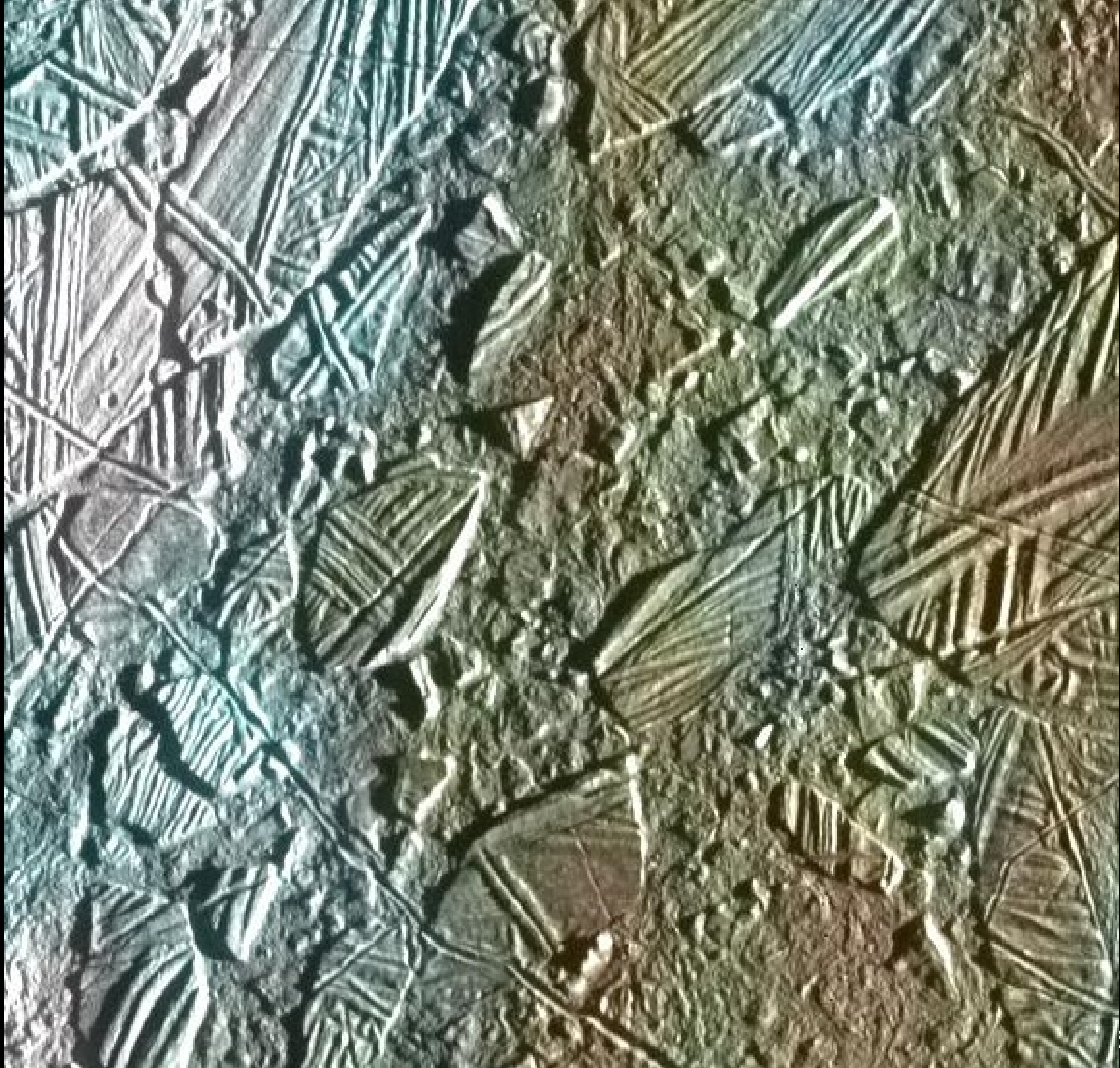
Ceres

Jordan

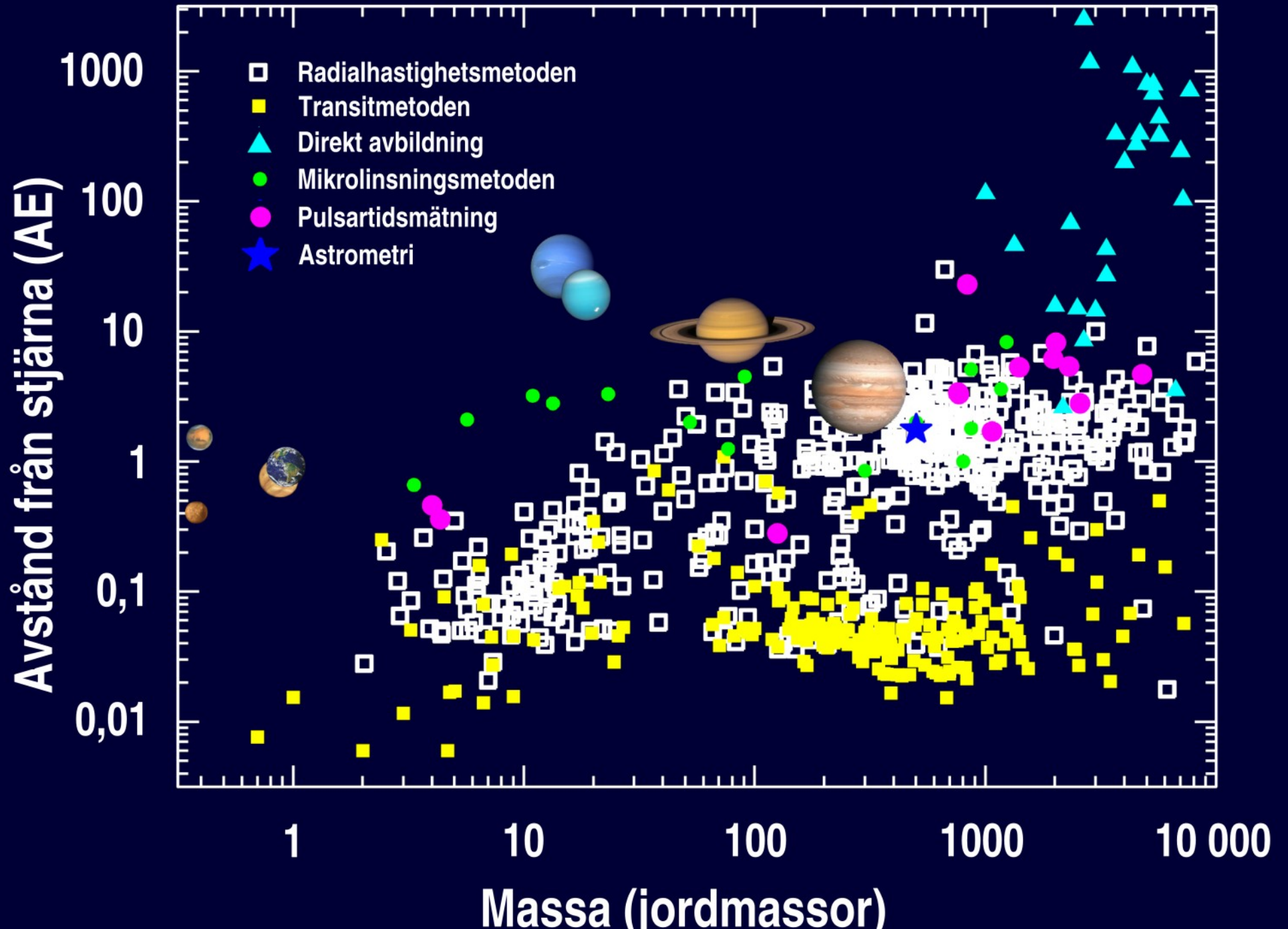
Merkurius

Mars

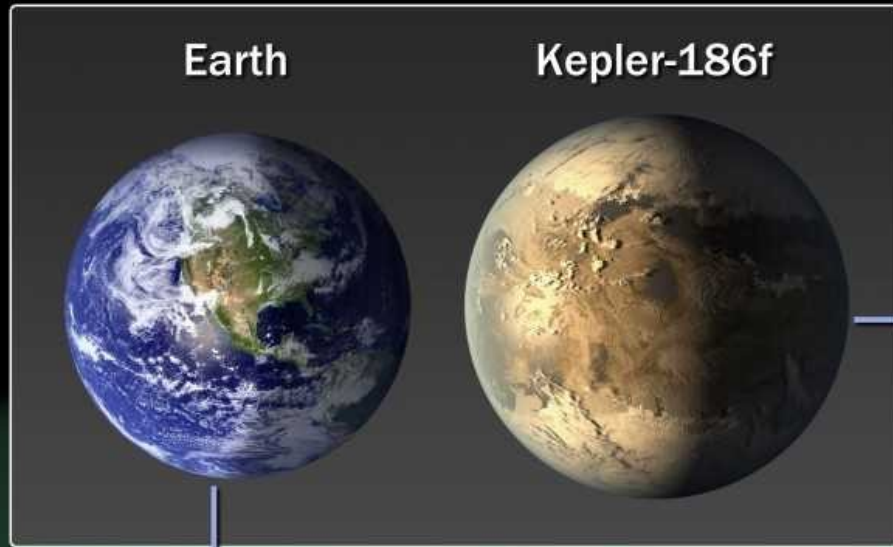
Venus







Den beboelige zonen



Kepler-186 System

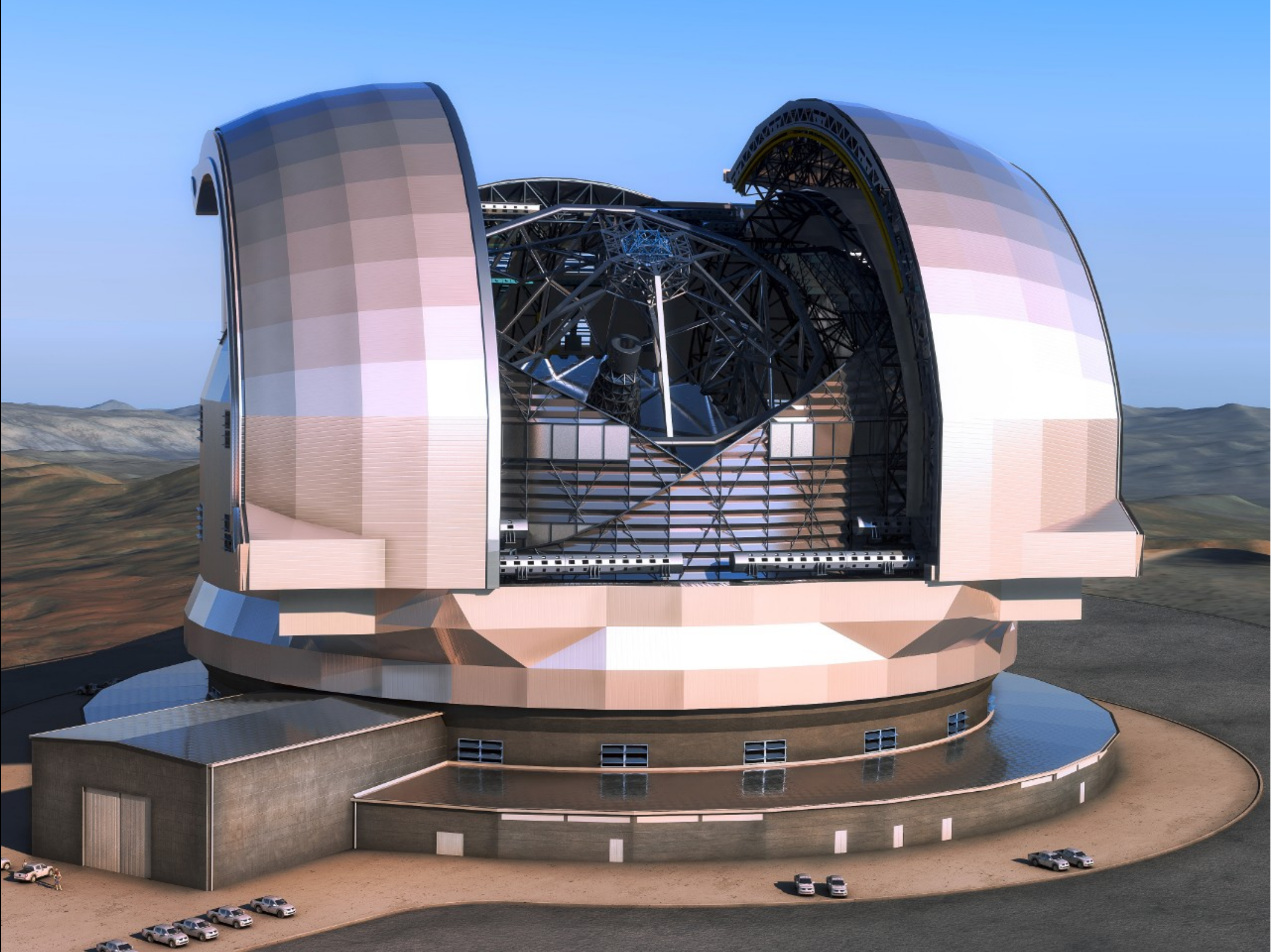


Solar System

Earth Venus Mercury

A diagram of the Solar System showing a central yellow star with three elliptical orbits. The orbits are labeled 'Earth', 'Venus', and 'Mercury' from outermost to innermost. A blue line from the Earth/Kepler-186f comparison box points to the Earth orbit.

