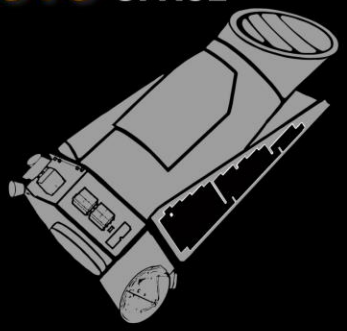
Kepler
BY THE NUMBERS

9.6 YEARS IN SPACE

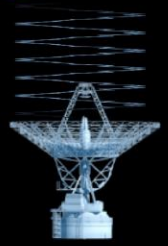


2 MISSIONS COMPLETED

3.12 GALLONS FUEL USED

530,506 STARS OBSERVED

678 GB SCIENCE DATA COLLECTED

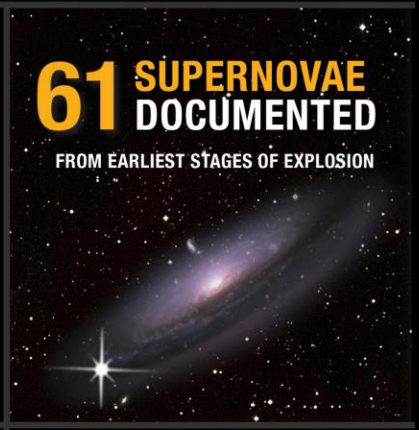


2,662 PLANETS CONFIRMED

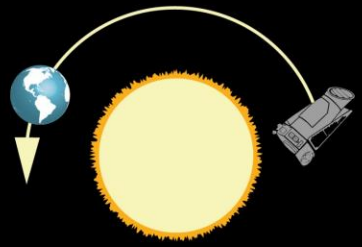
2,946 SCIENTIFIC PAPERS PUBLISHED

732,128 COMMANDS EXECUTED

61 SUPERNOVAE DOCUMENTED
FROM EARLIEST STAGES OF EXPLOSION



94 MILLION MILES AWAY