Planets and orbits to scale



Ljus från målobjekt

Ljus från referensskälla

Kollimator

Beamsplitter Kamera

Deformerbar spegel

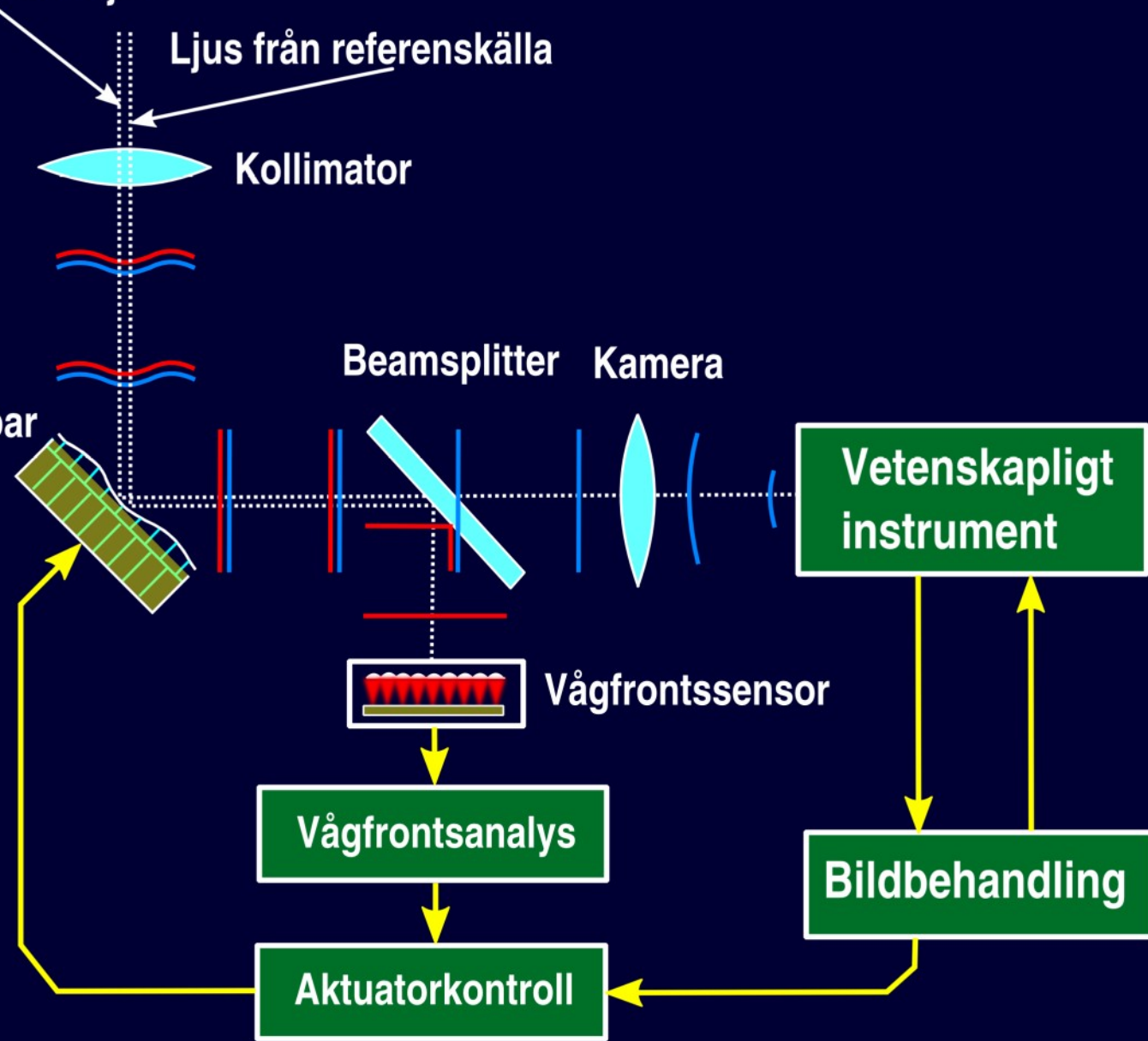
Vetenskapligt instrument

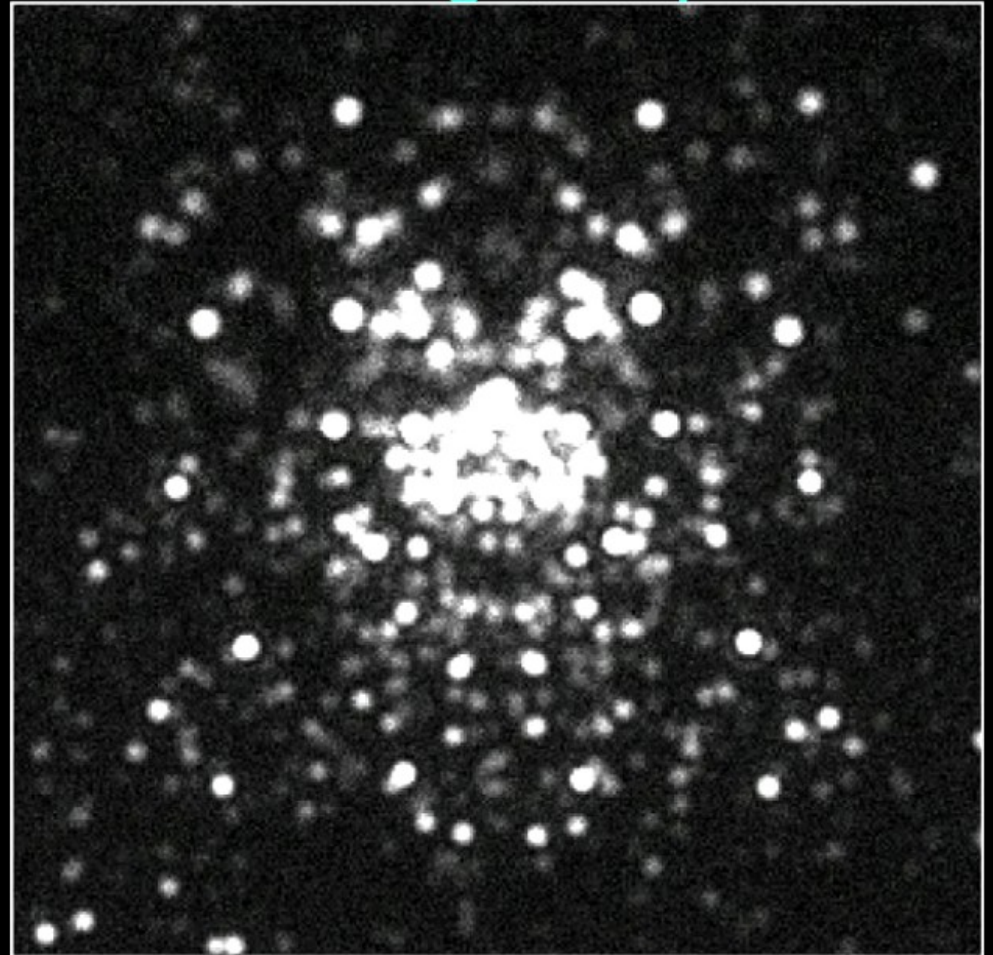
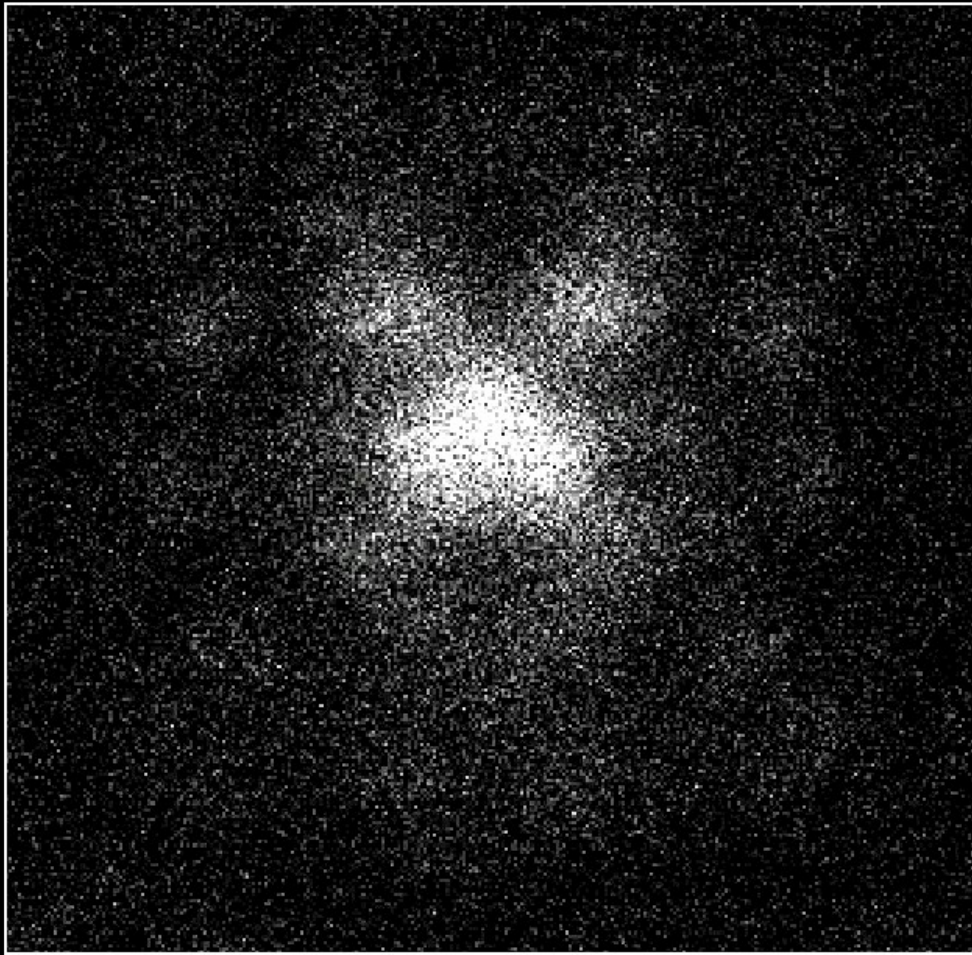
Vågfrontssensor

Vågfrontsanalys

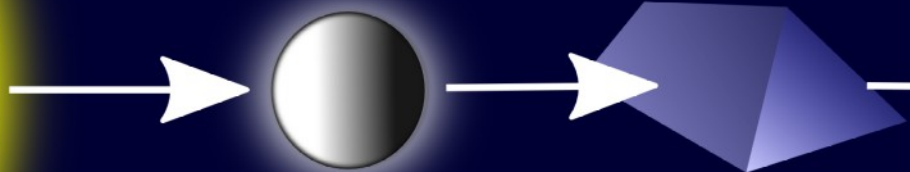
Bildbehandling

Aktuatorkontroll



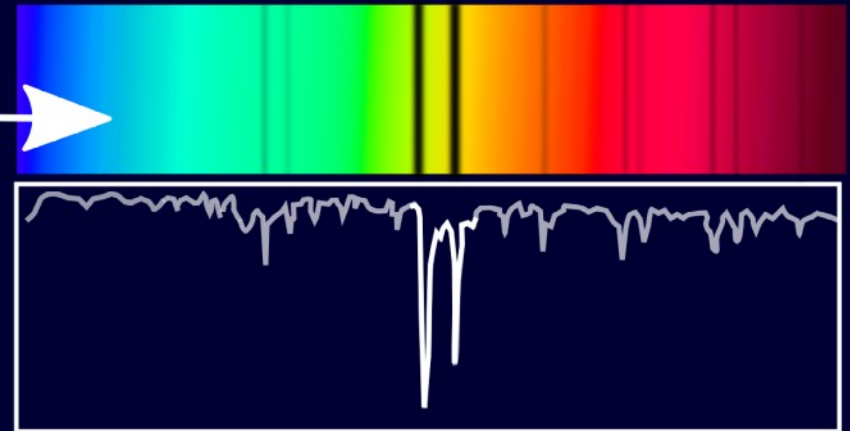


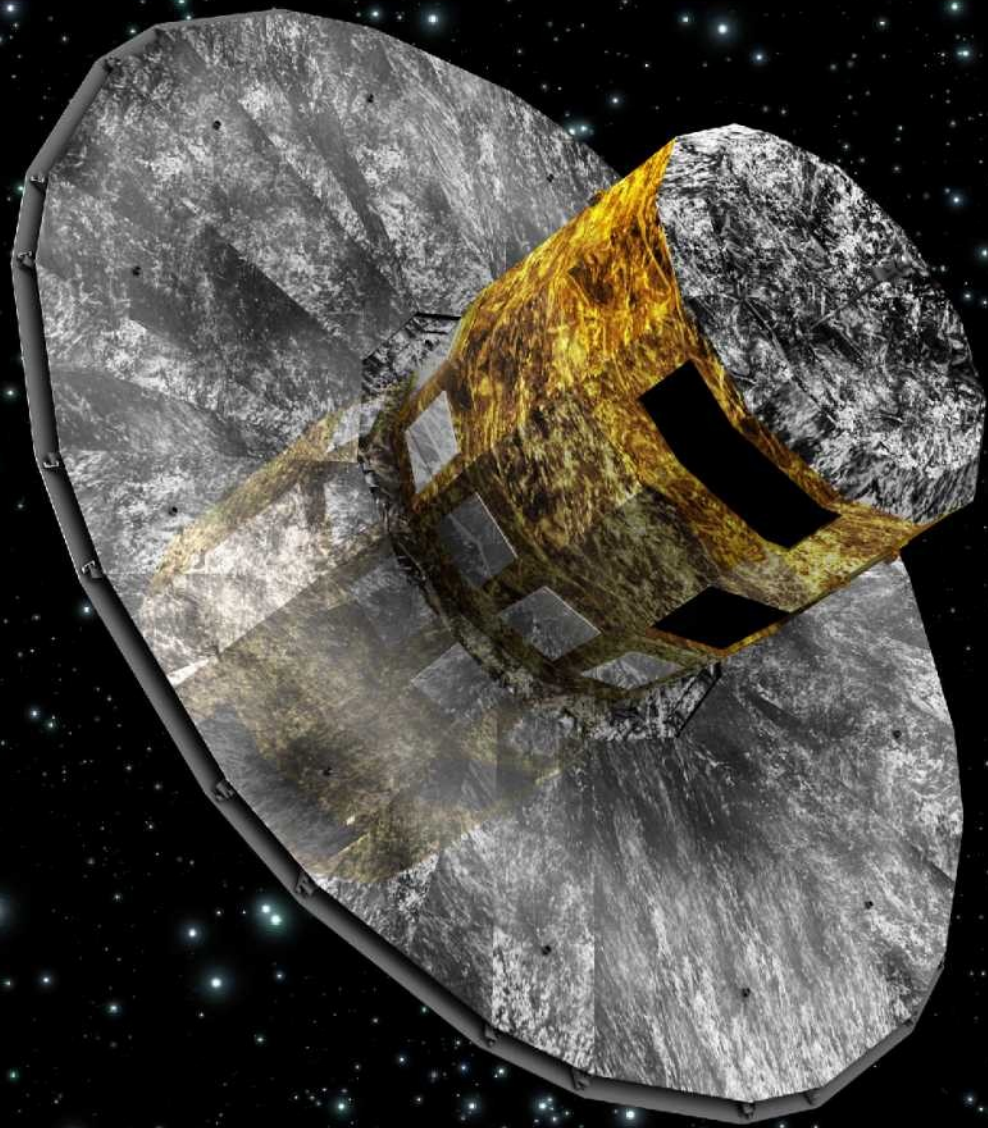
Stjärnans ljus filtreras genom
planetens natriumrika atmosfär

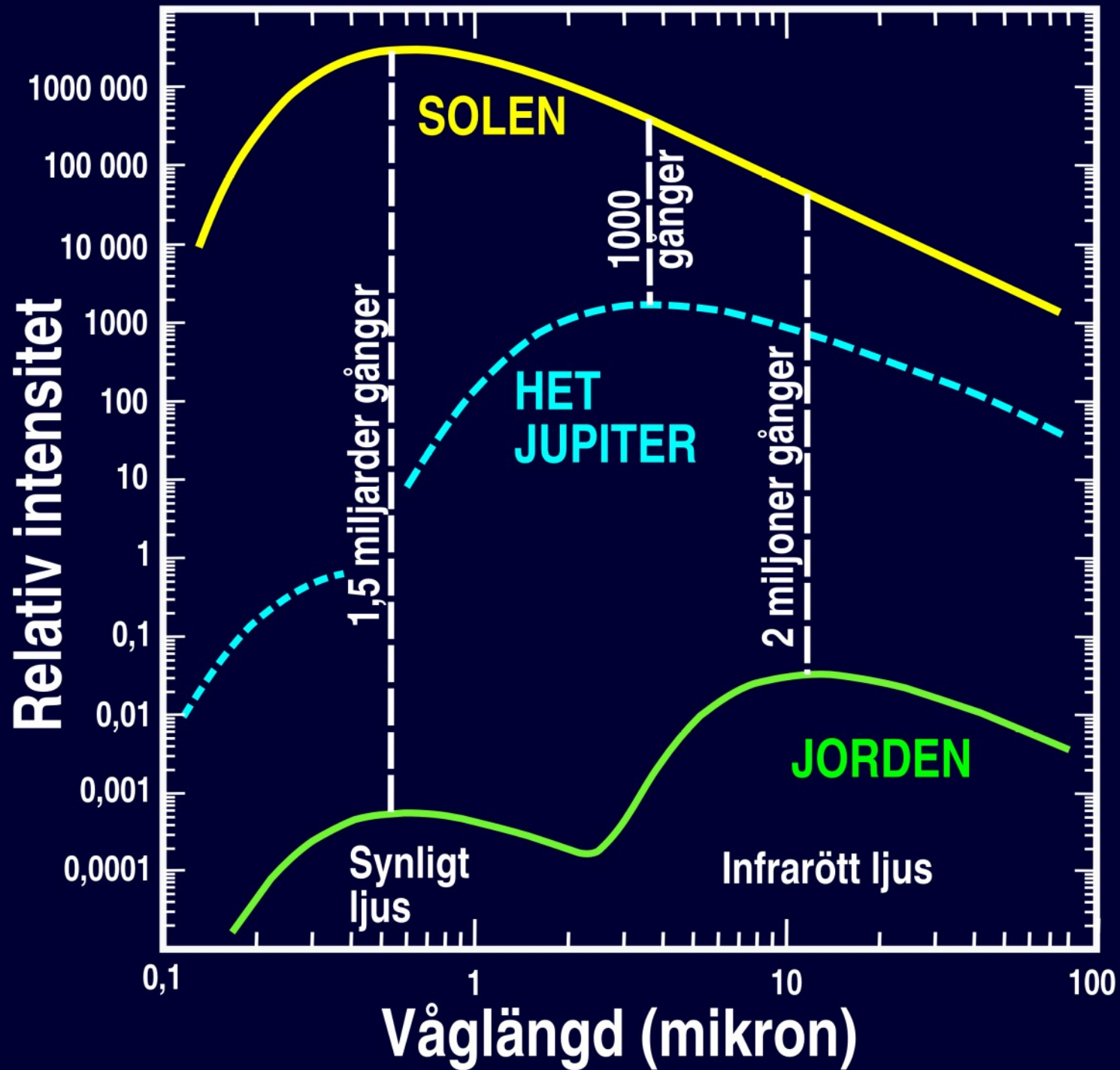


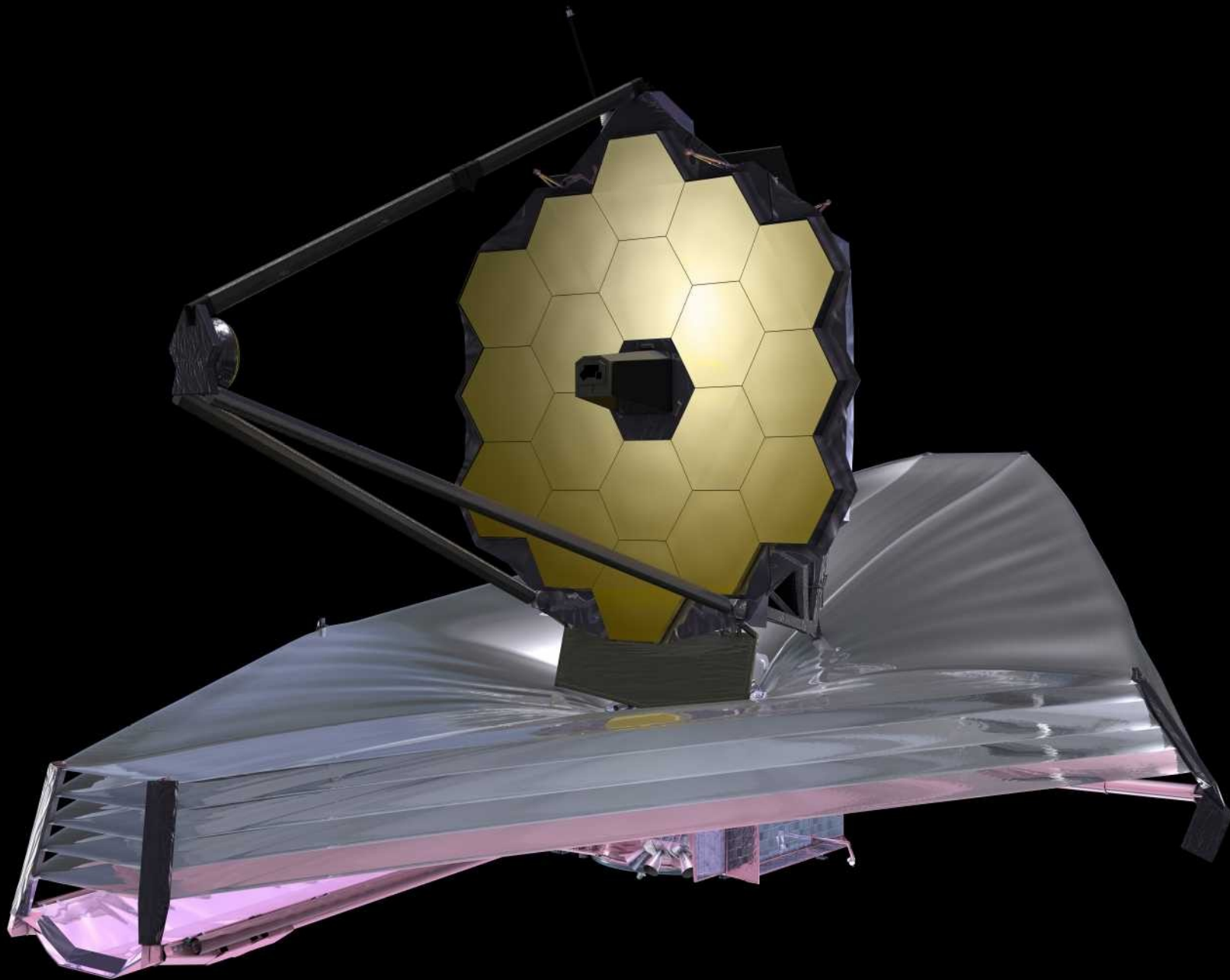
Spektrograf

Absorptionslinjespektrum









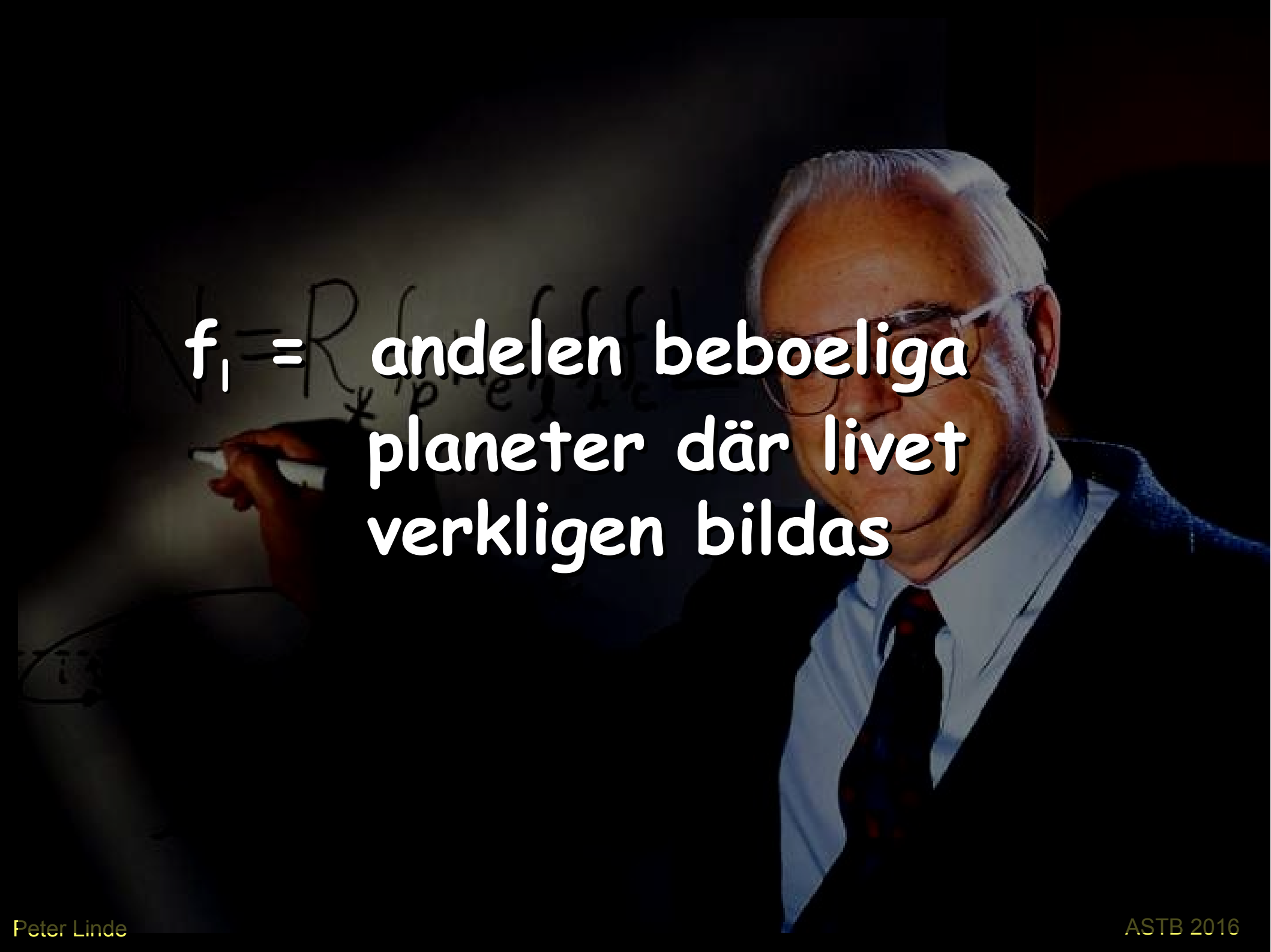
Interstellär radar?