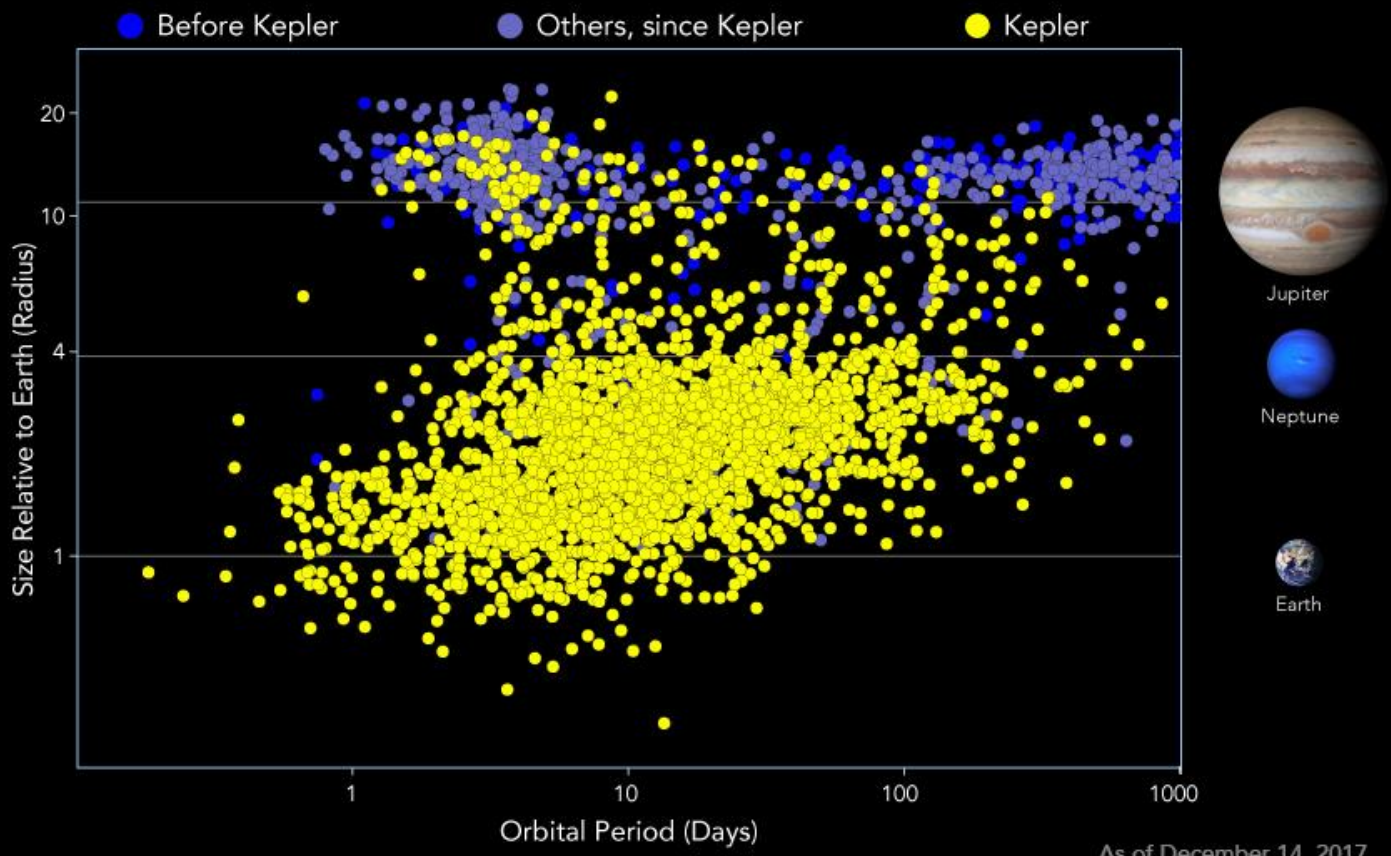


www.nasa.gov/kepler

As of October 24, 2018

@NASAKepler

Exoplanet Discoveries

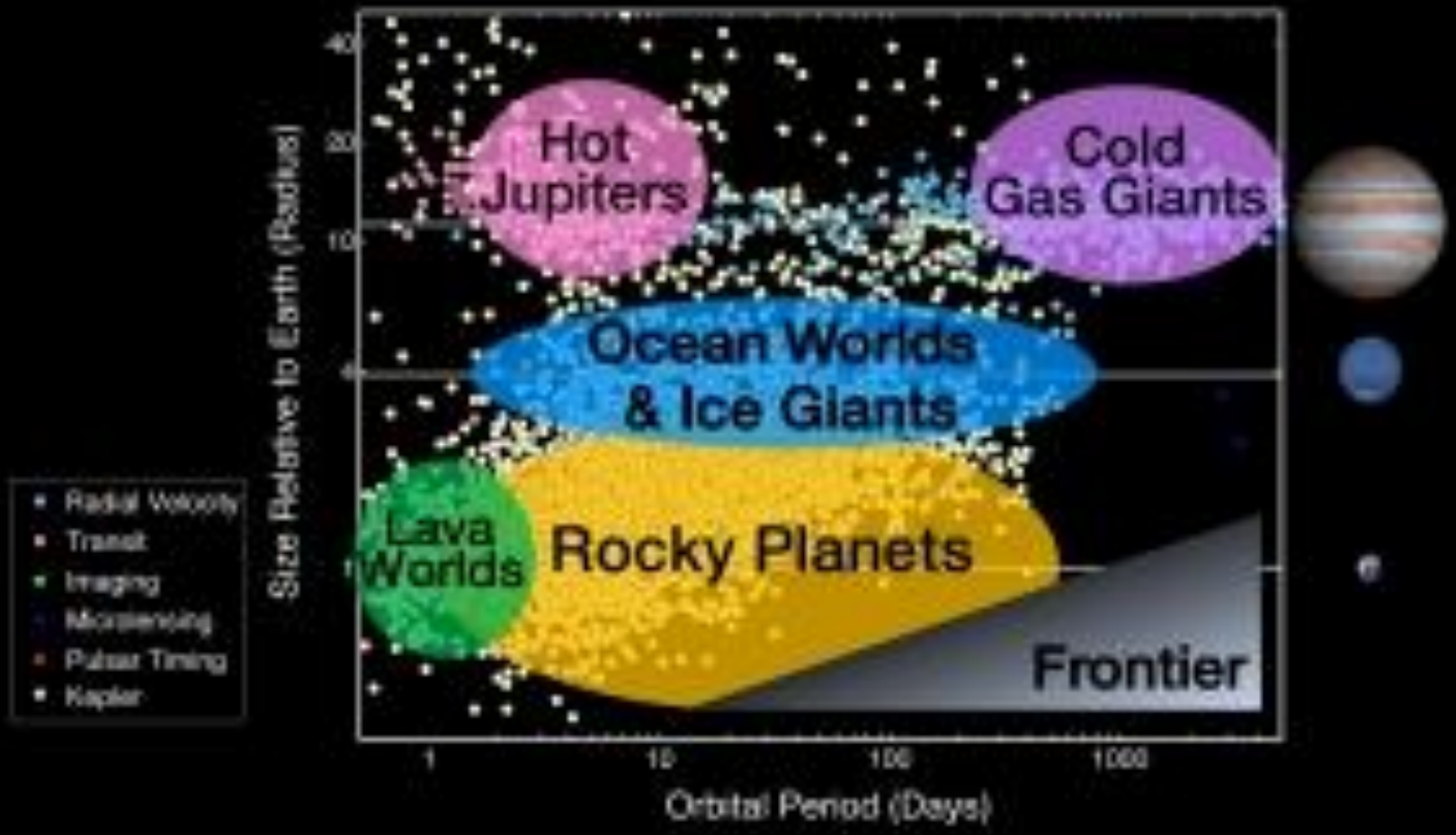


Total confirmed exoplanets = 3,567

Total Kepler = 2,525

As of December 14, 2017

Exoplanet Populations



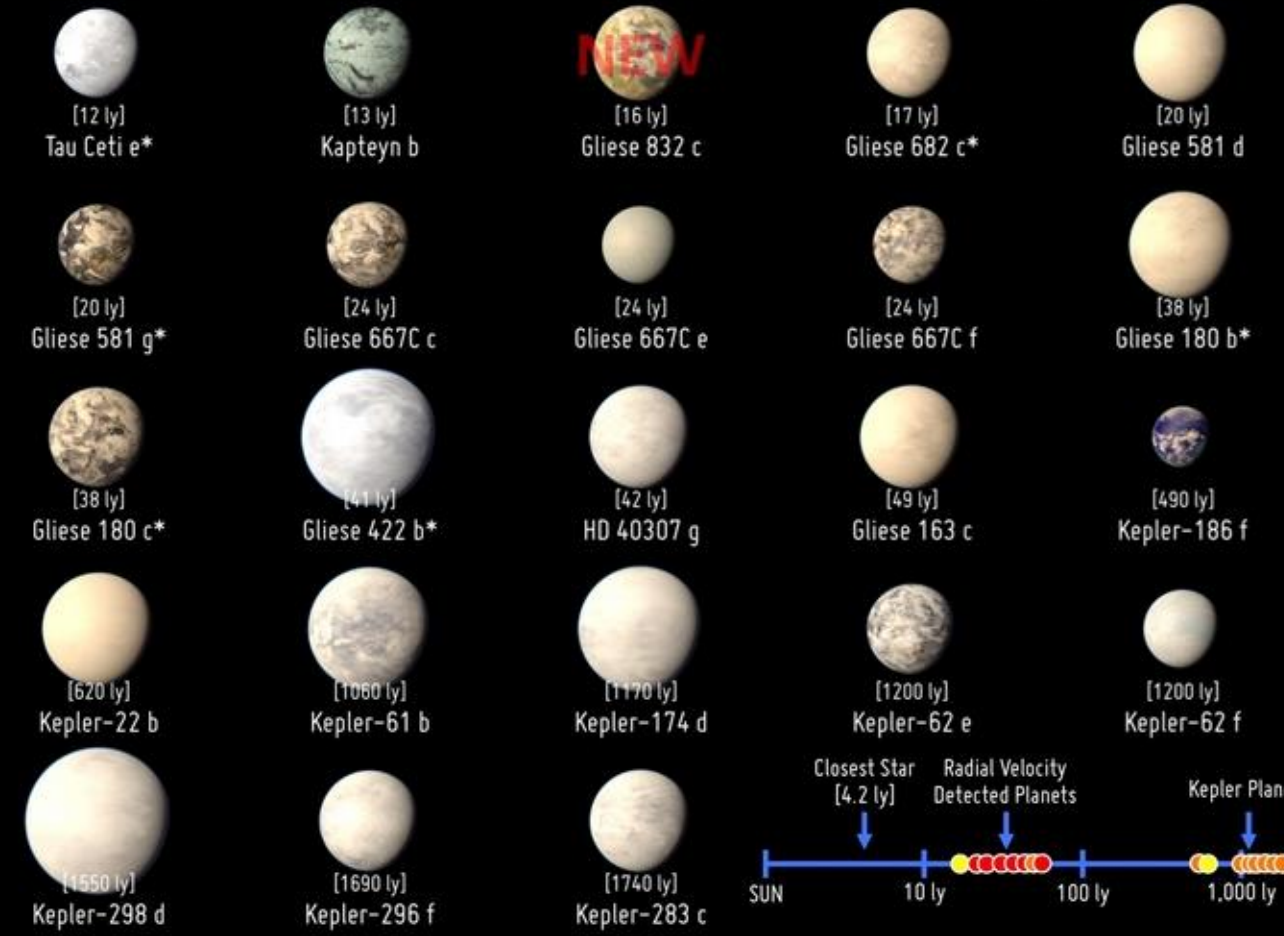
6500
5500
4500
3500
Surface Temperature of Star (K)
Earth's Solar System
Inner Planets
MERCURY
VENUS
MARS
Kepler-186 Planets
b
c
d
e
Kepler-186f
0.1
1.0
Distance from Star (AU)

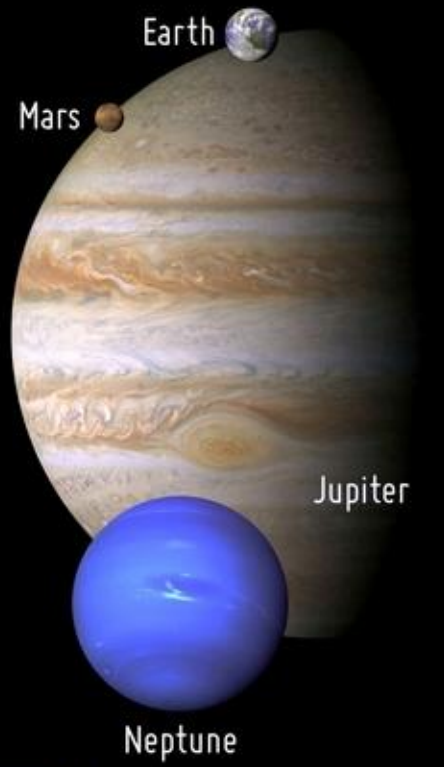
Current Potentially Habitable Exoplanets

Ranked by Distance from Earth in Light Years (ly)

PHL
MAPPING THE HABITABLE UNIVERSE

ARTISTIC REPRESENTATIONS





*planet candidates

CREDIT: PHL @ UPR Arecibo (phl.upr.edu) June 25, 2014

Habitable Exoplanets Catalog

Last Update: December 5, 2019

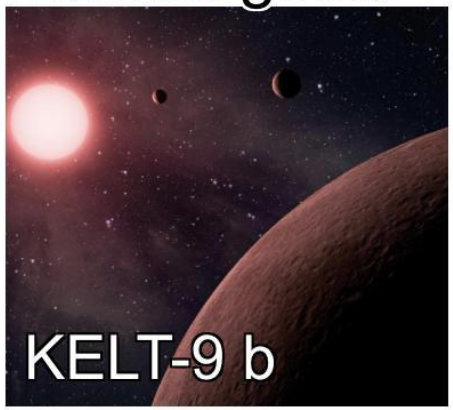
Current Number of Potentially Habitable Exoplanets

Subterran (Mars-size)	Terran (Earth-size)	Superterran (Super-Earth/Mini-Neptunes)	Total
1	20	34	55

subterran = 0.1 — 0.5 M_E or 0.4 — 0.8 R_E, **terran** = 0.5 — 5 M_E or 0.8 — 1.5 R_E, **superterran** = 5 — 10 M_E or 1.5 — 2.5 R_E. M_E = Earth masses, and R_E = Earth radii.

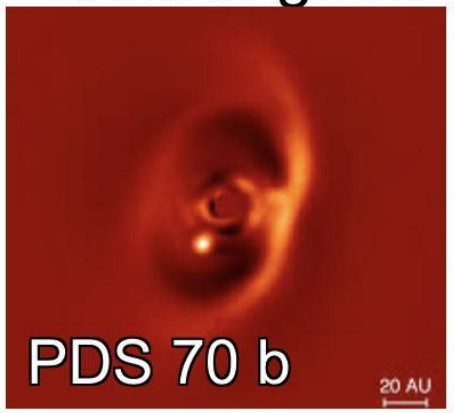
#3
James Webb and planet characterization