- Avstånd: 100 000 gånger längre än Titan
- Yta stor som Skåne behöver täckas med mottagare
- Yta stor som Lappland skulle behövas för sändardelen
- Sändareffekt: ca 10 TW (10 000 kärnkraftverk)
- Solenergi används för sändare
- Hundratal exoplaneter skulle kunna studeras inom 20 ljusår


A photograph of Peter Linde, an older man with white hair and glasses, wearing a dark suit, light blue shirt, and dark tie. He is standing in front of a whiteboard, holding a white marker in his right hand. The whiteboard has some faint, handwritten mathematical formulas. The background is dark, and the lighting is focused on the man and the whiteboard.

$n_e =$ antalet beboeliga
planeter per stjärna

3

A photograph of Peter Linde, an older man with white hair and glasses, wearing a dark suit, light blue shirt, and dark tie. He is standing in front of a whiteboard, holding a white marker in his right hand. The whiteboard has some faint, handwritten mathematical formulas, including $N = R \cdot f_p \cdot f_e \cdot f_l \cdot f_i$. The text is overlaid on the image in a large, white, sans-serif font.

$f_i =$ andelen beboeliga
planeter där livet
verkligen bildas

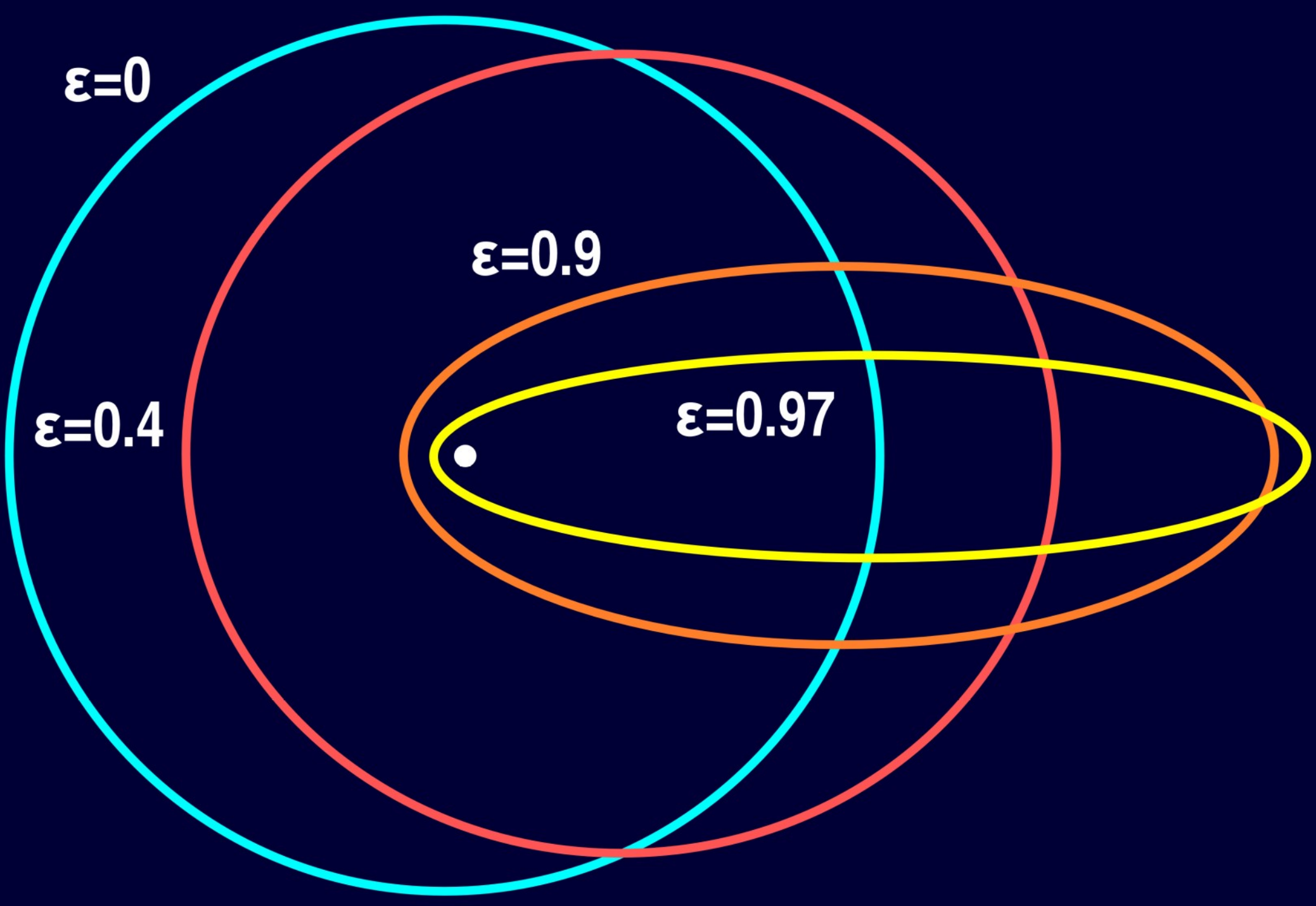


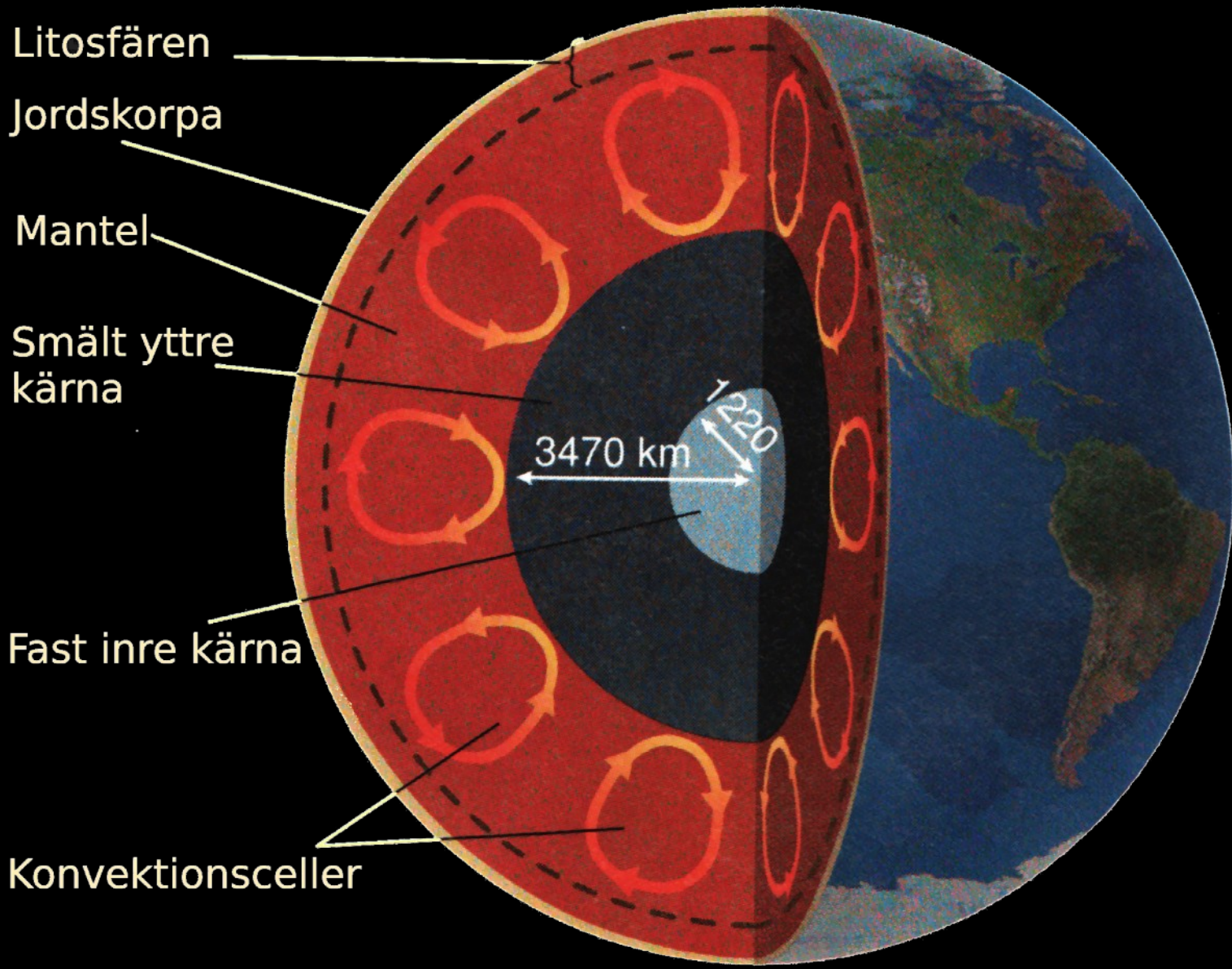
Hur mycket slump är livets uppkomst och utveckling?