lawful good



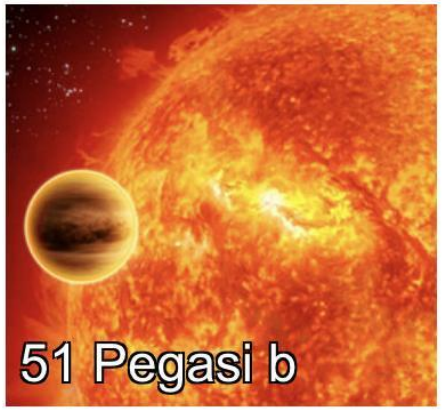
neutral good

chaotic good



lawful neutral

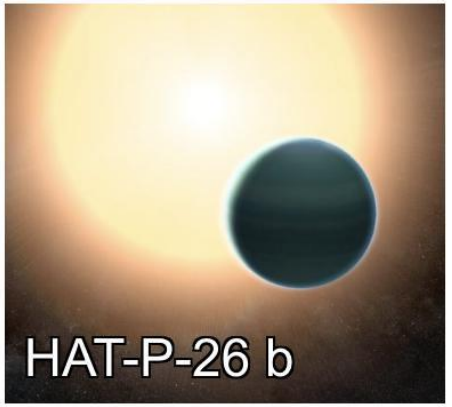
true neutral



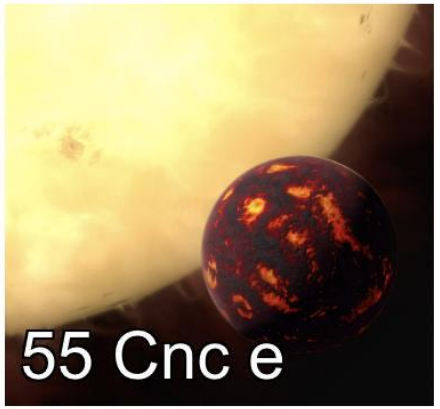
chaotic neutral

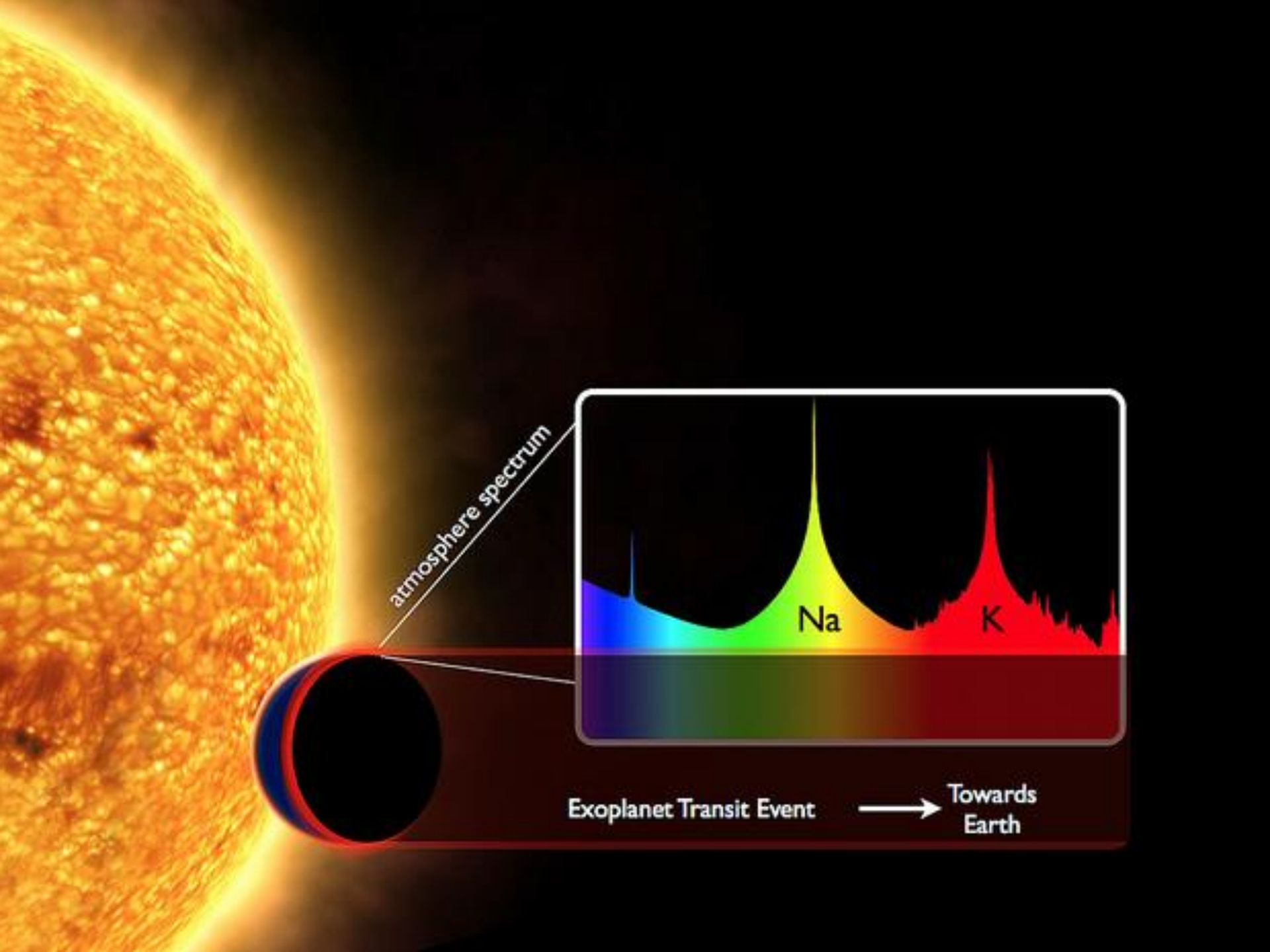
lawful evil

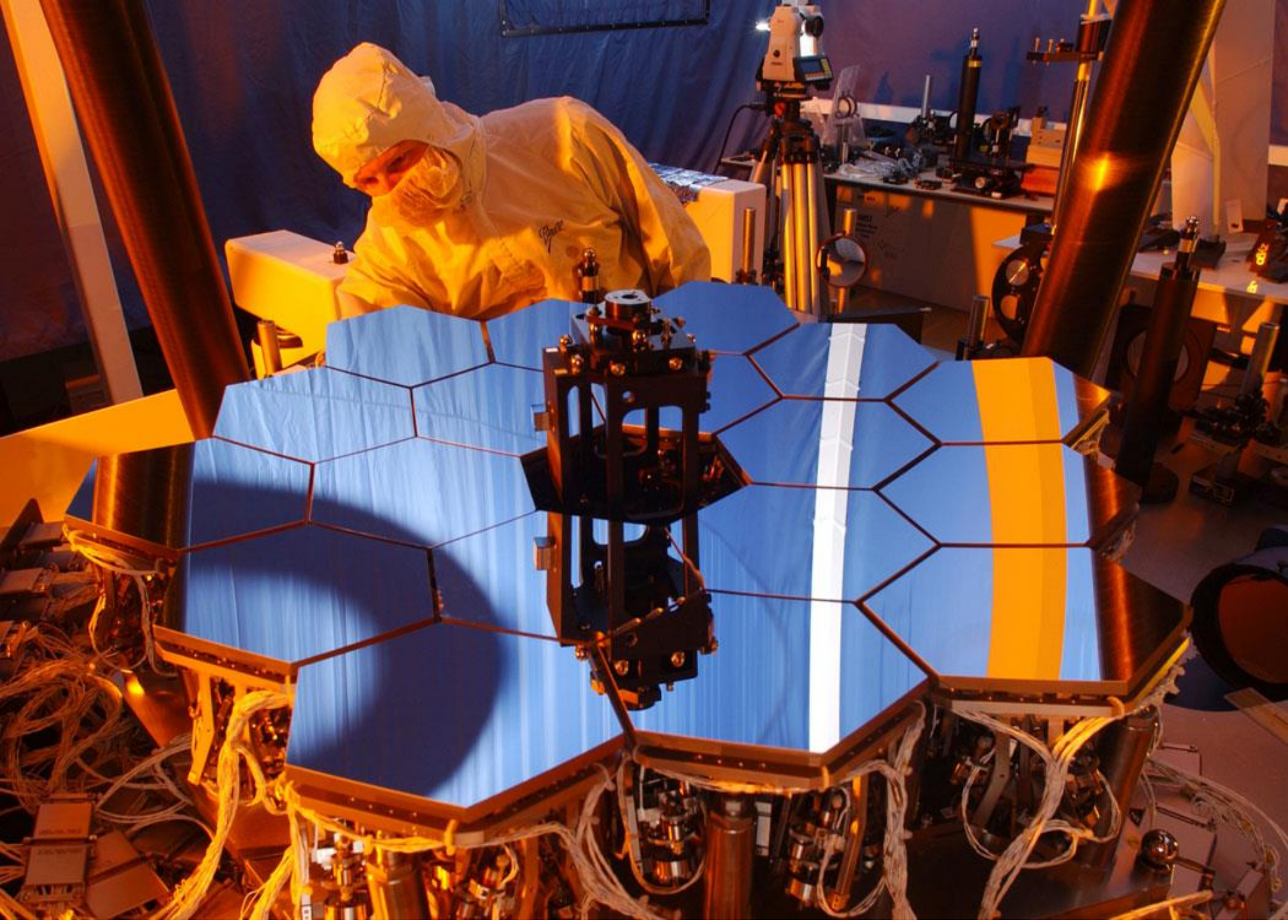
neutral evil



chaotic evil




atmosphere spectrum
Na
K
Exoplanet Transit Event
Towards Earth



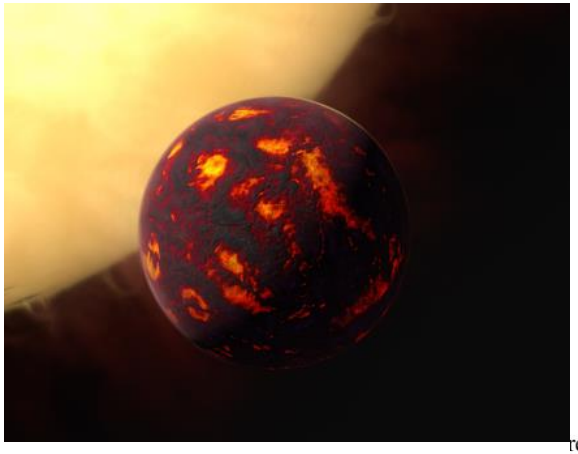
`HE ASTROPHYSICAL JOURNAL, 820:99 (13pp), 2016 April 1 doi:10.3847/0004-637X/820/2/99

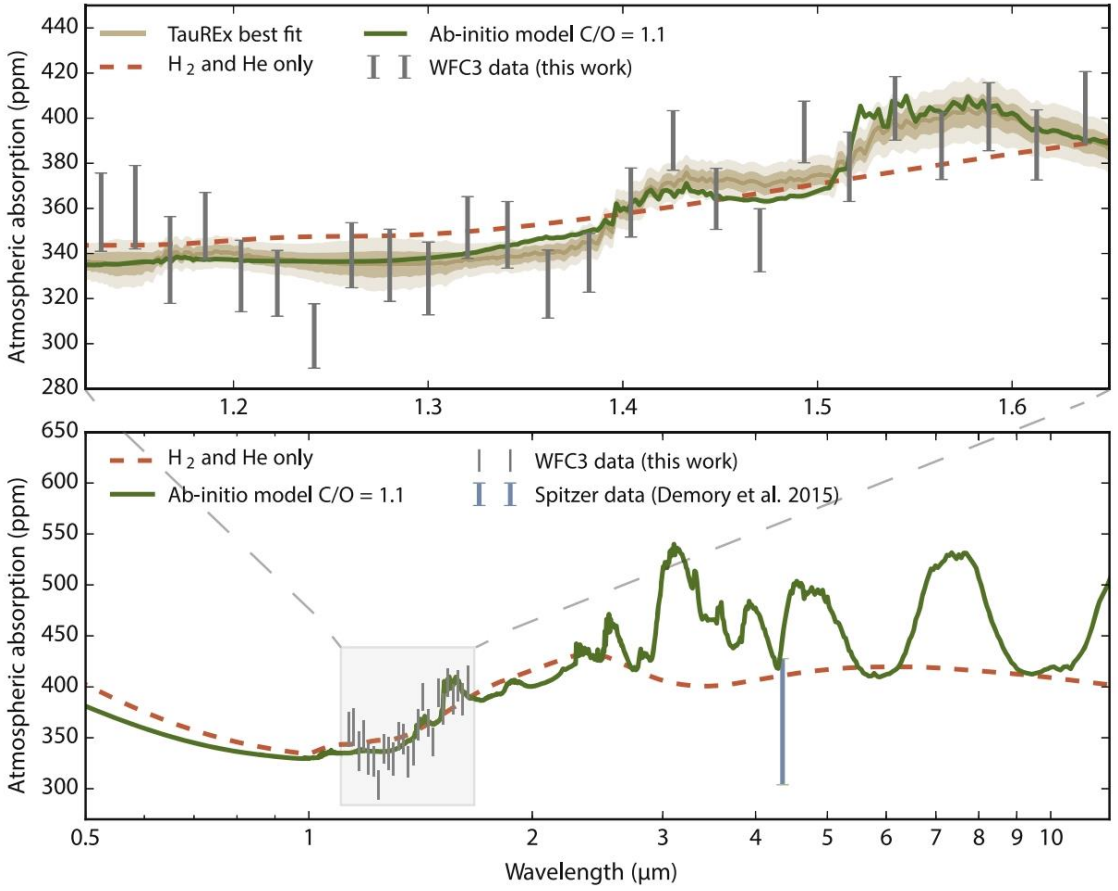
DETECTION OF AN ATMOSPHERE AROUND THE SUPER-EARTH 55 CANCRI E

A. TSIARAS[1], M. ROCCHETTO[1], I. P. WALDMANN[1], O. VENOT[2], R. VARLEY[1], G. MORELLO[1], M. DAMIANO[1,3], G. TINETTI[1], E. J. BARTON[1], S. N. YURCHENKO[1], AND J. TENNYSON[1]
[1] Department of Physics & Astronomy, University College London, Gower Street, WC1E6BT London, UK; angelos.tsiaras.14@ucl.ac.uk
[2] Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgium
[3] INAF–Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, I-90134 Palermo, Italy
Received 2015 November 27; accepted 2016 February 5; published 2016 March 24

)02	0.828396	−0.271626	0.075149	−0.025545	420 ± 23	386 ± 2.

We report the analysis of two new spectr
obtained with the WFC3 camera on boarc
that temperatures much higher than 200
observations were obtained in scanning
speed. We use our specialized pipelin
parameters when coupled with the geor
wavelength channel with an average relat
a straight line model with a 6σ confide
atmosphere, which is probably hydroger
HCN to be the most likely molecular car
spectroscopic observations in a broader
detection, we discuss here the implicati





ted transmission spectrum of the hot super-Earth 55 Cancri e (gray error bars), best fit obtained with $\mathcal{T}$-REx (brown line), t

Water Vapor and Clouds on the Habitable-Zone Sub-Neptune Exoplanet K2-18b

Björn Benneke,[1] Ian Wong,[2,3] Caroline Piaulet,[1] Heather A. Knutson,[4] Joshua Lothringer,[5] Caroline V. Morley,[6] Ian J.M. Crossfield,[7] Peter Gao,[8,3] Thomas P. Greene,[9] Courtney Dressing,[10] Diana Dragomir,[11] Andrew W. Howard,[12] Peter R. McCullough,[5] Eliza M.-R. Kempton,[13,14] Jonathan J. Fortney,[15] and Jonathan Fraine[16]

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[8] *Dep*

[10] *Dep*

[11] *Dep*

[12] *De*

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[14] *I*

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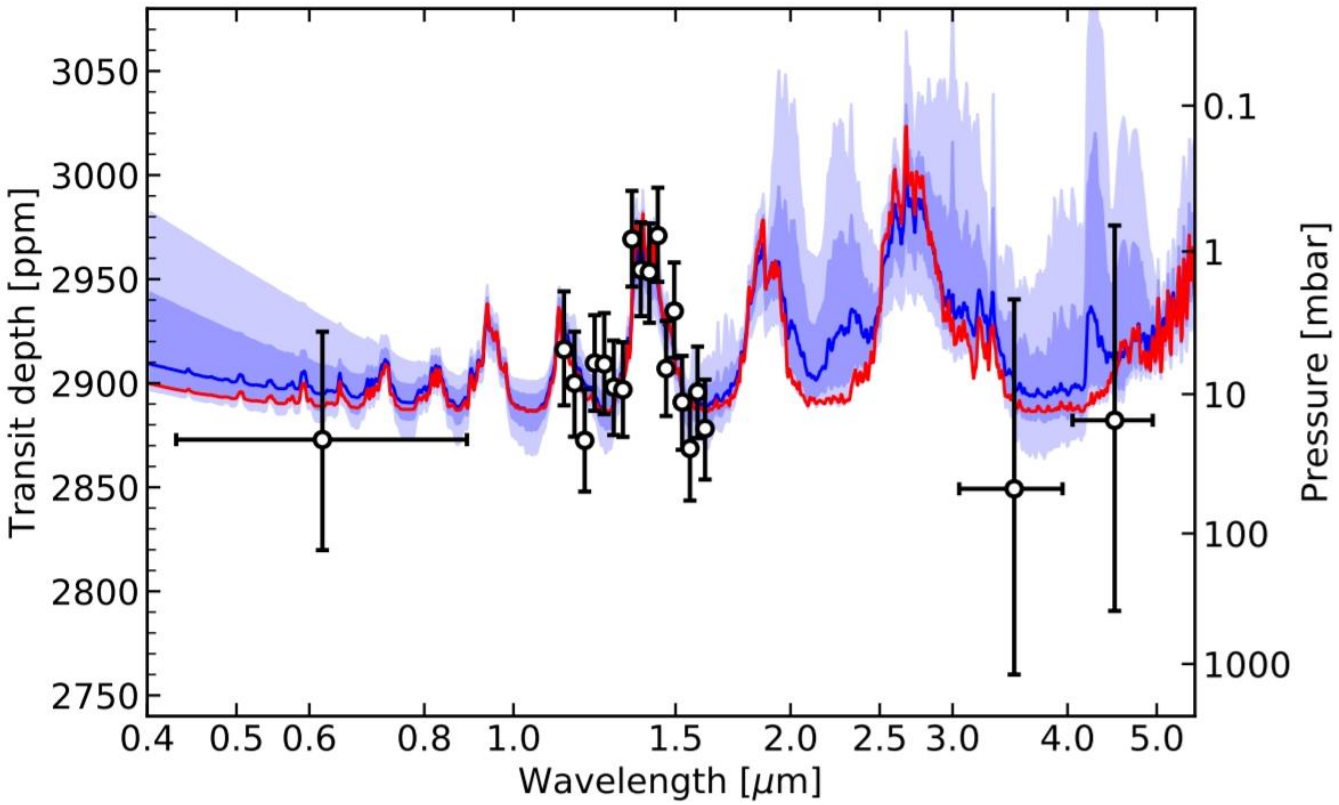
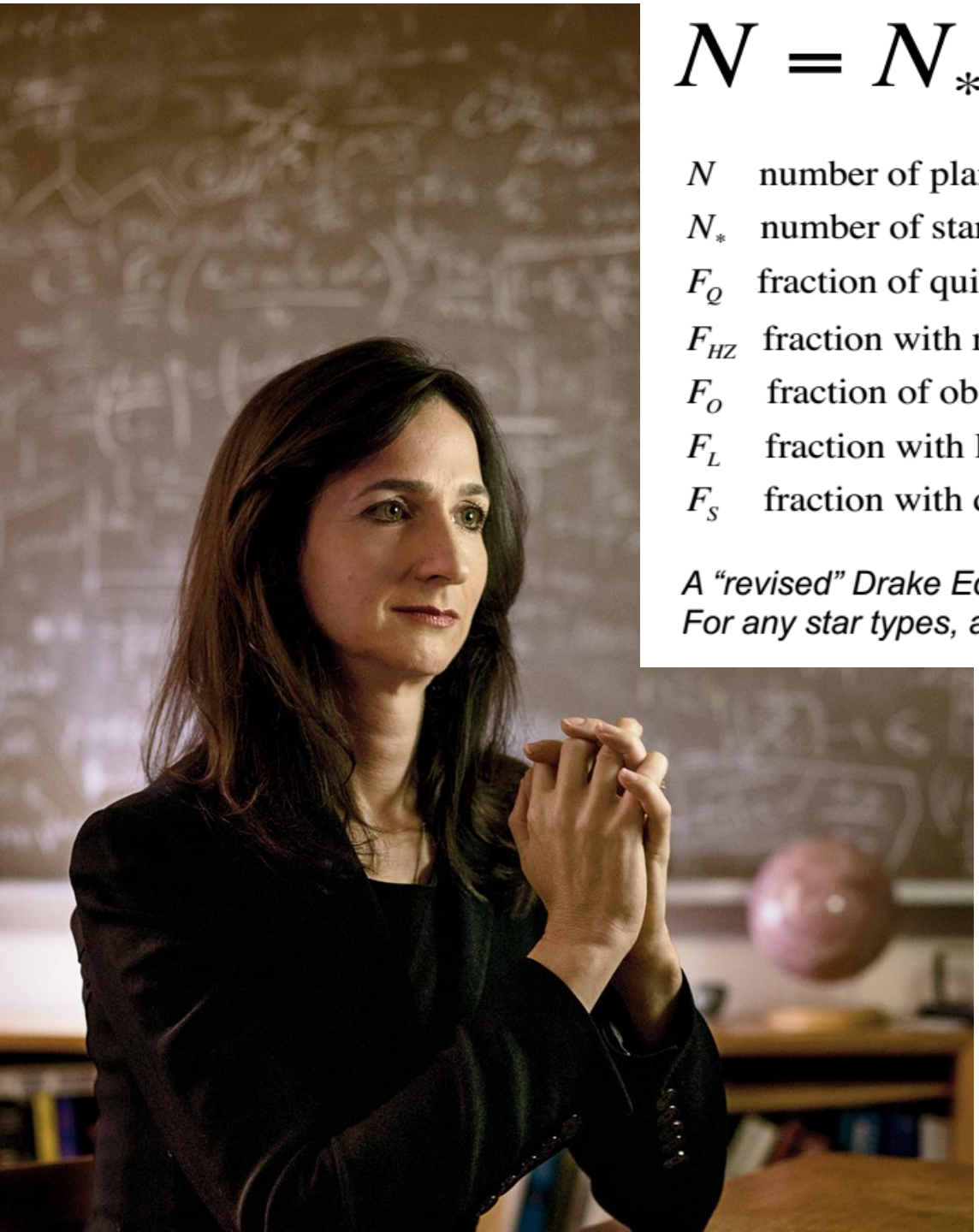
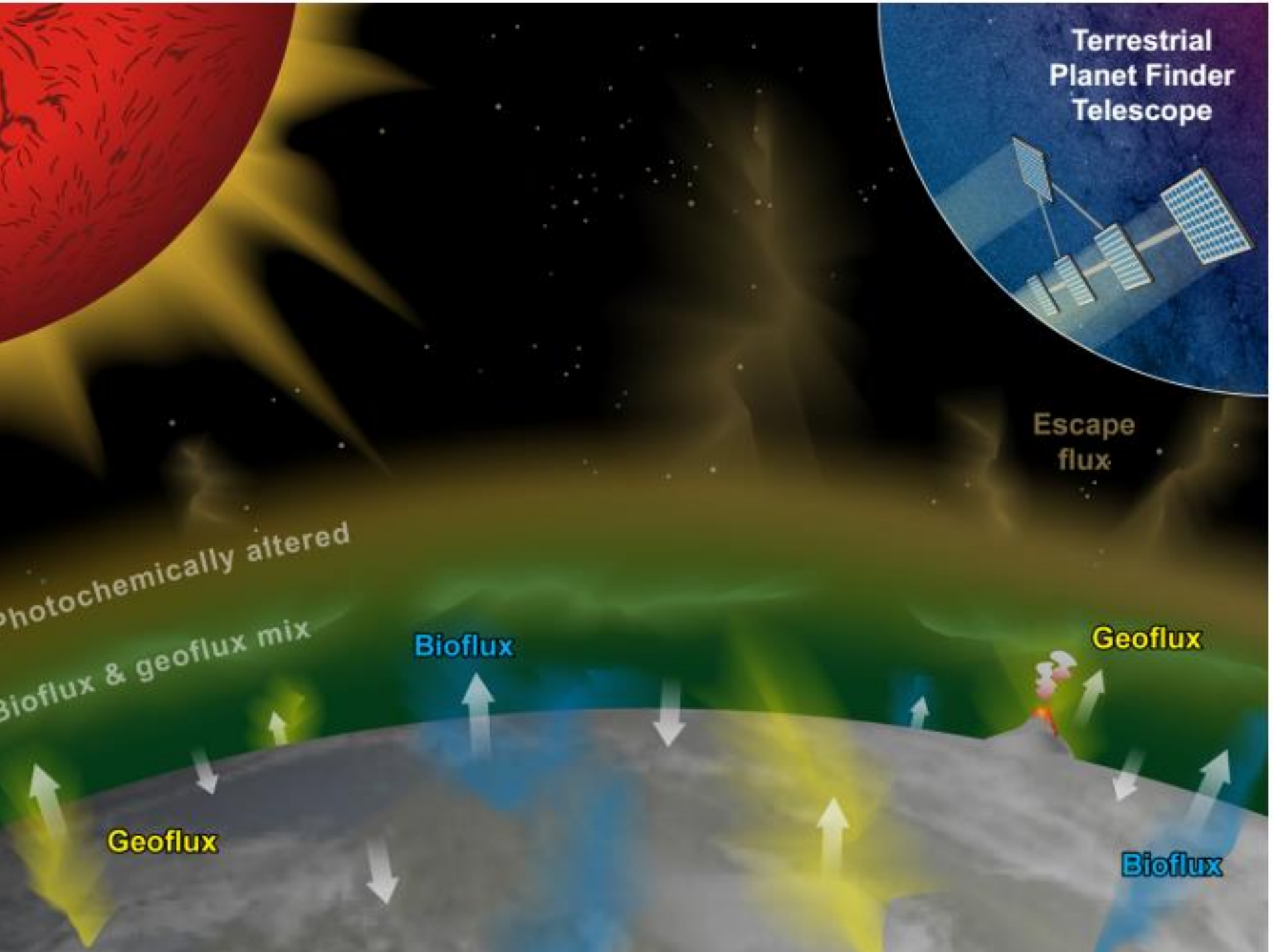