MARK GARLICK/SCIENCE PHOTO LIBRARY Science Photo Library









Litosfären

Jordskorpa

Mantel

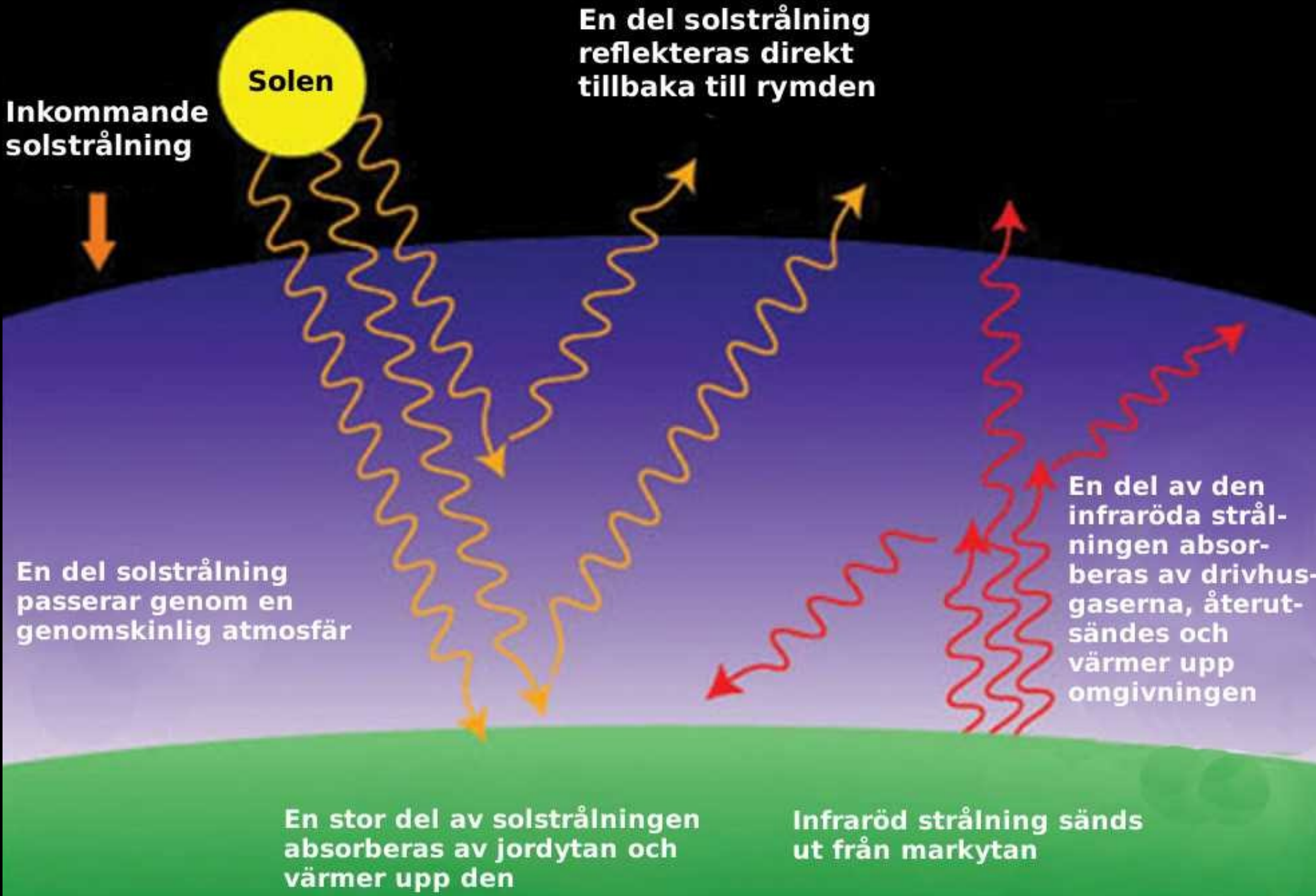
Smält yttre kärna

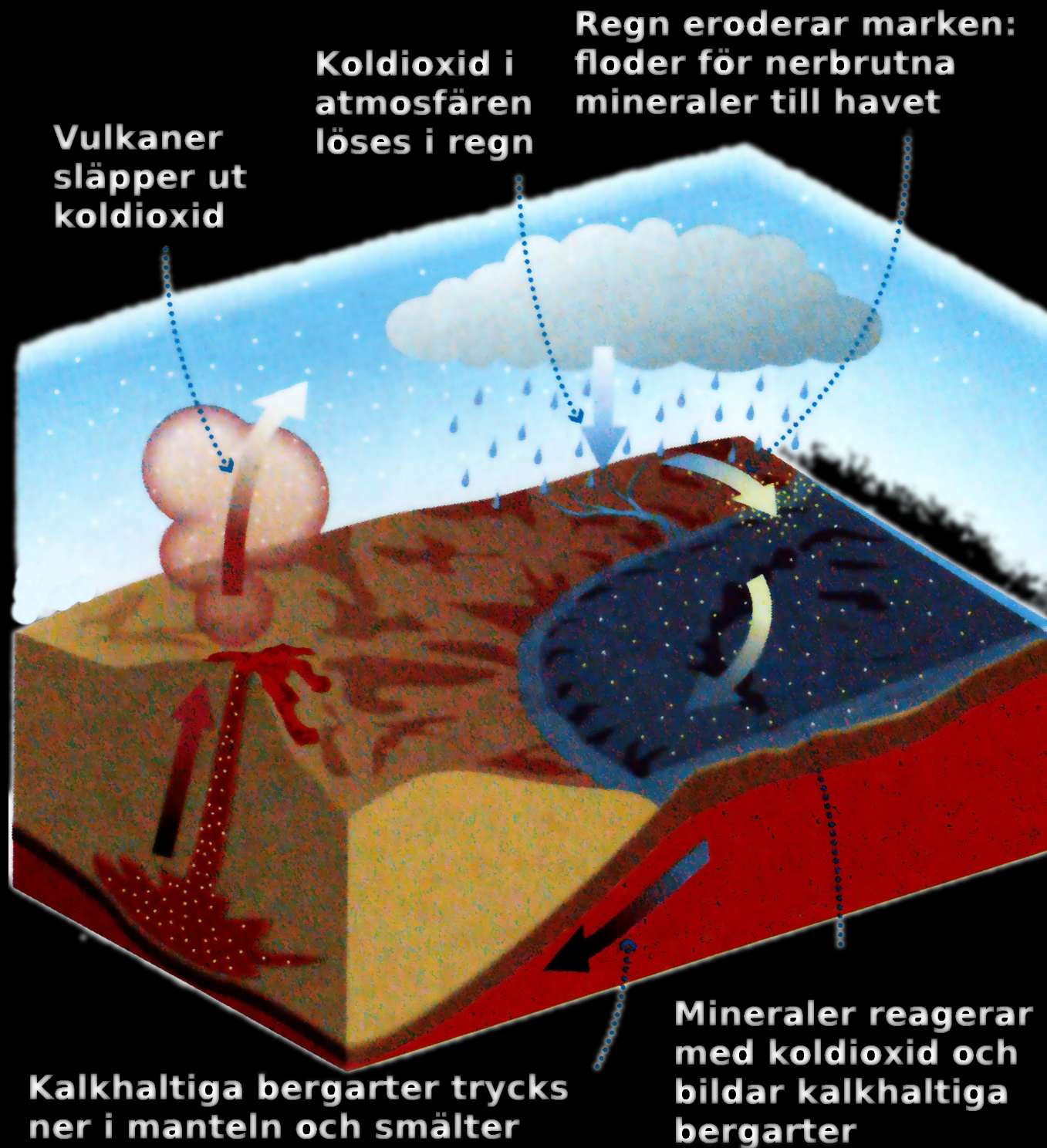
Fast inre kärna

Konvektionsceller

3470 km

1220

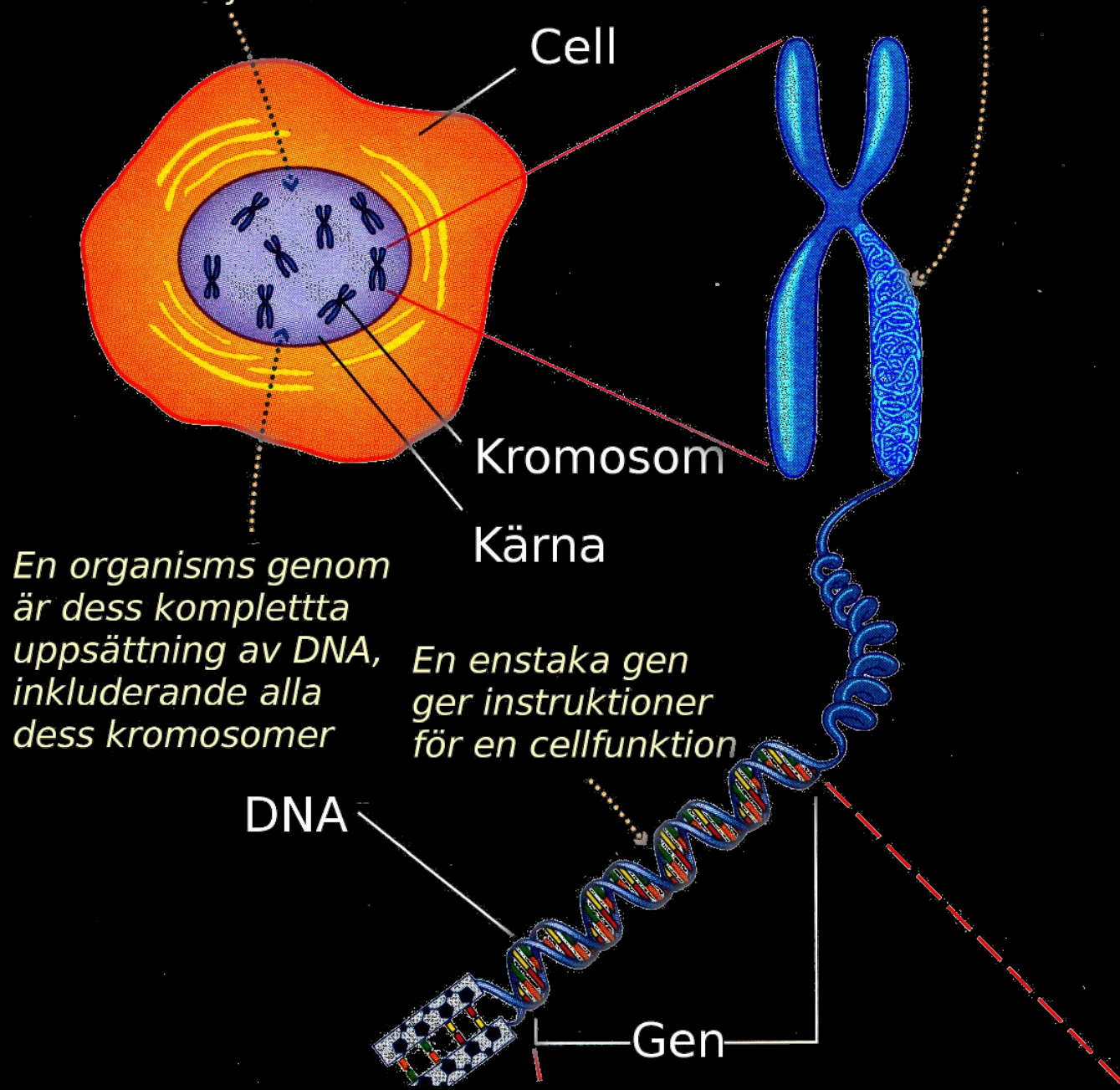






Generna finns i kromosomerna inne i varje cellkärna

Kromosomerna innehåller långa strängar av DNA



Cell

Kromosom

Kärna

DNA

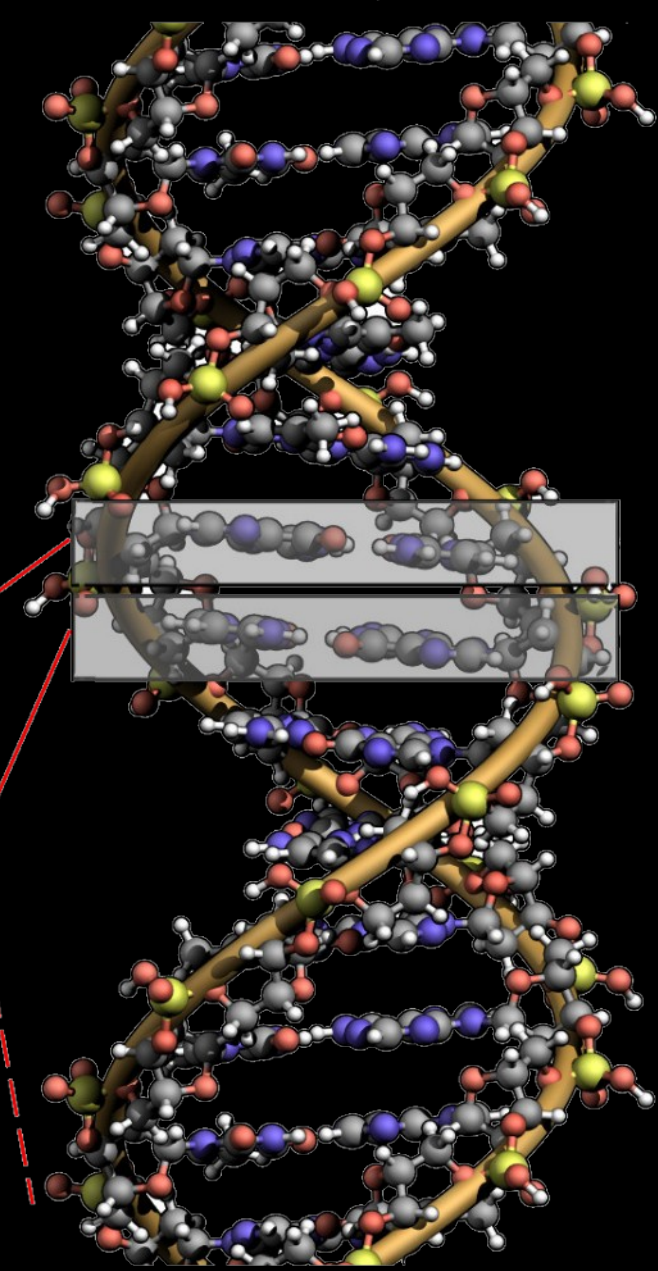
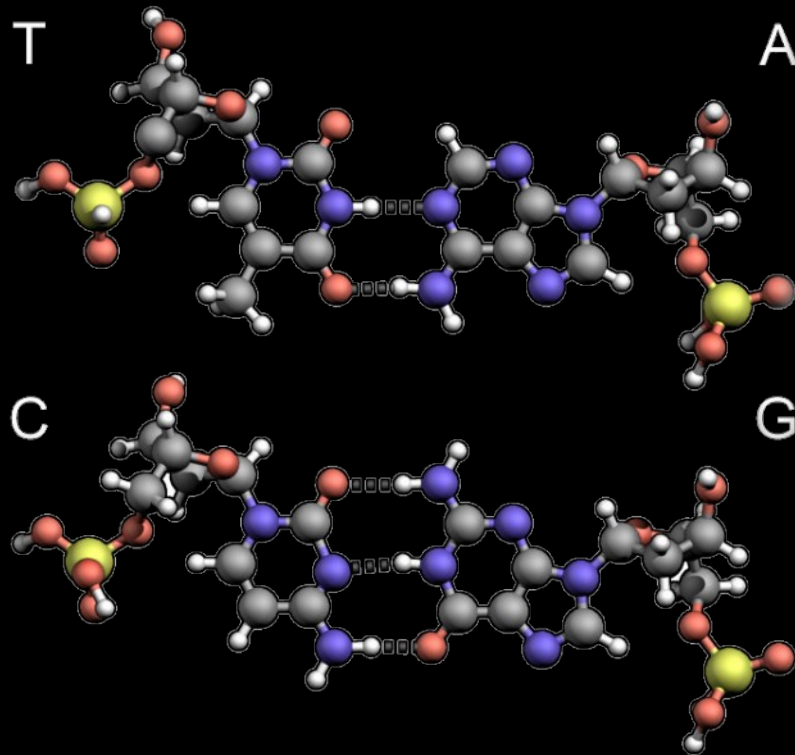
Gen

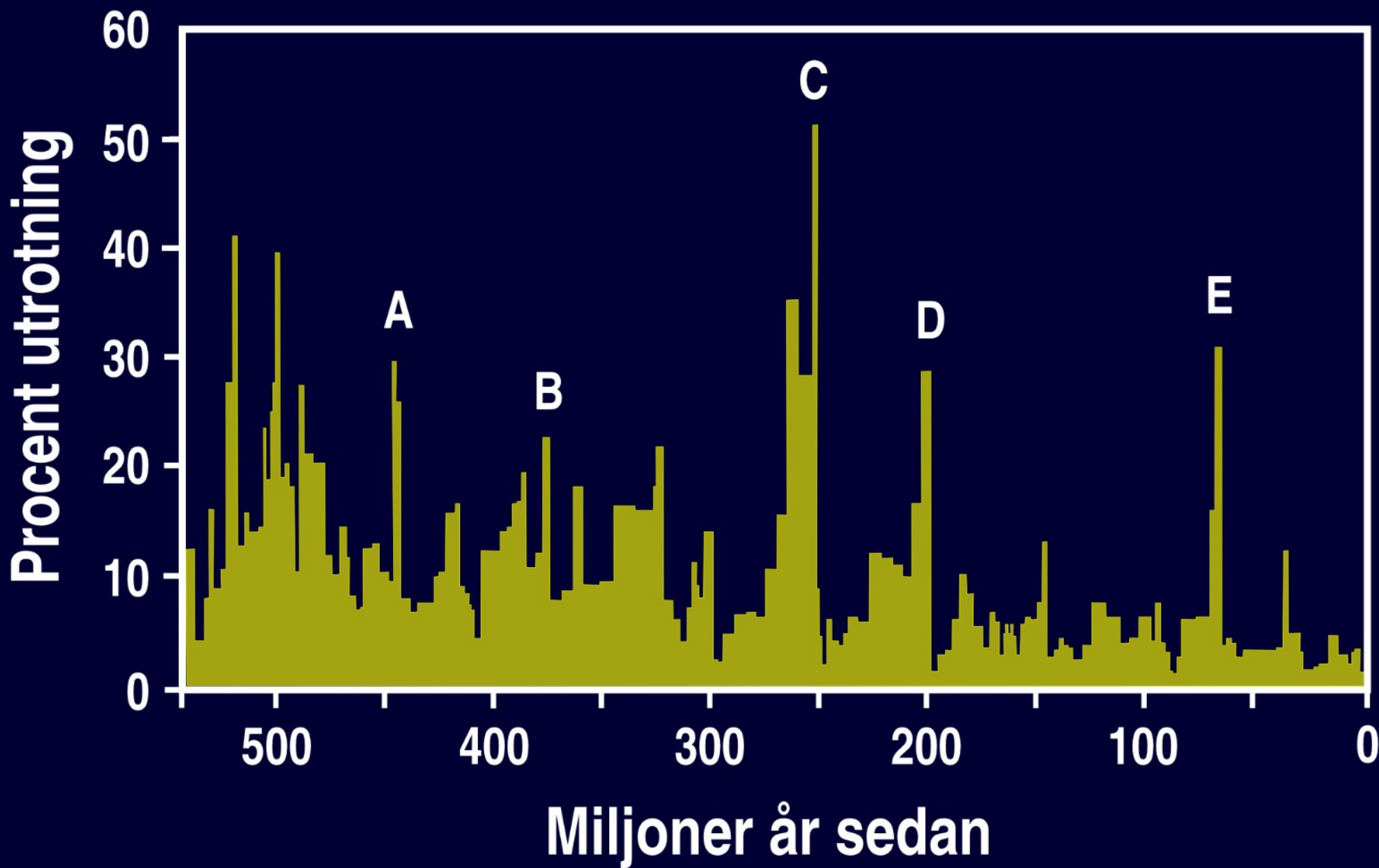
En organisms genom är dess kompletta uppsättning av DNA, inkluderande alla dess kromosomer

En enskilda gen ger instruktioner för en cellfunktion

Atomer

- Väte
- Syre
- Kväve
- Kol
- Fosfor





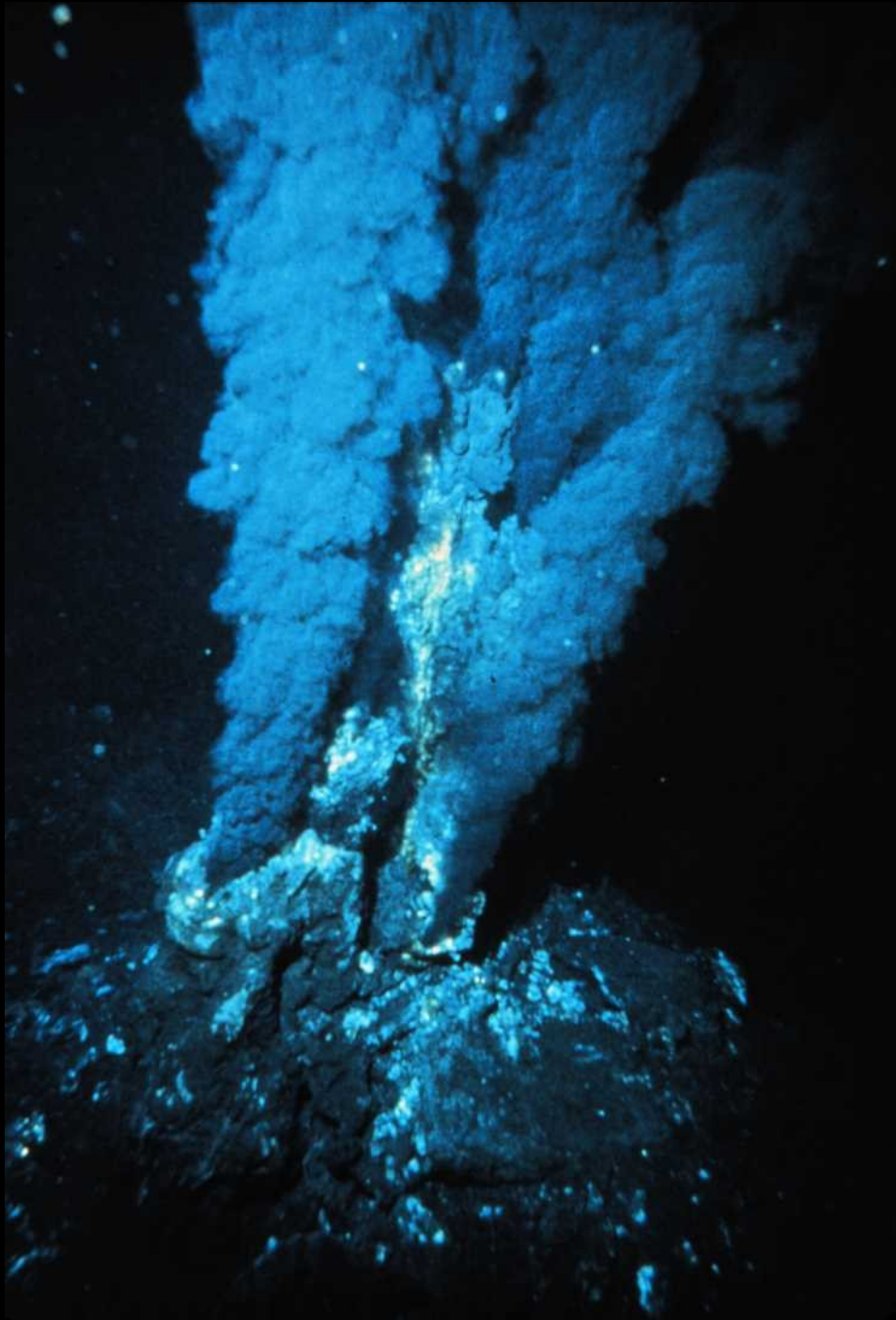


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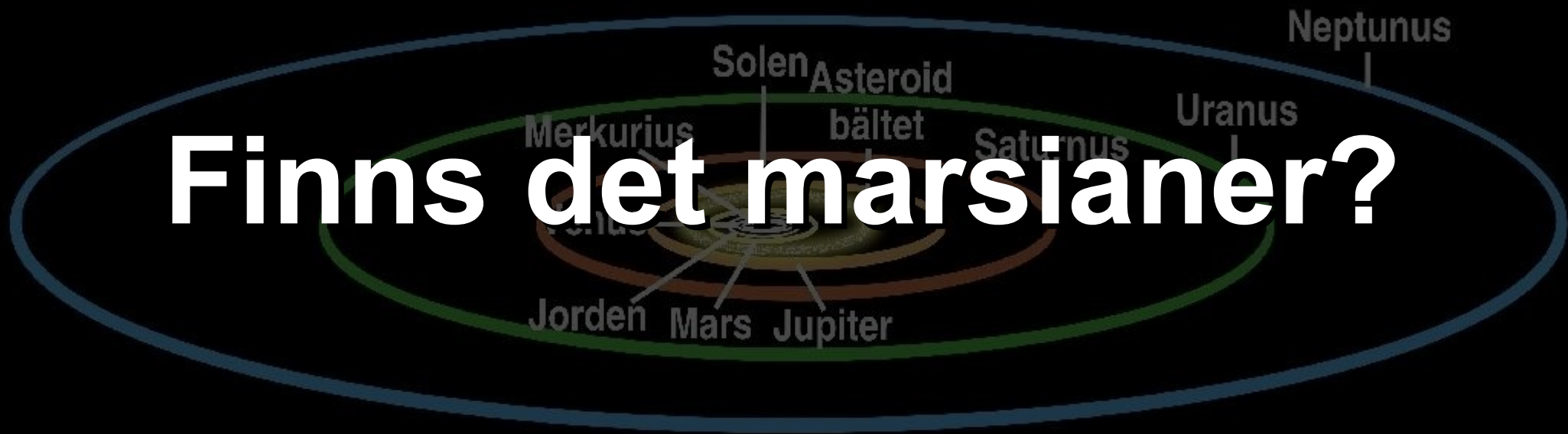
© M. L. 2001
3 22

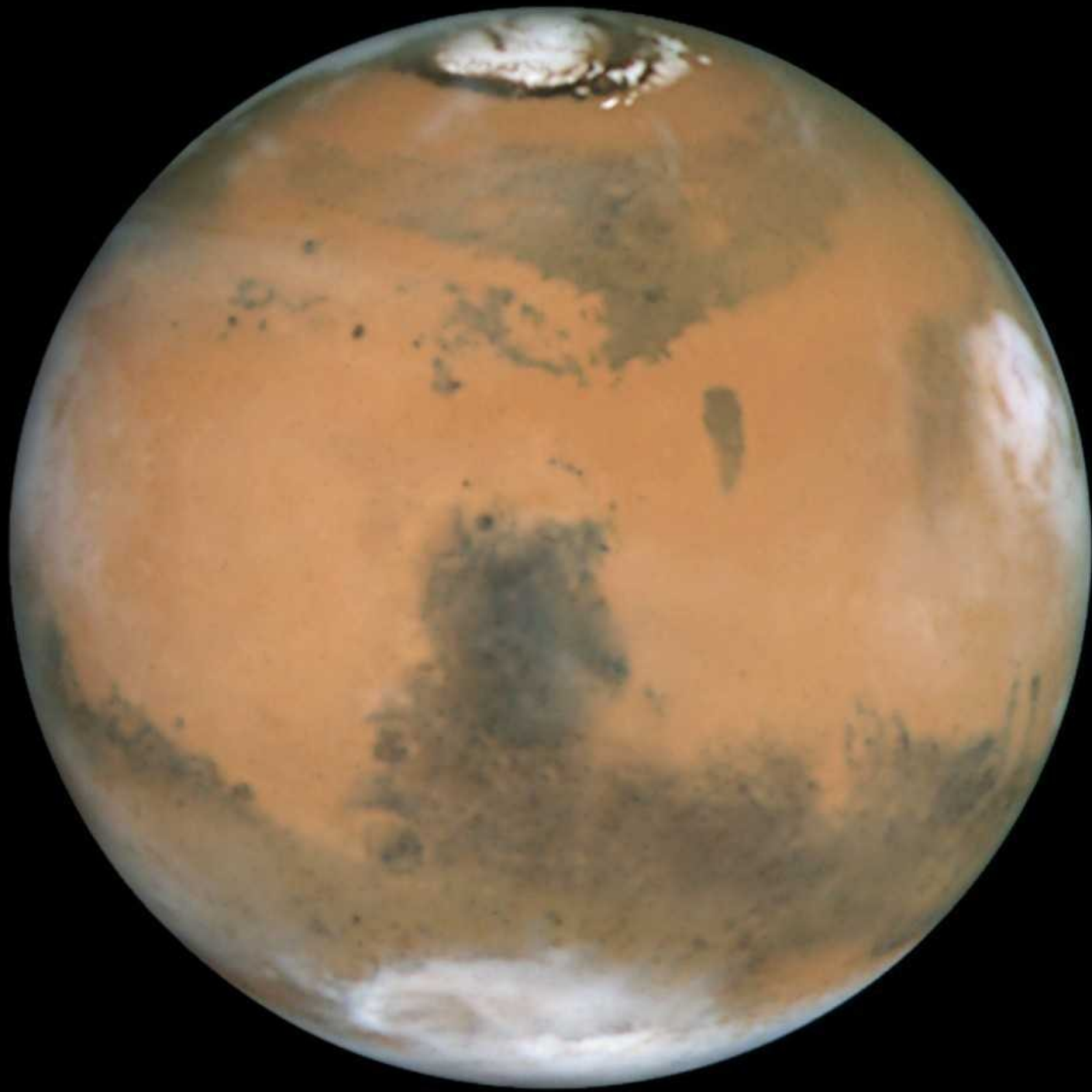




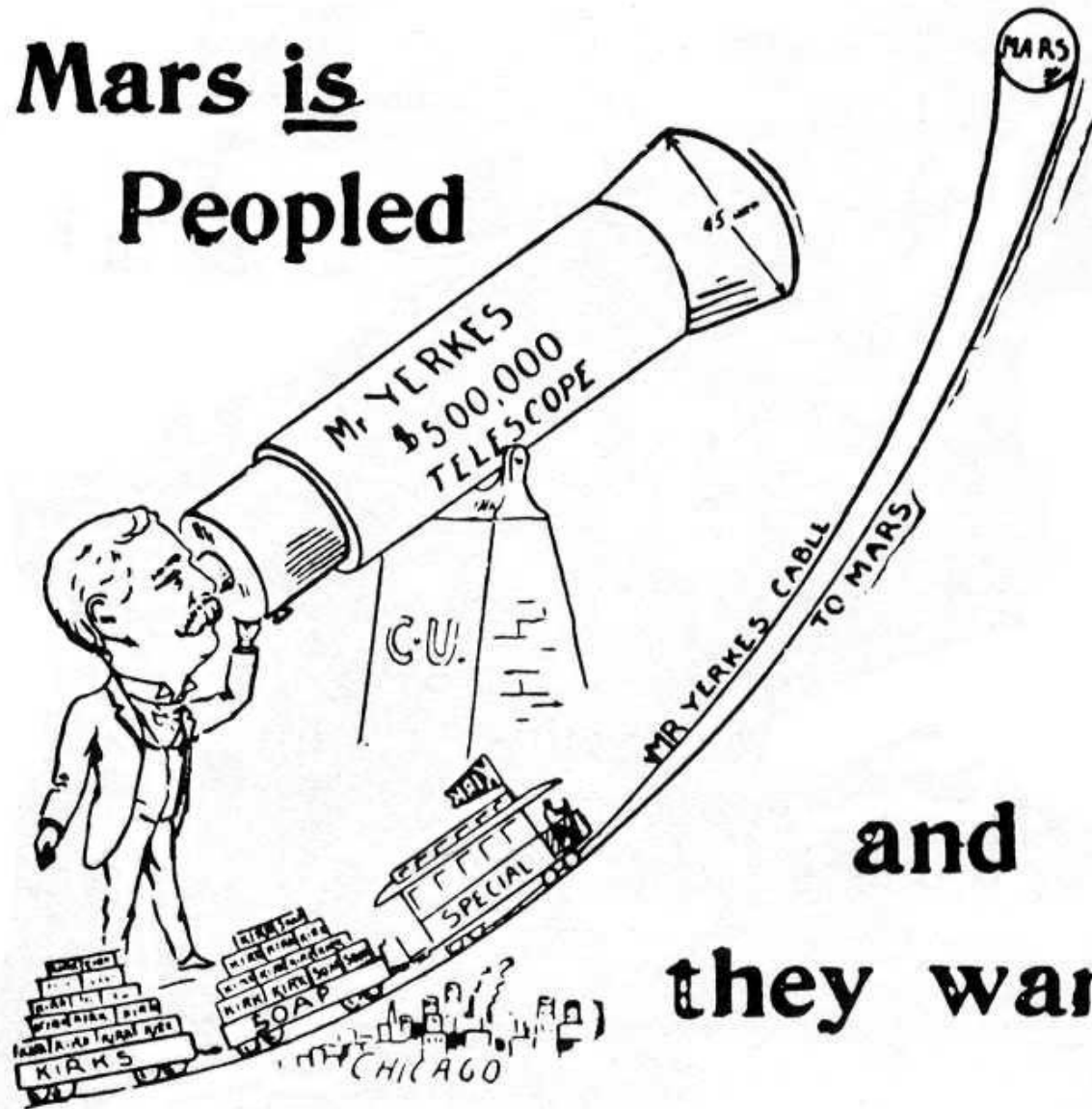
SCIENCEPHOTOLIBRARY

Finns det marsianer?





Mars is
Peopled



and
they want

KIRK'S
AMERICAN  **FAMILY**
SOAP

Kirk's Dusky Diamond Soap, best for Ladies Toilet.

Radio Listeners in Panic, Taking War Drama as Fact

***Many Flee Homes to Escape 'Gas Raid From
Mars'—Phone Calls Swamp Police at
Broadcast of Wells Fantasy***

A wave of mass hysteria seized thousands of radio listeners throughout the nation between 8:15 and 9:30 o'clock last night when a broadcast of a dramatization of H. G. Wells's fantasy, "The War of the Worlds," led thousands to believe that an interplanetary conflict had started with invading Martians spreading wide death and

and radio stations here and in other cities of the United States and Canada seeking advice on protective measures against the raids.

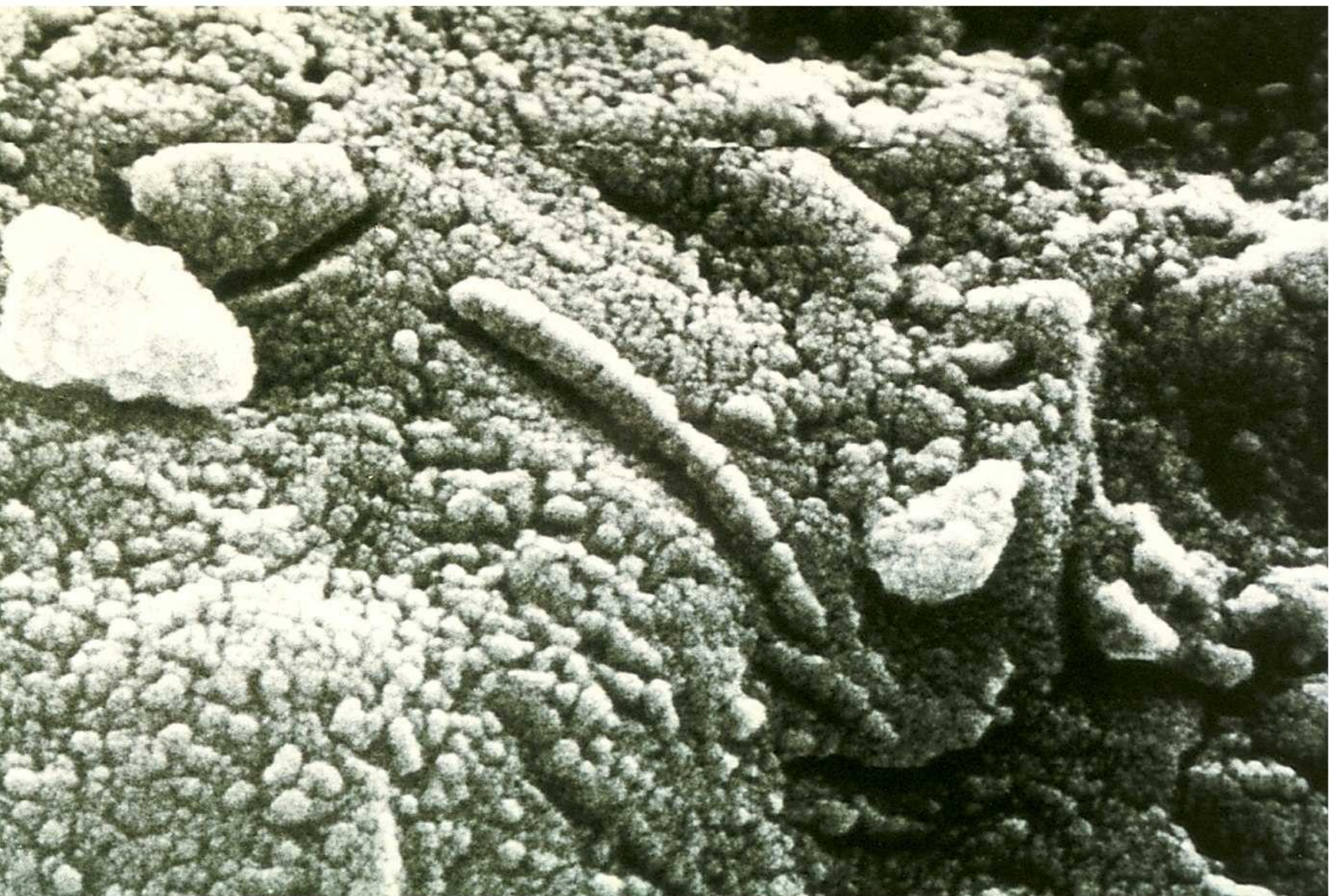
The program was produced by Mr. Welles and the Mercury Theatre on the Air over station WABC and the Columbia Broadcasting System's coast-to-coast network, from 8 to 9 o'clock.

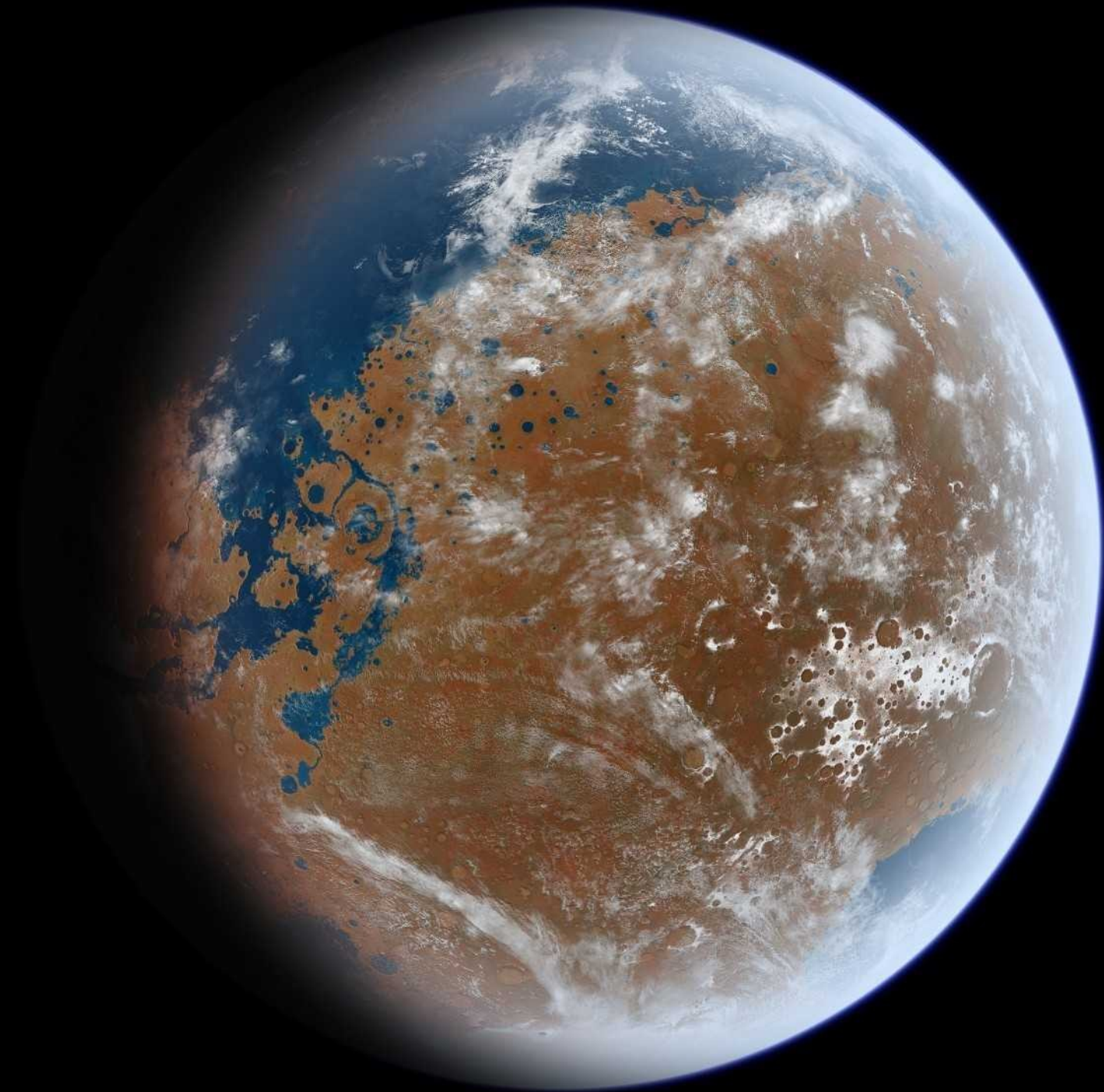


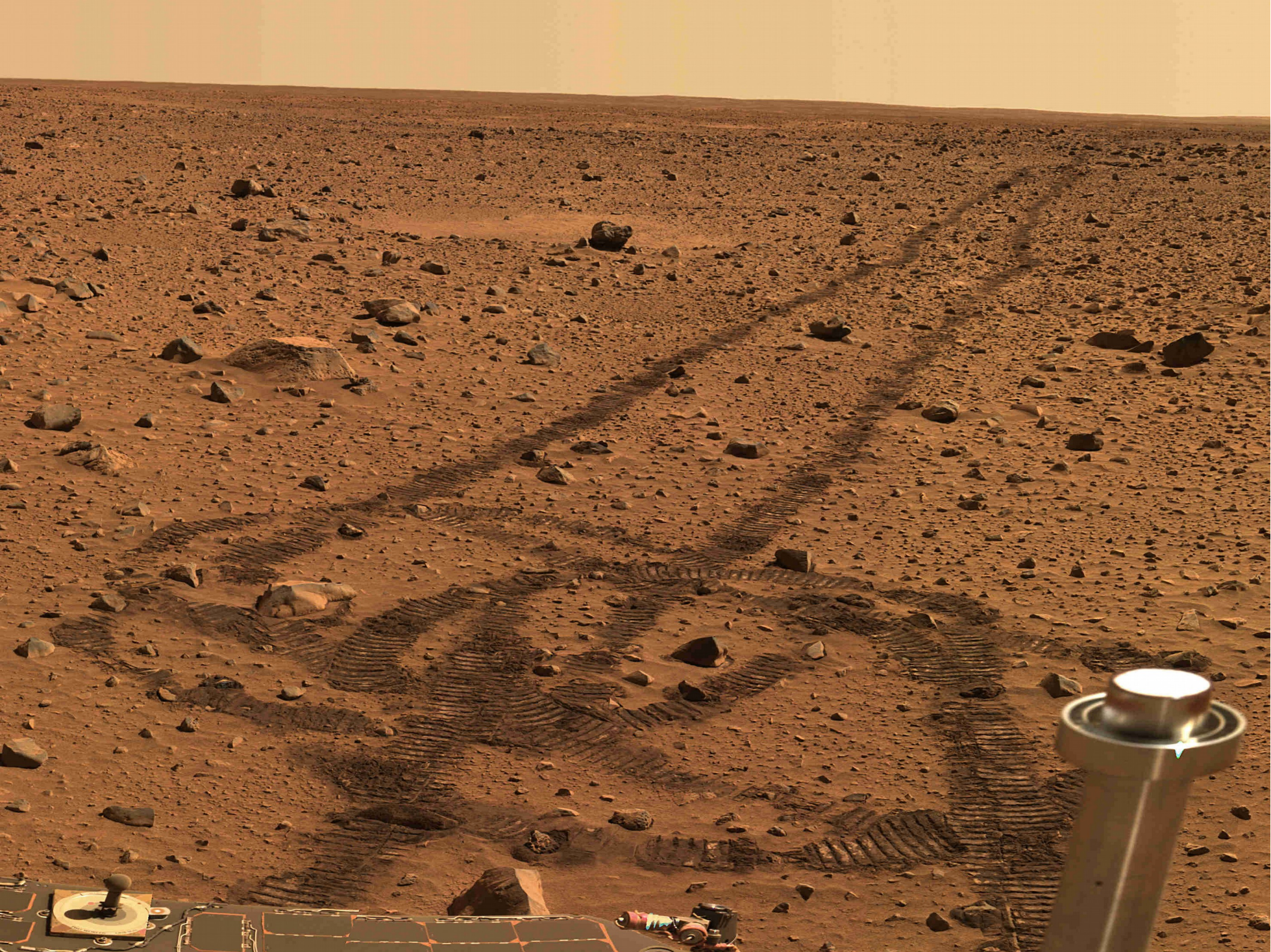




150 km









Don P. Mitchell

f_l = andelen beboeliga
planeter där livet
verkligen bildas

0.5 ?

0.01 ?

A man with white hair and glasses, wearing a dark suit, light blue shirt, and dark tie, is standing in front of a whiteboard. He is holding a white marker in his right hand. The whiteboard has some faint mathematical equations written on it, including $N = R \times p \times e \times i \times c$. The background is dark, and the man is looking towards the camera with a slight smile.

$f_i =$ andelen planeter med högt utvecklat liv (civilisationer)

$f_c =$ andelen civilisationer som avger uppfattningsbara signaler



Planeter är det gott om, men finns det andra civilisationer?

Drawing by Alan Dunn; © 1950, 1978
The New Yorker Magazine, Inc.

Fermis paradox:

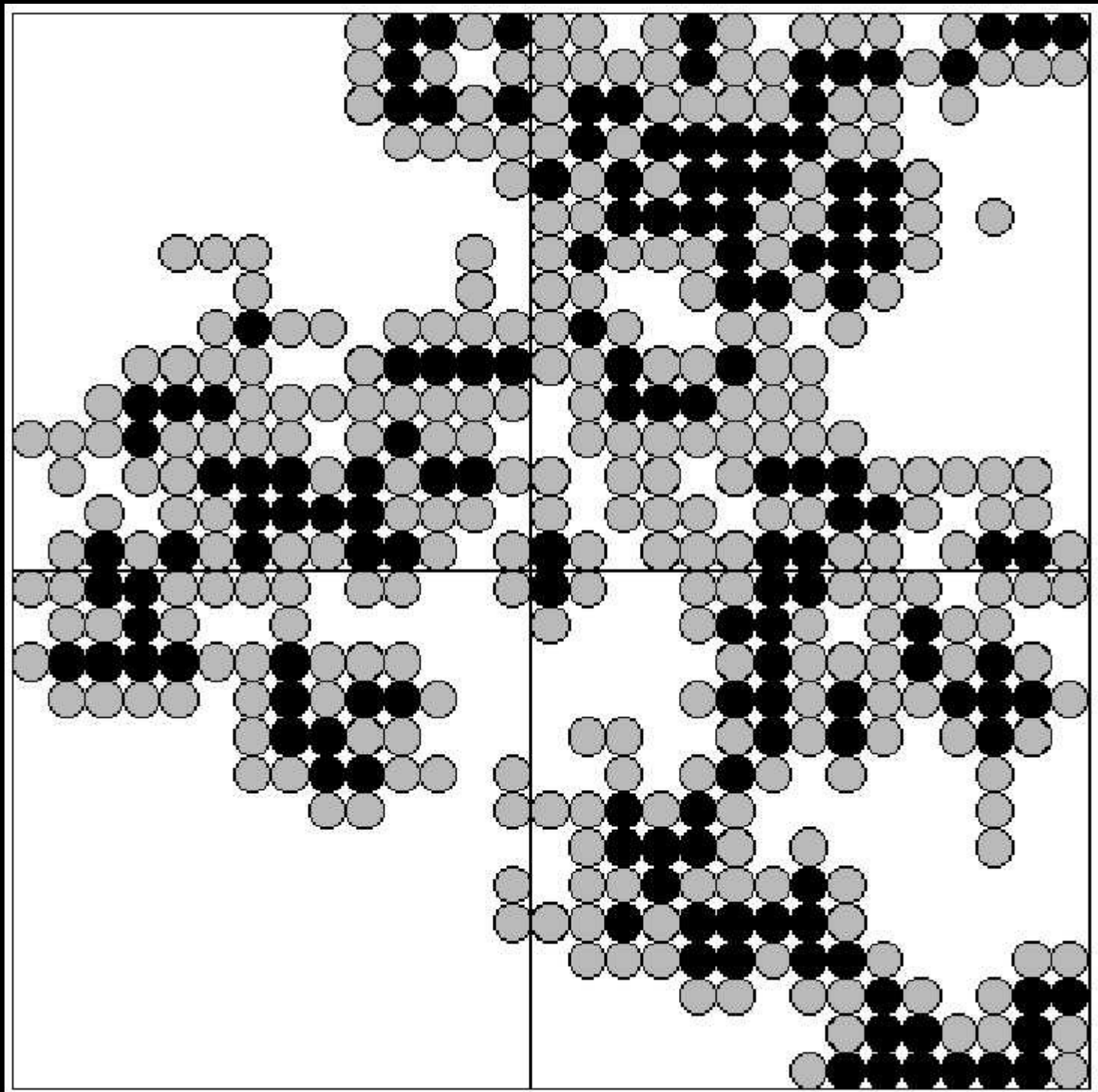
Var är de?



Drawing by Alan Dunn; © 1950, 1978
The New Yorker Magazine, Inc.

Förklaring? Det Stora Filtret

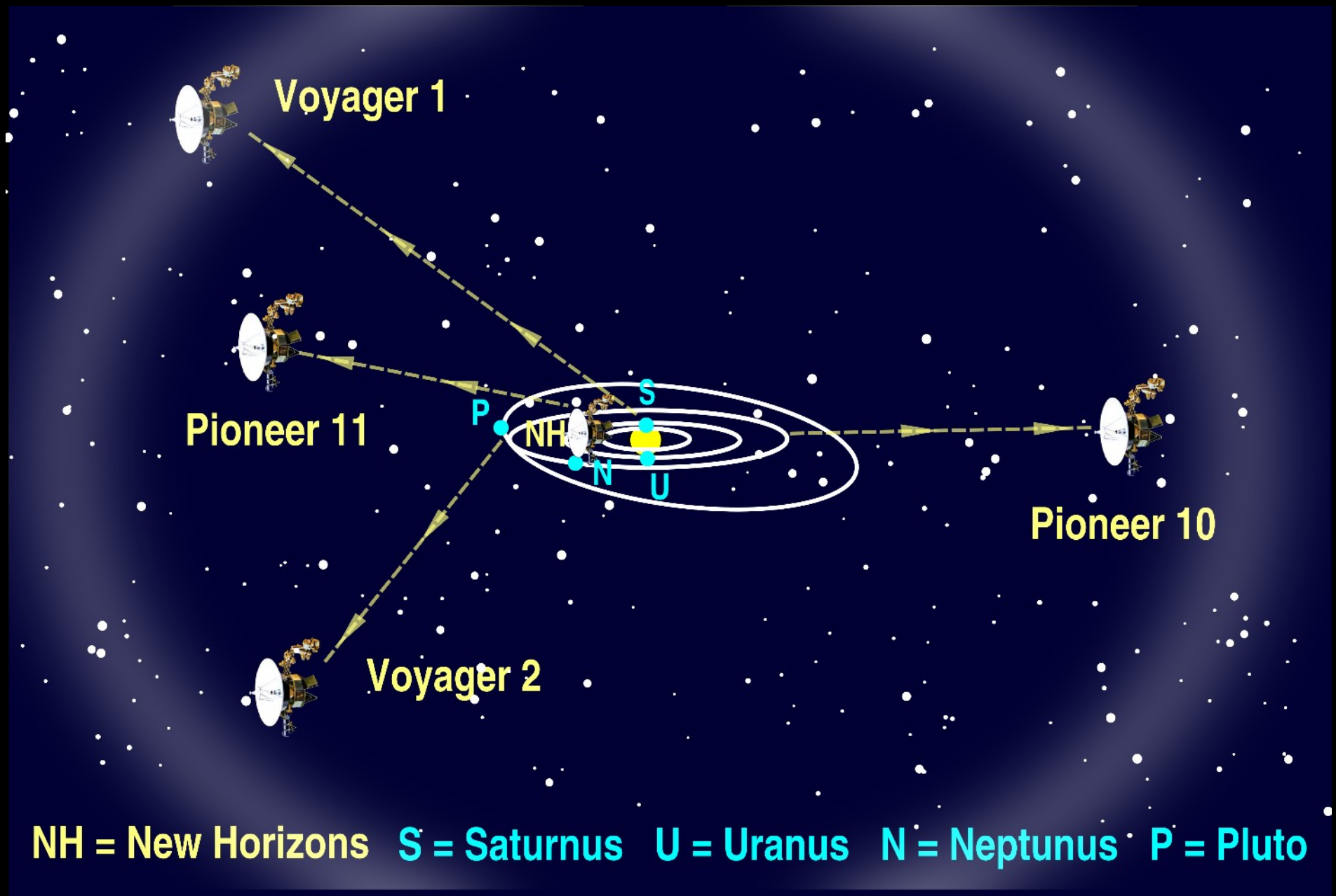
- *Det finns troligen massor av jordliknande planeter i galaxen*
- *På många av dessa bör livet ha uppkommit liksom på jorden*
- *Vi ser inga avancerade civilisationer – därför att de inte finns!*
- *Slutsats: Det måste finnas ett “filter”*
- *Finns det i vår historia – har vi passerat det?*
- *I så fall: Vi har en lysande framtid!*
- *Annars – filtret måste finnas vår framtid*
- *I så fall: Vår civilisation går under innan vi erövrat galaxen!*





**Vi kommunicerar själva
med universum**

Rymdsonder på flykt



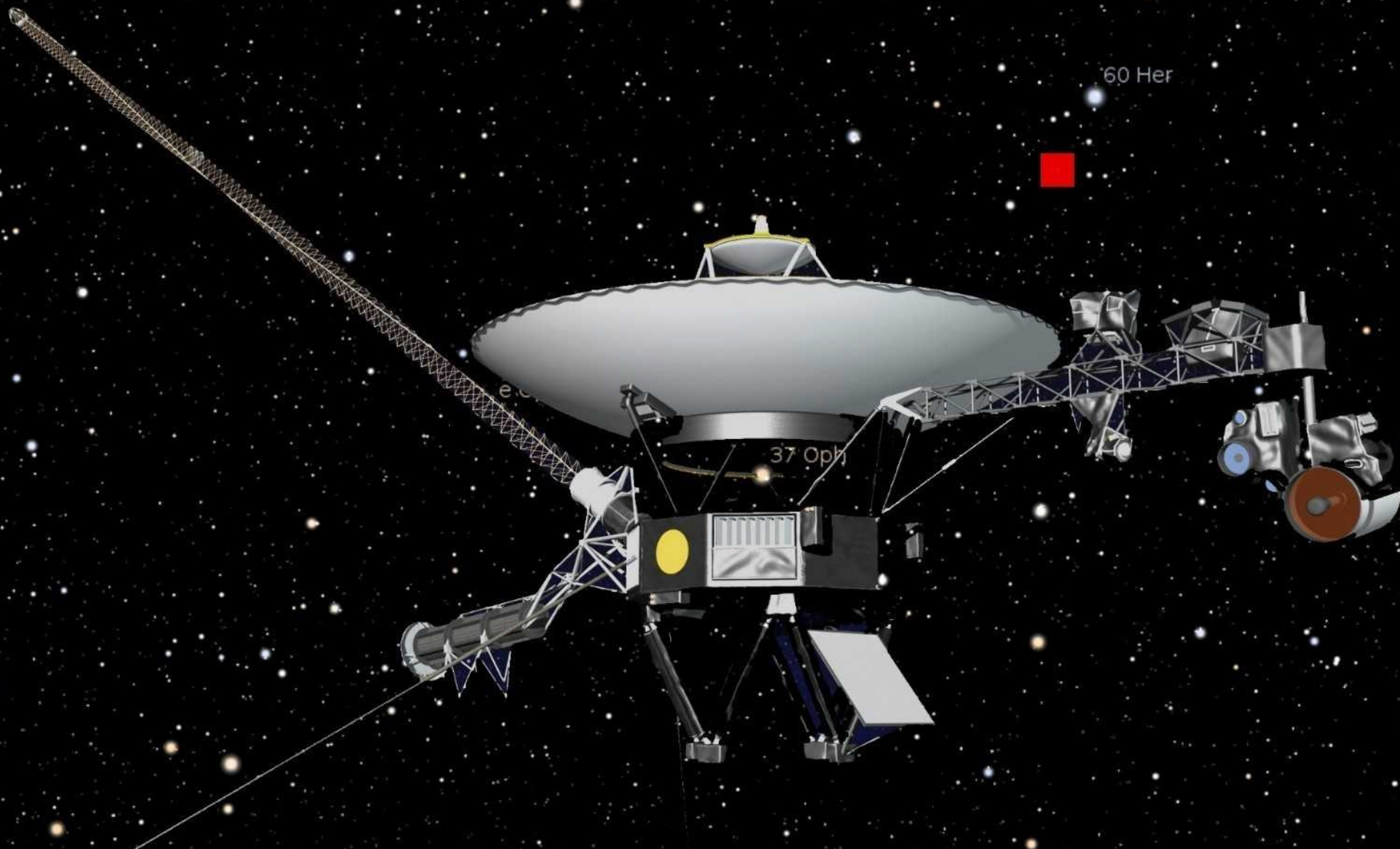
Rasalgethi

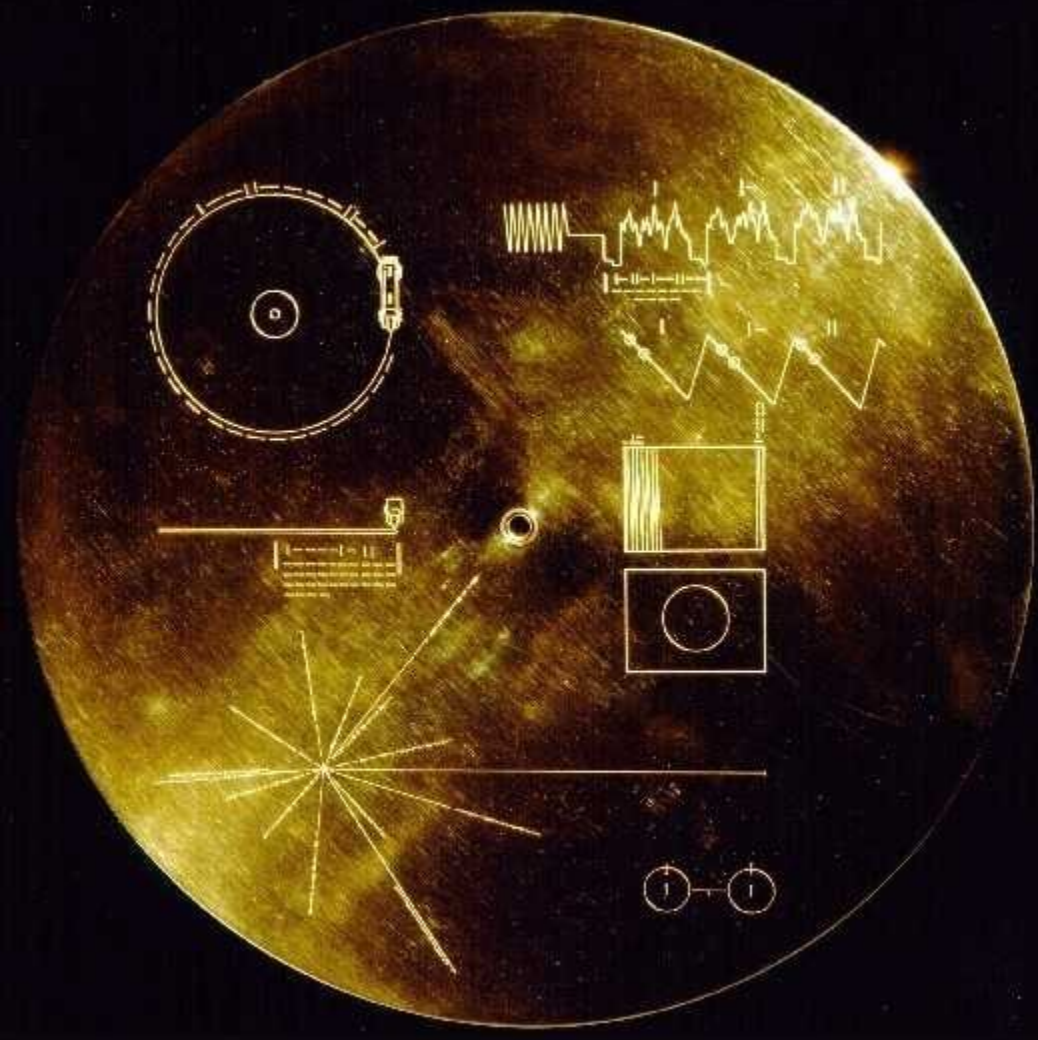
HIP.83430

60 Her

37 Oph

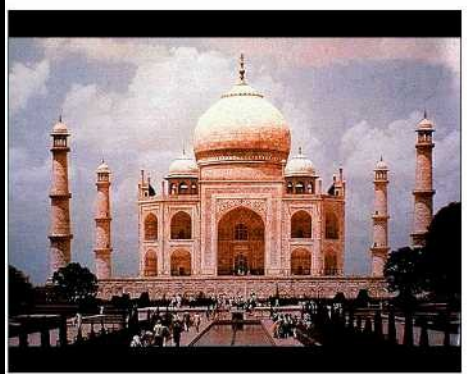
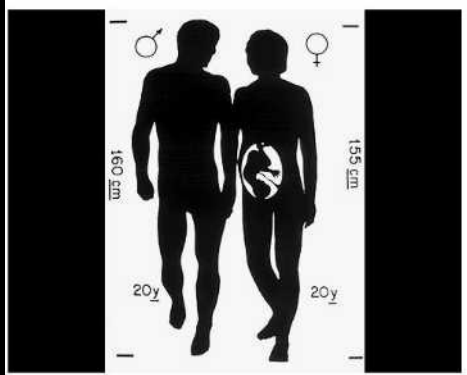
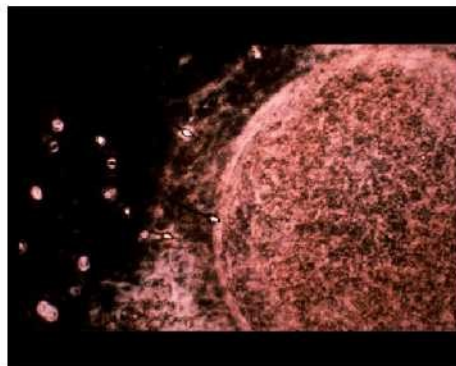
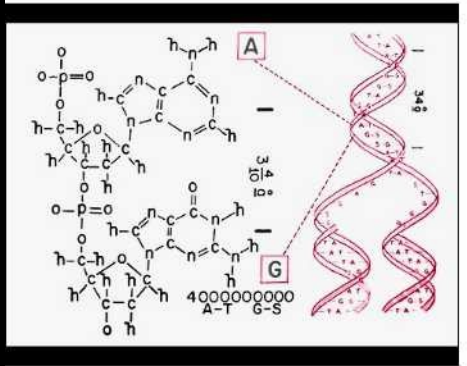
κ Op





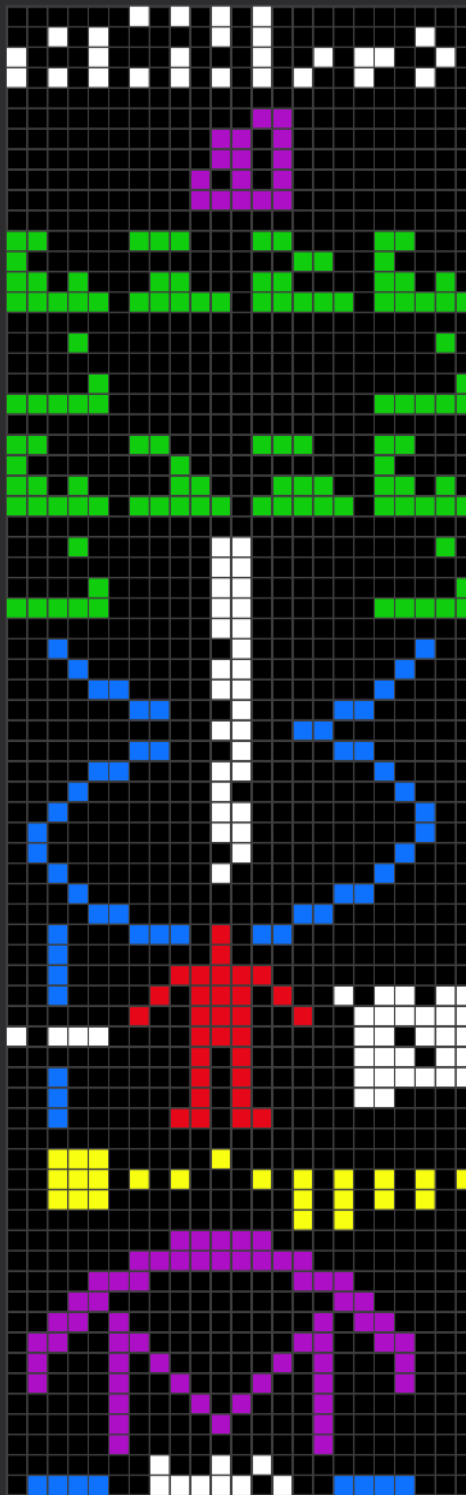
• = = 1	-- = 12	
•• = - = 2	--- = 24	
••• = = 3	-- = 100 = 10 ²	
•••• = - = 4	- = 1000 = 10 ³	
••••• = - = 5	2+3=5	
•••••• = - = 6	8+17=25	$5 + \frac{2}{3} = 5\frac{2}{3}$
= 7	$\frac{1}{2} + \frac{1}{3} = \frac{5}{6}$	2 x 3 = 6
- = 8	$\frac{1}{3} + \frac{1}{5} = \frac{8}{15}$	13 x 28 = 364
- = 9	$\frac{1}{3} + \frac{1}{5} = \frac{8}{15}$	
- = 10		

$1\text{M} = 10^6$	$1\text{L} = 10^3$	$1\text{L} = 10^3$
$1\frac{42}{100} \times 10^9 \text{t} = 1\text{s}$	$\frac{1}{21} \text{L} = 1\text{cm}$	
$86400\text{s} = 1\text{d}$	$1\text{L} = 21 \times 10^8 \text{g}$	
$365\text{d} = 1\text{y}$	$10^2 \text{cm} = 1\text{m}$	
$6 \times 10^{23} \text{M} = 1\text{g}$	$1000\text{m} = 1\text{km}$	
$1000\text{g} = 1\text{kg}$		
$6 \times 10^{27} \text{g} = 1\text{e}$		





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01000000001000000001000
00100000001000000010000
00010000000000001100000
00001100000001100000000
00100011010111000000000
001000000010000000000000
00100000111100000000000
00100001011101001011011
00000010011100100111111
10111000011100000110111
00000000010100000111011
00100000010100000111111
00100000010100000110000
00100000110110000000000
000000000000000000000000
001110000010000000000000
00111010100010101010101
00111000000000101010100
000000000000000101000000
000000001111110000000000
000000111111111000000000
000011100000001110000000
00011000000000011000000
00110100000000010110000
011001100000000110011000
01000101000001010001000
01000100100010010001000
00000100010100010000000
00000100001000010000000
00000100000000010000000
00000001001010000000000
01111001111101001111000
```



Talen 1 - 10 i binär kod

Atomnummer för livets viktigaste ämnen

Kemiska beteckningar för DNA-molekyler

Antalet nukleotider i mänskligt DNA

DNA:s spiralstruktur

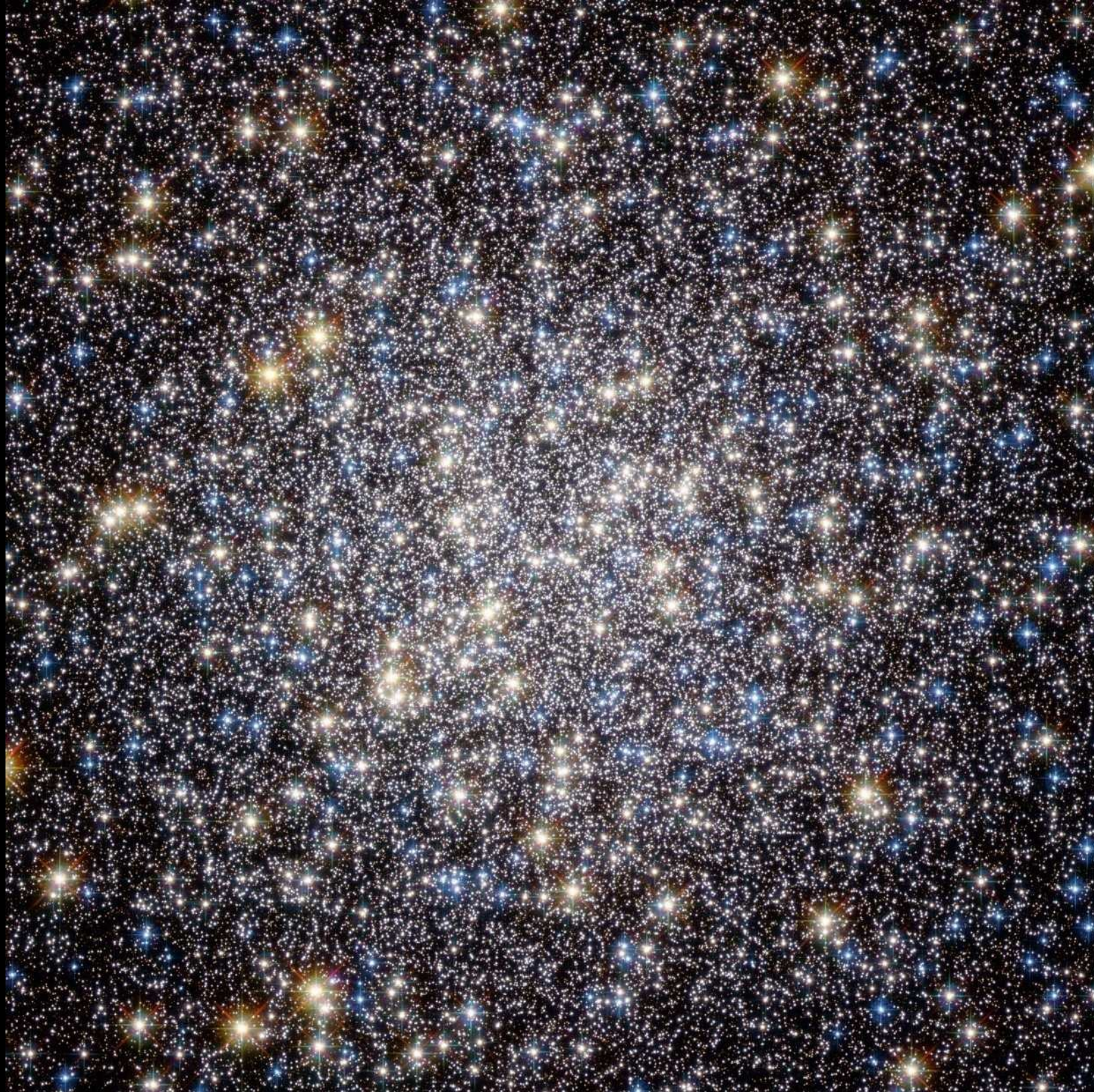
Människofigur

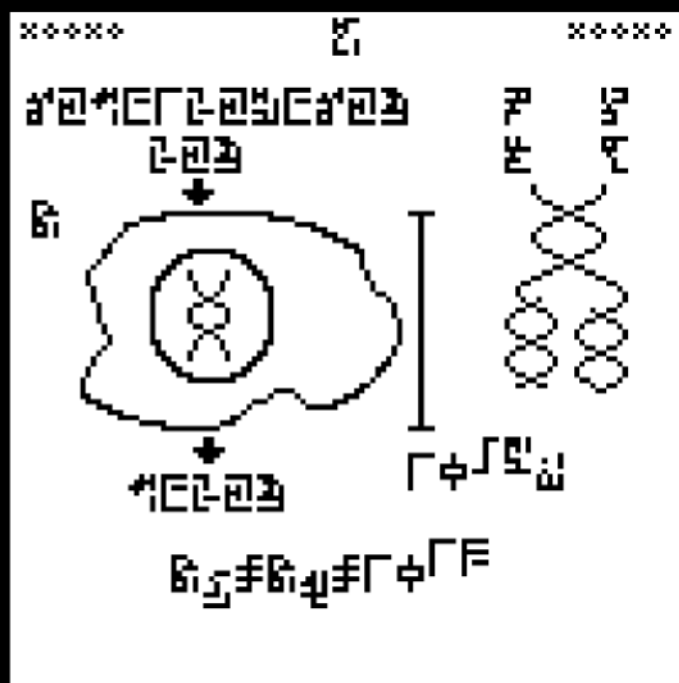
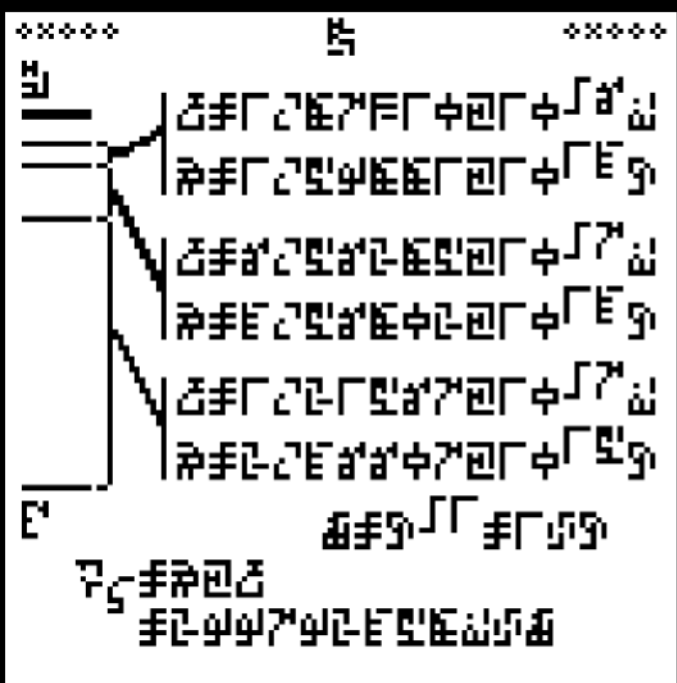
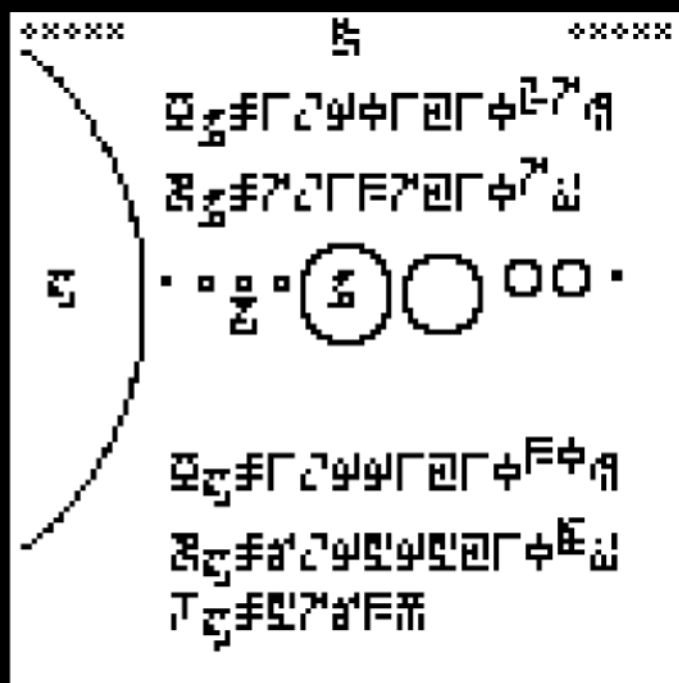
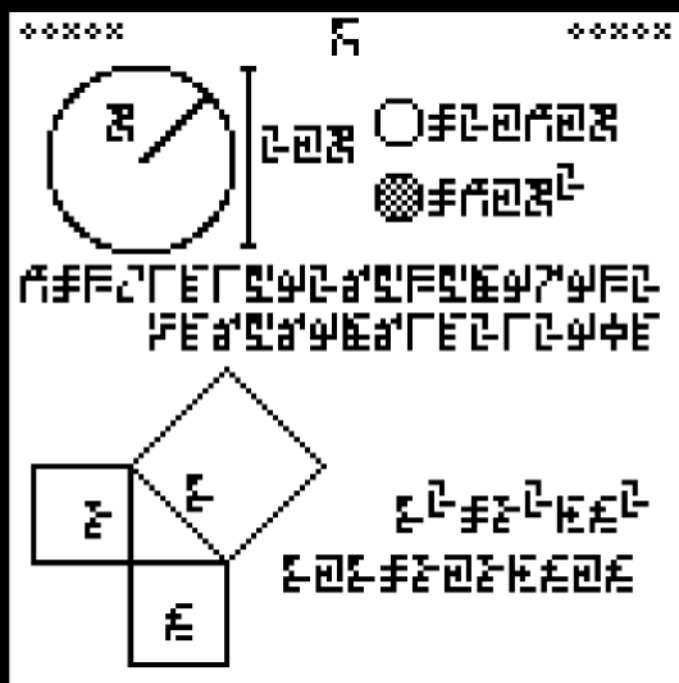
Talen 14 och 4 miljarder

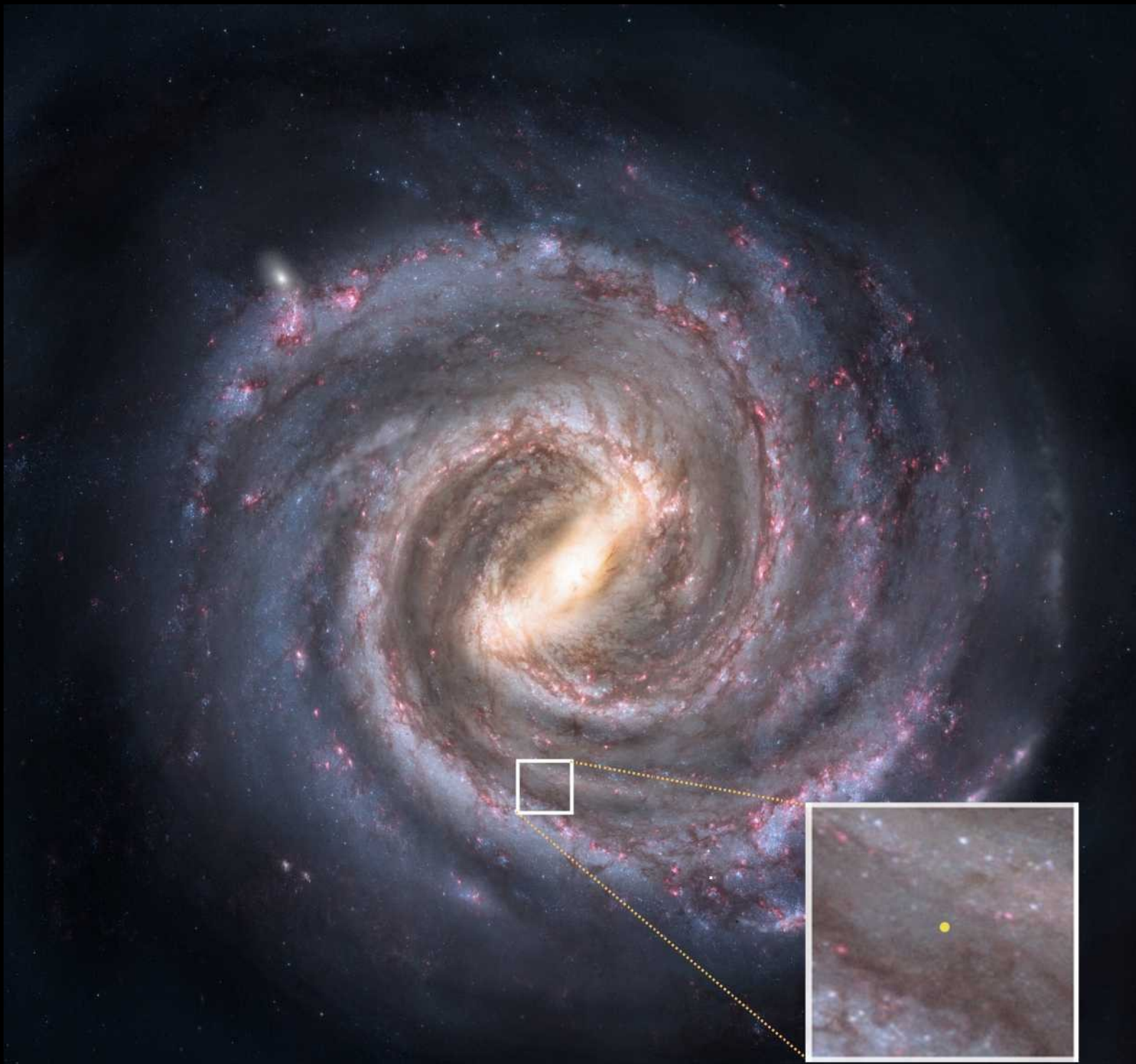
Figur över solsystemet

Areciboteleskopet med signalutsändning

Talet 2430









SETI

**– att lyssna efter
intelligenta signaler**



Wow!

1		2		1	4	3
1	16	1		1	1	
1	11	1		1	11	1
	1				3	1
1	24	3	12	1	21	1
Q	1	6	1	2	1	1
U	31	1		3	7	1
J	1	31	3	111	11	1
5	1				1	1
	14	1		113	2	11
1	3	1		1	1	
1	4		1	1	1	11
	4	1	1	1	11	111
	1			1		1
1	1	1			11	2
	1					1
	1					14

Allen Telescope Array (ATA-42)



Meddelande	Objekt	Stjärnbild	Sändes	Tas emot(?)
Arecibomeddelandet	Messier 13	Herkules	16 nov, 1974	Ca 27000
<i>Cosmic Call 1</i>	16 Cyg A	Svanen	24 maj, 1999	Nov 2069
	15 Sge	Pilen	30 jun, 1999	Feb 2057
	HD 17842	Pilen	30 jun, 1999	Okt 2067
	GI 777	Svanen	1 jul, 1999	Apr 2051
<i>Teen Age Message</i>	HD 197076	Delfinen	29 aug, 2001	Feb 2070
	47 UMa	Stora Björnen	3 sep, 2001	Jul 2047
	37 Gem	Tvillingarna	3 sep, 2001	Dec 2057
	HD 126053	Jungfrun	3 sep, 2001	Jan 2059
	HD 76151	Hydran	4 sep, 2001	Maj 2057
	HD 193664	Draken	4 sep, 2001	Jan 2059
<i>Cosmic Call 2</i>	HIP 4872	Cassiopeia	6 jul, 2003	Apr 2036
	HD 245409	Orion	6 jul, 2003	Aug 2040
	55 Cnc	Kräftan	6 jul, 2003	Maj 2044
	HD 10307	Andromeda	6 jul, 2003	Sept 2044
	47 UMa	Stora Björnen	6 jul, 2003	Maj 2049
<i>Across the Universe</i>	Polstjärnan	Lilla Björnen	4 feb, 2008	Ca 2439
<i>A Message From Earth</i>	Gliese 581	Vågen	9 okt, 2008	Mar 2029
<i>Hello from Earth</i>	Gliese 581	Vågen	28 aug, 2009	Jan 2030

Meddelande	Namn	Stjärnbild	Sändes	Tas emot(?)
Arecibomeddelandet	Messier 13	Herkules	16 nov, 1974	Ca 27000
<i>Cosmic Call 1</i>	16 Cyg A	Svanen	24 maj, 1999	Nov 2069
	15 Sge	Pilen	30 jun, 1999	Feb 2057
	HD 17842	Pilen	30 jun, 1999	Nov 2067
	GI 777	Svanen	1 jul, 1999	Apr 2051
<i>Teen Age Message</i>	HD 197076	Delfinen	9 aug, 2001	Feb 2070
	47 UMa	Stora Björnen	3 sep, 2001	Jul 2047
	37 Gem	Villingarna	2 sep, 2001	Dec 2057
	HD 120953	Julstjärn	3 sep, 2001	Jan 2059
	HD 76193	Hydran	4 sep, 2001	Maj 2057
	HD 193664	Draken	4 sep, 2001	Jan 2059
<i>Cosmic Call 2</i>	HIP 4872	Cassiopeia	6 jul, 2003	Apr 2036
	HD 245409	Orion	6 jul, 2003	Aug 2040
	55 Cnc	Kräftan	6 jul, 2003	Maj 2044
	HD 10307	Andromeda	6 jul, 2003	Sept 2044
	47 UMa	Stora Björnen	6 jul, 2003	Maj 2049
<i>Across the Universe</i>	Polstjärnan	Lilla Björnen	4 feb, 2008	Ca 2439
<i>A Message From Earth</i>	Gliese 581	Vår	2 okt, 2008	Maj 2008

Är det rätt att sända meddelanden till andra civilisationer?

$f_c =$ andelen civilisationer som
avger uppfattningsbara
signaler

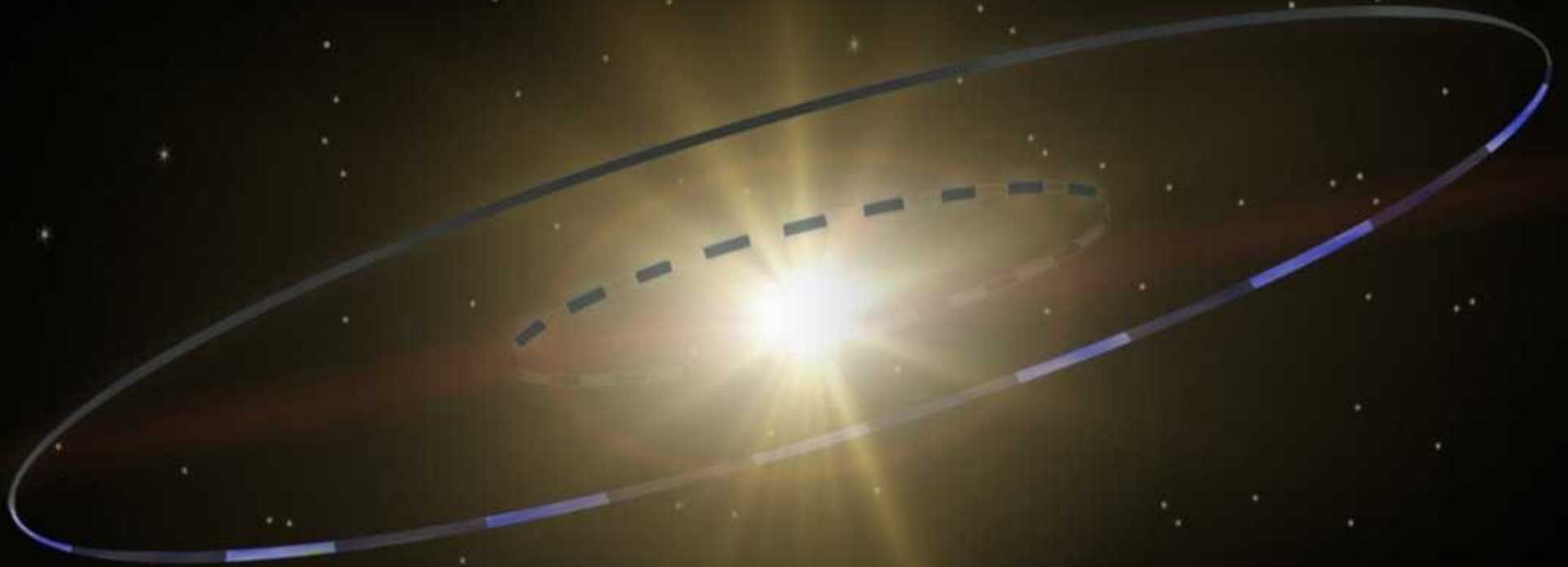
0.5 ??

0.5 ??

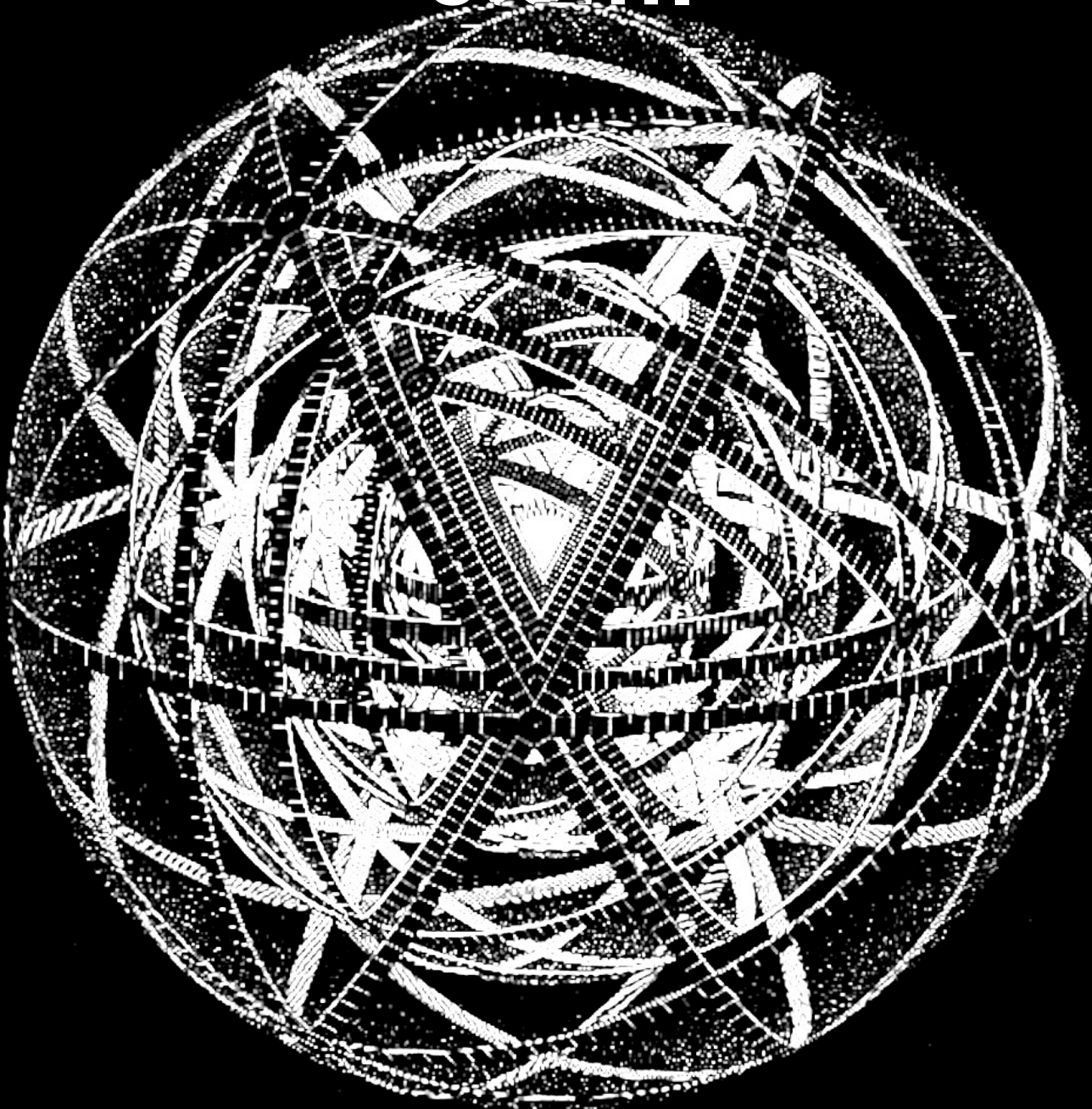
A man with white hair and glasses, wearing a dark suit, light blue shirt, and dark tie, is writing on a whiteboard. The whiteboard has some faint, illegible markings. The background is dark.

**L = medeltiden för hur länge
sådana civilisationer
existerar**

”Ringworld”



Dyson sfärer, multipla ringvärldar, etc....





Camila
11 år

Luna 12 år



Sissel 22

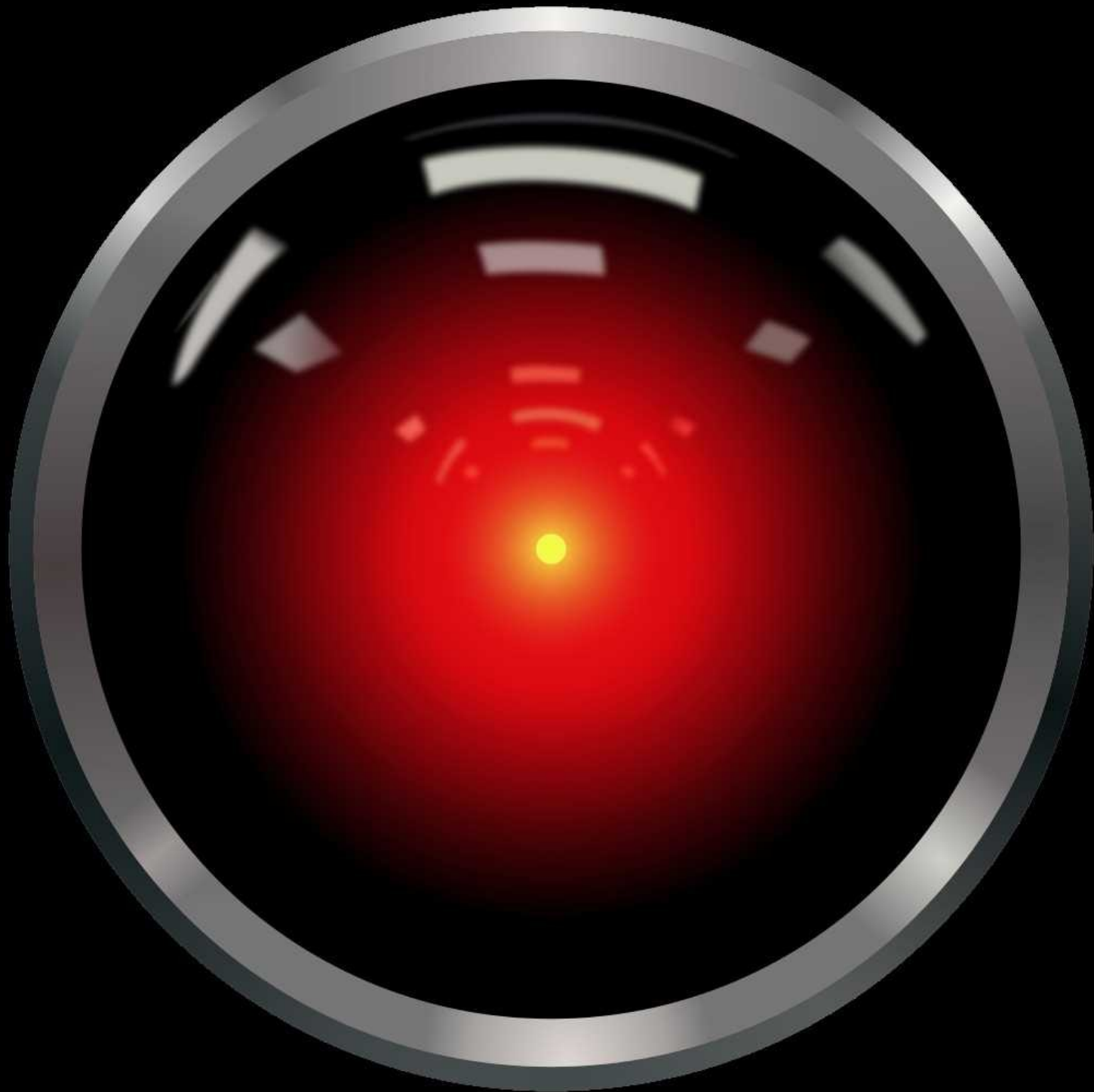
Madeline 10 år





E. Smit





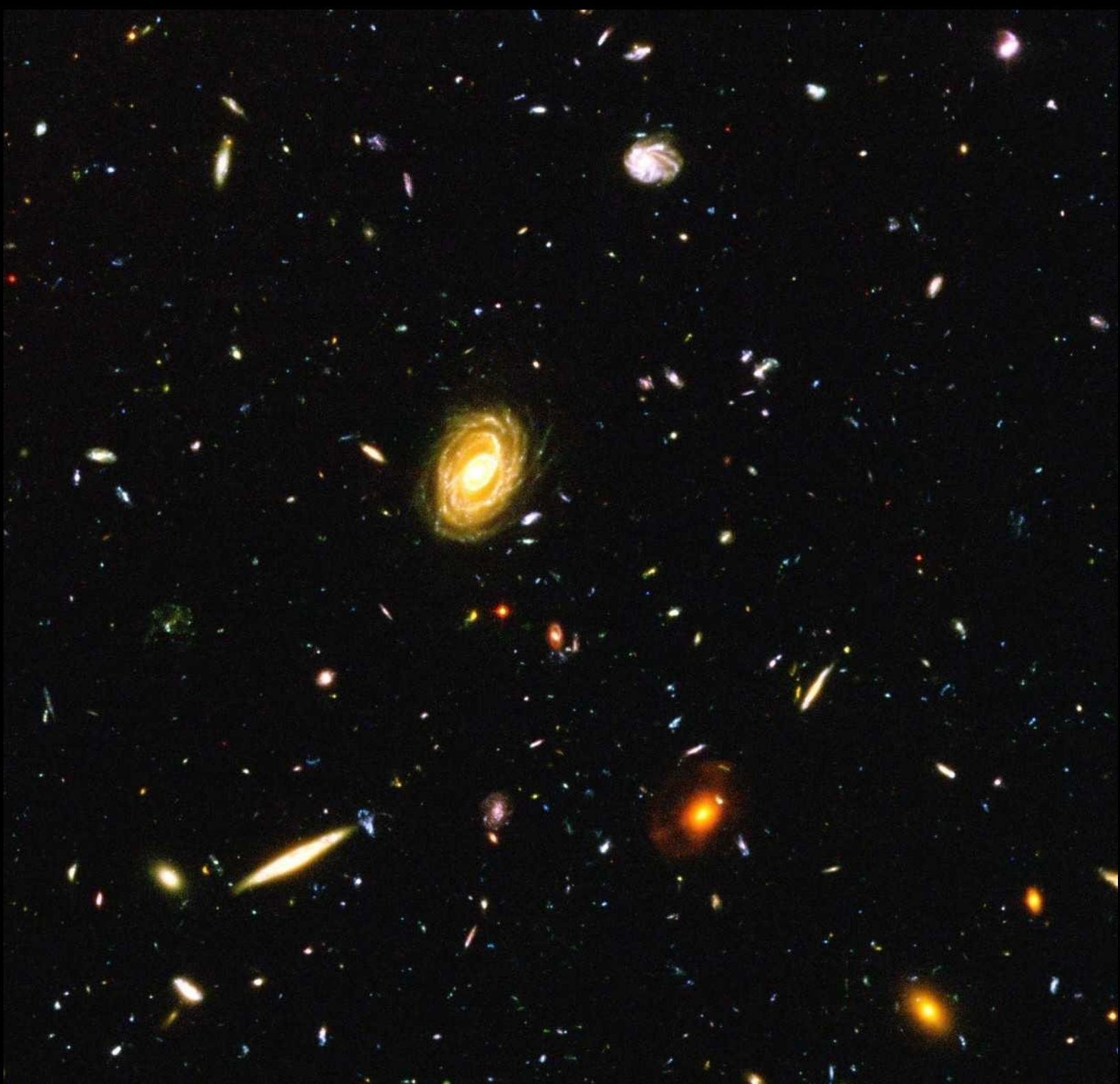


**Finns det en jordisk
superintelligens år 2050?**

N = antal "samtidiga" civilisationer
i Vintergatan med
detekterbara signaler

13 125 !

1 !



Alltså: Finns det liv i universum?

- Det finns 100 miljarder galaxer
- Det finns 100 miljarder stjärnor i varje galax
- De flesta stjärnor har planeter

Livet bör inte bara ha uppkommit på jorden!

... men det kan vara långt mellan civilisationerna, både i tid och rum!

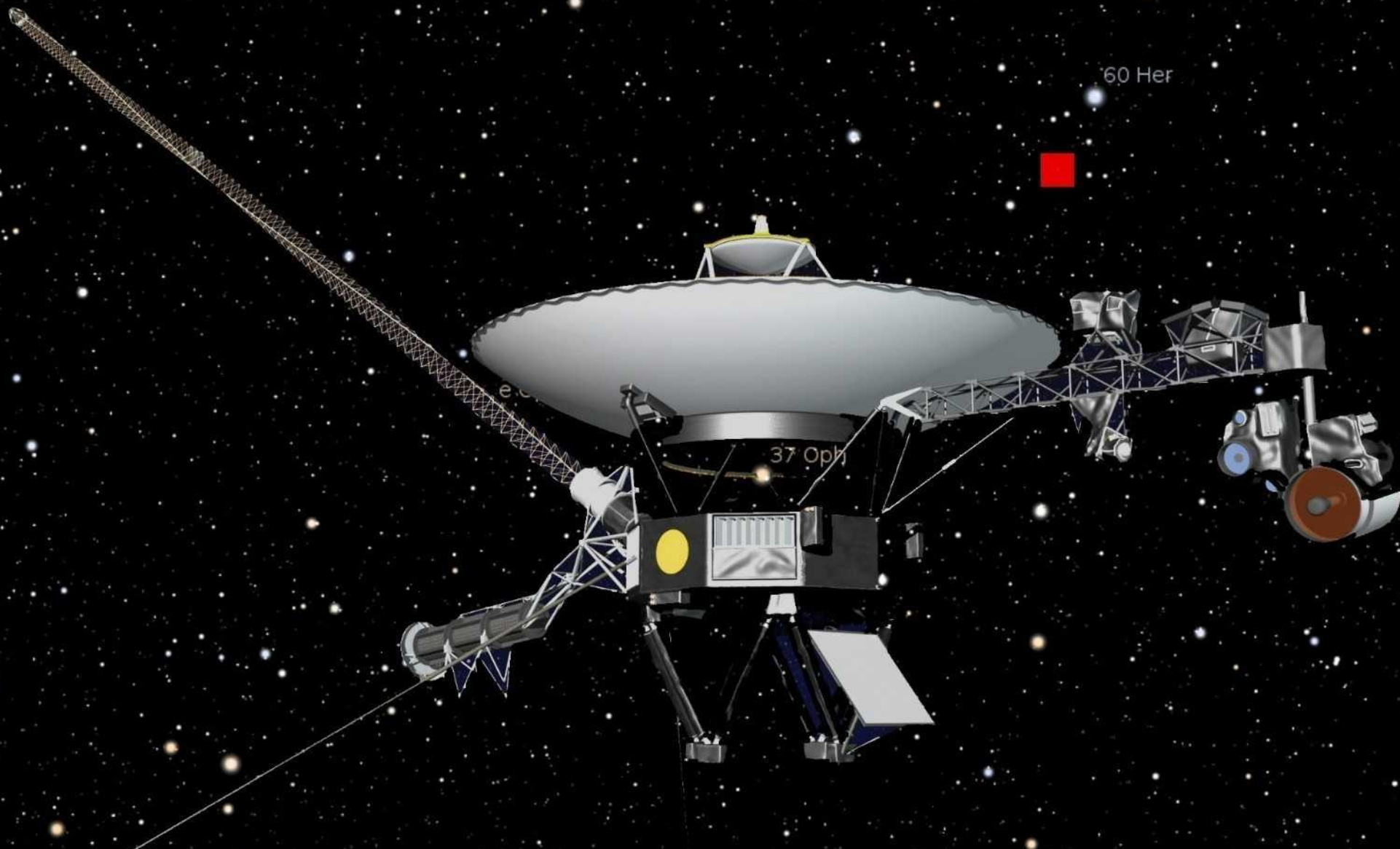
Rasalgethi

HIP.83430

60 Her

37 Oph

κ Op



JAKTEN PÅ LIV I UNIVERSUM

[HEM](#)[BOKEN](#)[FÖRFATTAREN](#)[BOKTIPS](#)[TIDSKRIFTER](#)[BLOGGAR](#)[ORGANISATIONER](#)[FORSKA SJÄLV](#)[ERRATA](#)[KONTAKT](#)

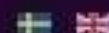
HEM

[ETT KOSMISKT PERSPEKTIV](#)[HUR BILDAS ETT PLANETSYSTEM?](#)[LIVETS UTVECKLING PÅ JORDEN](#)[UTOMJORDISKT LIV PÅ NÄRA HÅLL](#)[EXOPLANETER - FRÅN SPEKULATION TILL VERKLIGHET](#)[ETT MENAGERI AV EXOPLANETER](#)[EXOPLANETER - I FRAMTIDEN](#)[LIVSTECKEN FRÅN JORDEN](#)[HUR MANGA CIVILISATIONER FINNS DET?](#)

Välkommen!

Välkommen till [peterlinde.net](#). Denna webbplats är avsedd att fungera som ett komplement till min bok "Jakten på liv i universum", utgiven på **Karavans förlag** i Lund. Här finns plats för bakgrundsmaterial i form av litteraturtips och länkar till information på nätet. Mycket av detta har jag själv använt som underlag till boken. Flera av de områden som berörs utvecklas mycket snabbt, framför allt gäller detta forskningen inom exoplanetområdet. Praktiskt taget dagligen presenteras nya upptäckter, så att en bok som diskuterar exoplaneter riskerar att snart bli inaktuell. Förhoppningen är att aktuell information ska vara tillgänglig här.

Varje kapitel i boken har en motsvarighet på denna webbplats. Det finns en liten introduktion och efterhand kommer kortare nyhetsartiklar att dyka upp. Välkommen att ge synpunkter i kommentarsfälten. Det finns också ett antal frågeställningar att grubbla på och tillfälle till att ge sin egen åsikt.



ANTAL KÄNDA EXOPLANETER

22 Aug 2013 - 940

SENAST INLAGT

- Kepler kan inte repareras
- Signaler skickas till Gilese 526
- Recensioner och Media
- Kepler har problem
- SVT: "En bok, en författare"
- Astronomiträff i Karlskrona
- P1:s "Vetandets Värld" om liv i universum (1 och 2)
- Malmö bokdagar
- Panspermiteorin får





Tack så mycket!