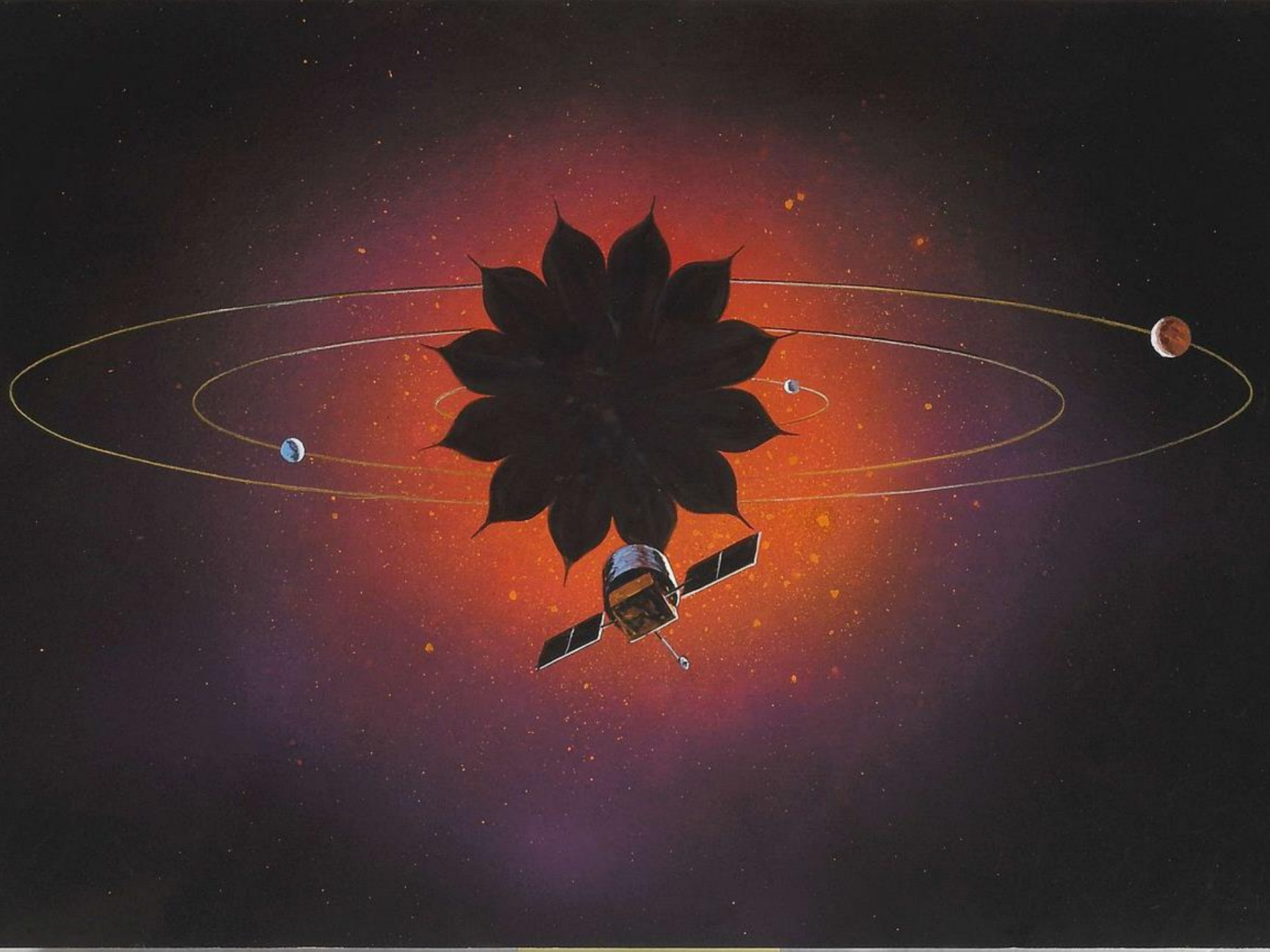


$$N = N_* F_Q F_{HZ} F_O F_L F_S$$

N	number of planets with detectable biosignature gases
N_*	number of stars within the sample
F_Q	fraction of quiet stars
F_{HZ}	fraction with rocky planets in the HZ
F_O	fraction of observable systems
F_L	fraction with life
F_S	fraction with detectable spectroscopic signatures

A "revised" Drake Equation
For any star types, any well defined survey


Terrestrial
Planet Finder
Telescope
Escape
flux
Photochemically altered
Bioflux & geoflux mix
Bioflux
Geoflux
Geoflux
Bioflux



$$N = N_* F_Q F_{HZ} F_O F_L F_S$$

Term	M Stars
N_*	30,000
F_Q	(0.2)
F_{HZ}	0.15
F_O	0.001
F_L	1
F_S	0.5
N	**2**

In summary:

- Better estimates on the number of stars and galaxies
- Vast data on the existence of orbiting planets
- Developing tools to get clearer pictures / characterization
- Possibility of detecting biological signatures on the horizon


B"H
XIIIth International Conference
on TORAH and SCIENCE
TORAH & SCIENCE CONFERENCE
The Shul
Chaim Yakov Shlomo
College of Jewish Studies
Sustainability, Resilience
and the
Torah
IS THE WORLD AS WE KNOW IT
COMING TO AN END?

The Washington Post
Democracy Dies in Darkness

Opinions

Are we alone in the universe?

By **Charles Krauthammer**
December 29, 2011

Huge excitement last week. Two Earth-size planetsfound orbiting a sun-like star less than a thousand light-years away. This comes two weeks after the stunning announcement of another planet orbiting another star at precisely the right distance — within the "habitable zone" that is not too hot and not too cold — to allow for liquid water and therefore possible life.

Unfortunately, the planets of the right size are too close to their sun, and thus too scorching hot, to permit Earth-like life. And the Goldilocks planet in the habitable zone is too large. At 2.4 times the size of Earth, it is probably gaseous, like Jupiter.

Modern satellite data, applied to the Drake Equation, suggest that the number should be very high. So why the silence? Carl Sagan (among others) thought that the answer is to be found, tragically, in the final variable: the high probability that advanced civilizations destroy themselves.

In other words, this silent universe is conveying not a flattering lesson about our uniqueness but a tragic story about our destiny. It is telling us that intelligence may be the most cursed faculty in the entire universe — an endowment not just ultimately fatal but, on the scale of cosmic time, nearly instantly so.

4 When I see Your heavens, the work of Your fingers, the moon and stars that You have established,

ד כִּי־אֶרְאֶה שָׁמֶיךָ מַעֲשֵׂה אֶצְבְּעֹתֶיךָ יָרֵחַ
וְכוֹכָבִים אֲשֶׁר כּוֹנָנְתָּה:

5 what is man that You should remember him, and the son of man that You should be mindful of him?

ה מָה־אֱנוֹשׁ כִּי־תִזְכְּרֶנּוּ וּבֶן־אָדָם כִּי
תִפְקְדֶנּוּ:

6 Yet You have made him slightly less than the angels, and You have crowned him with glory and majesty.

ו וַתְּחַסְּרֵהוּ מְּעַט מֵאֱלֹהִים וְכָבוֹד וְהָדָר
תְּעַטְּרֵהוּ:

7 You give him dominion over the work of Your hands; You have placed everything beneath his feet.

ז תַּמְשִׁילֵהוּ בְּמַעֲשֵׂי יָדֶיךָ כֹּל שַׁתָּה
תַּחַת־רַגְלָיו:

8 Flocks and cattle, all of them, and also the beasts of the field;

ח צֹנָה וַאֲלָפִים כֻּלָּם וְגַם בַּהֲמוֹת שָׂדָי:

9 the birds of the sky and the fish of the sea, he traverses the ways of the seas.

ט שְׁמַיִם וּדְגֵי הַיָּם עֹבֵר אָרְחוֹת יַמִּים: