Faculty Journal club @ 2024/10/30

Hayato Shimabukuro

Searching for Extraterrestrial Intelligence with the Square Kilometre Array

Astro-ph/1412.4867

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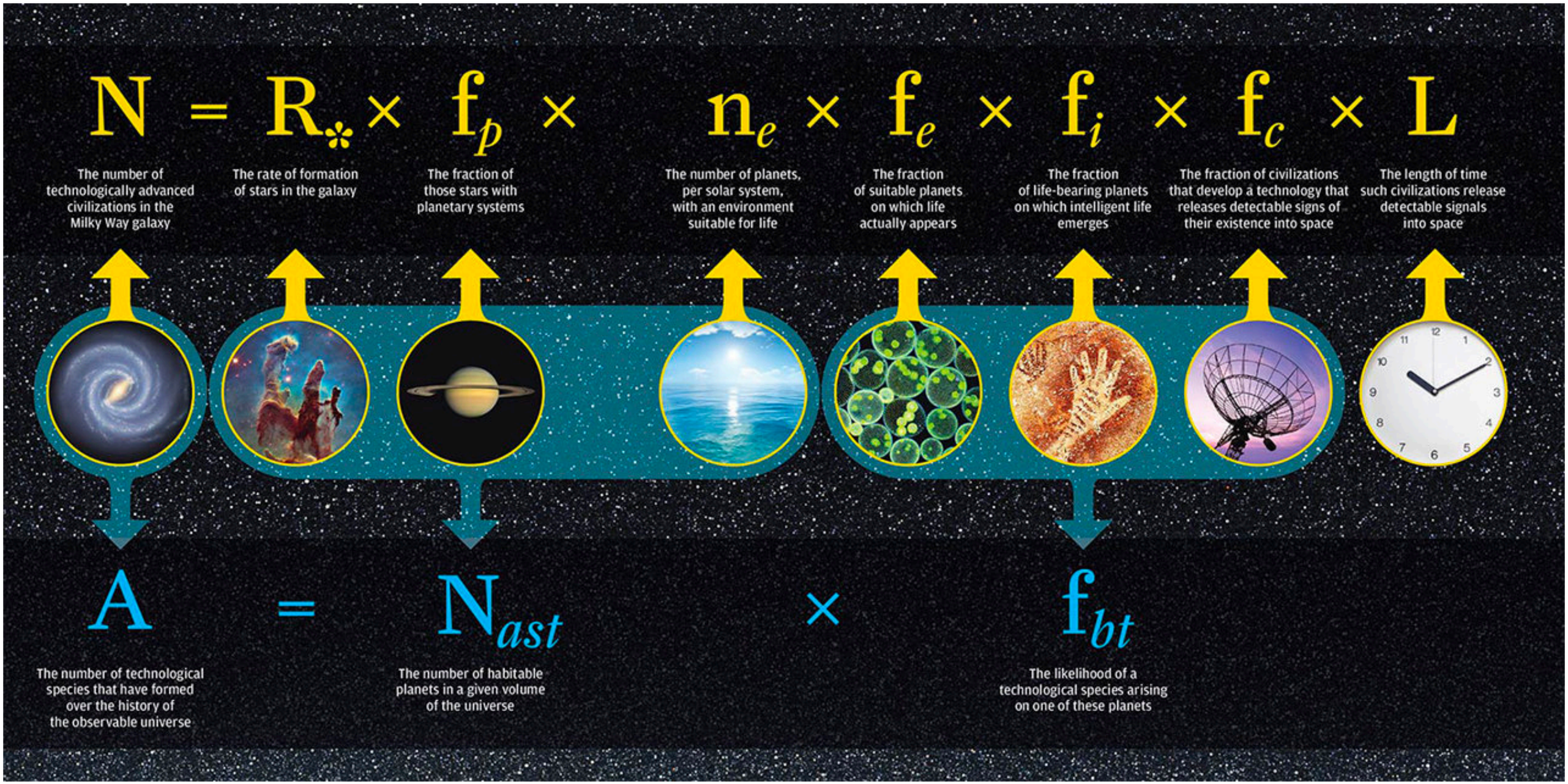
(Question)

What do you think how much extraterrestrial life(地外生命) is expected to exist in our galaxy?

Drake equation

•Drake equation estimates the number of extraterrestrial life in our Galaxy.



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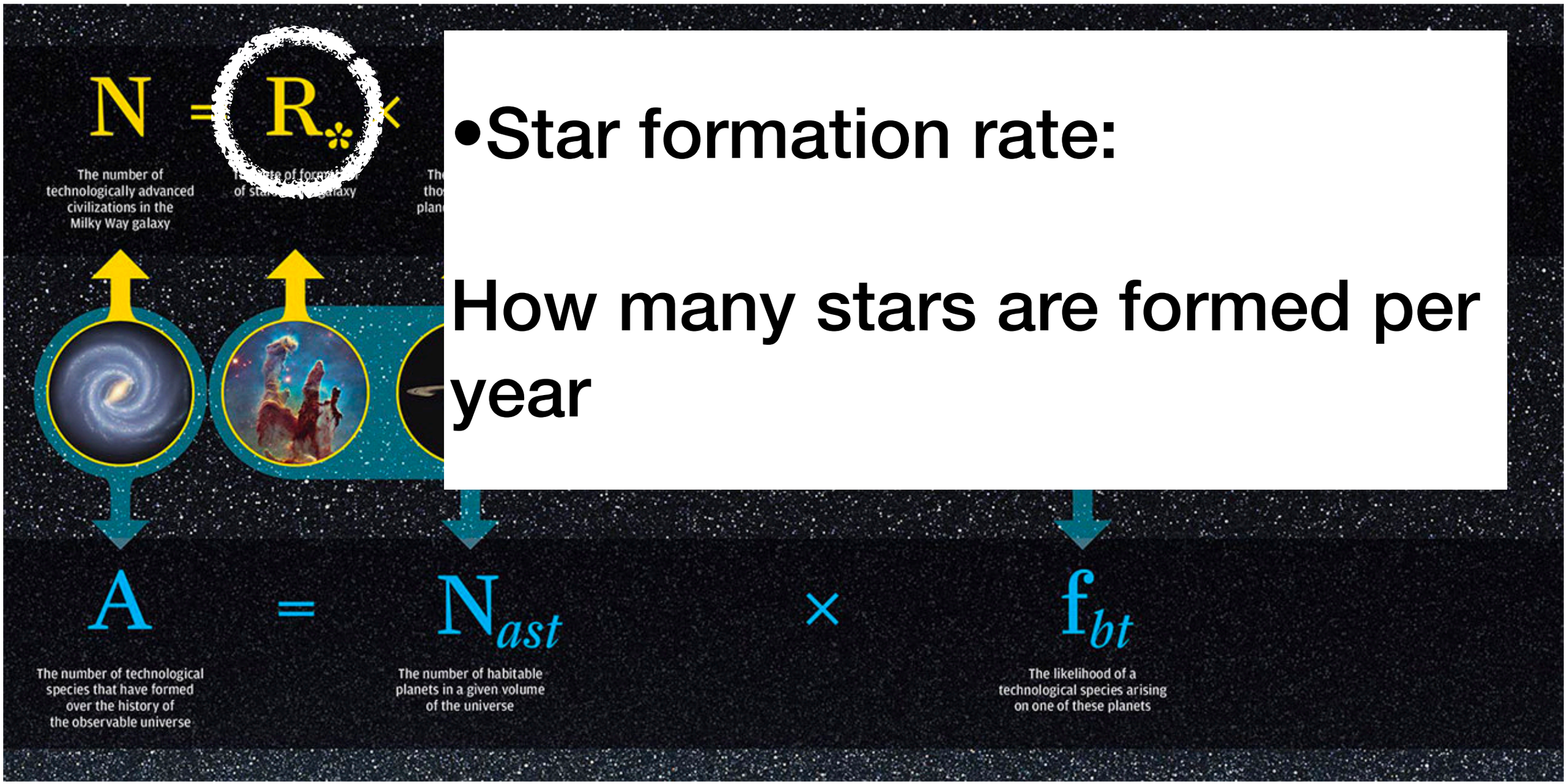

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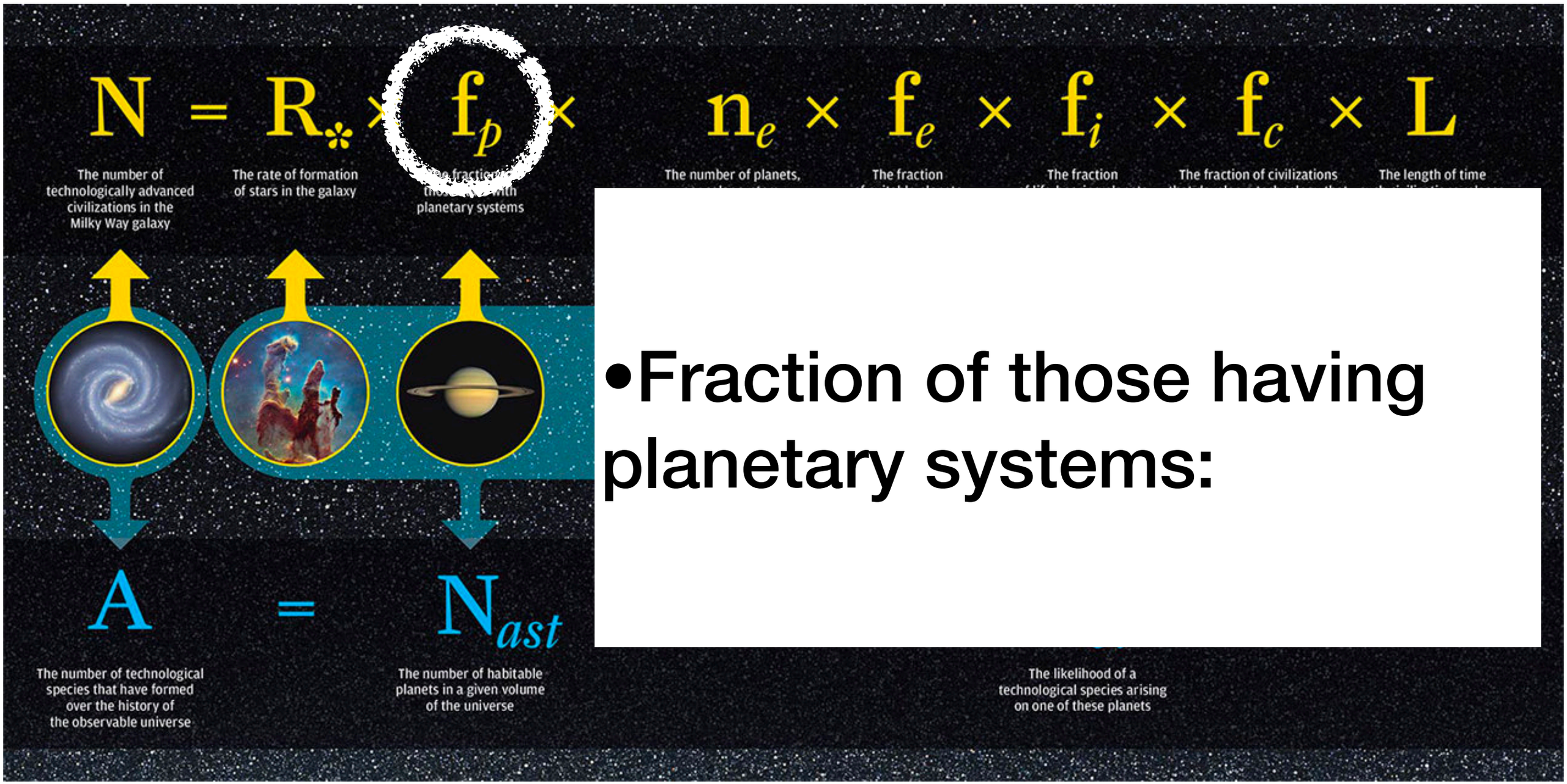

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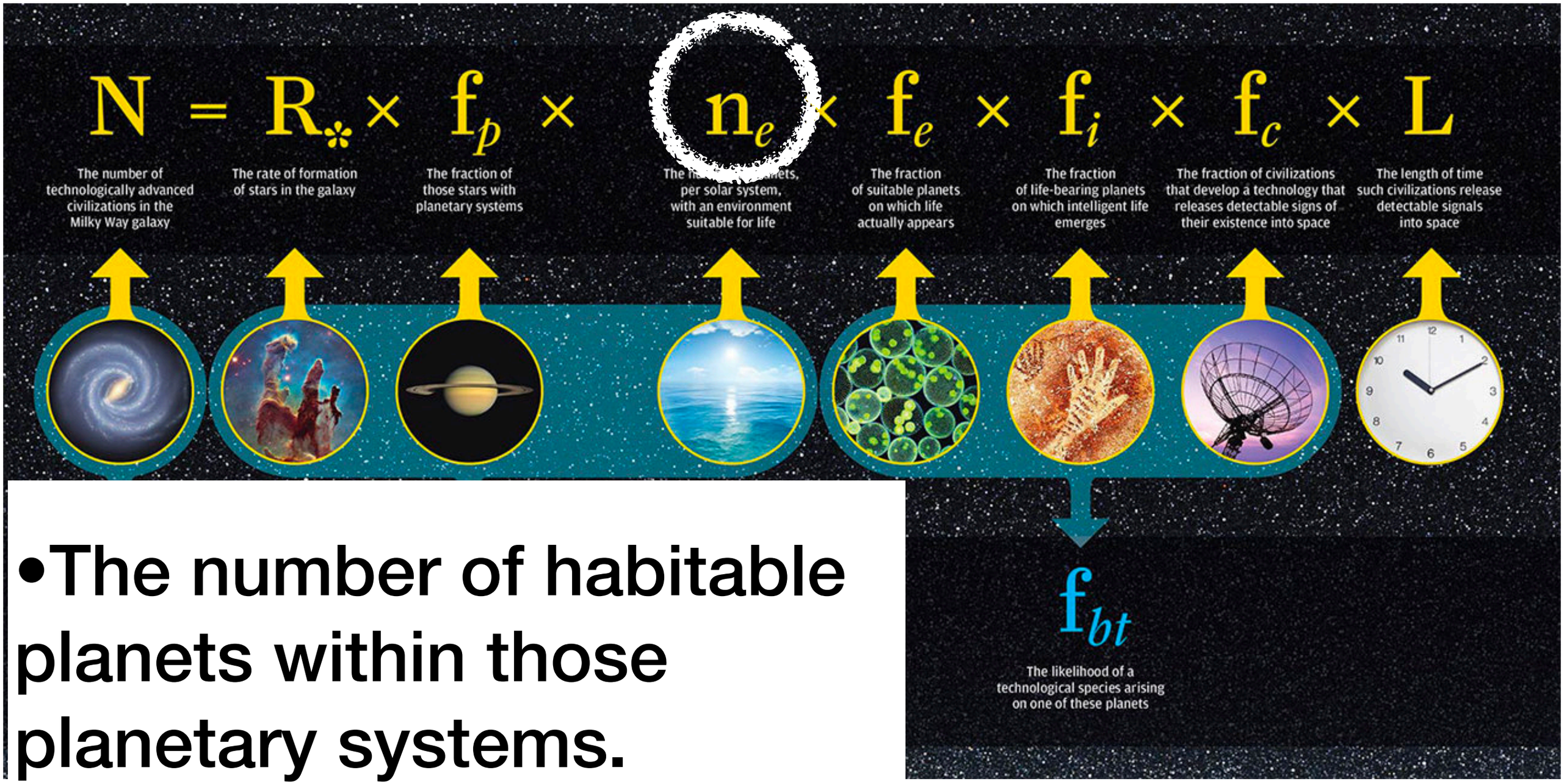

•The number of habitable planets within those planetary systems.

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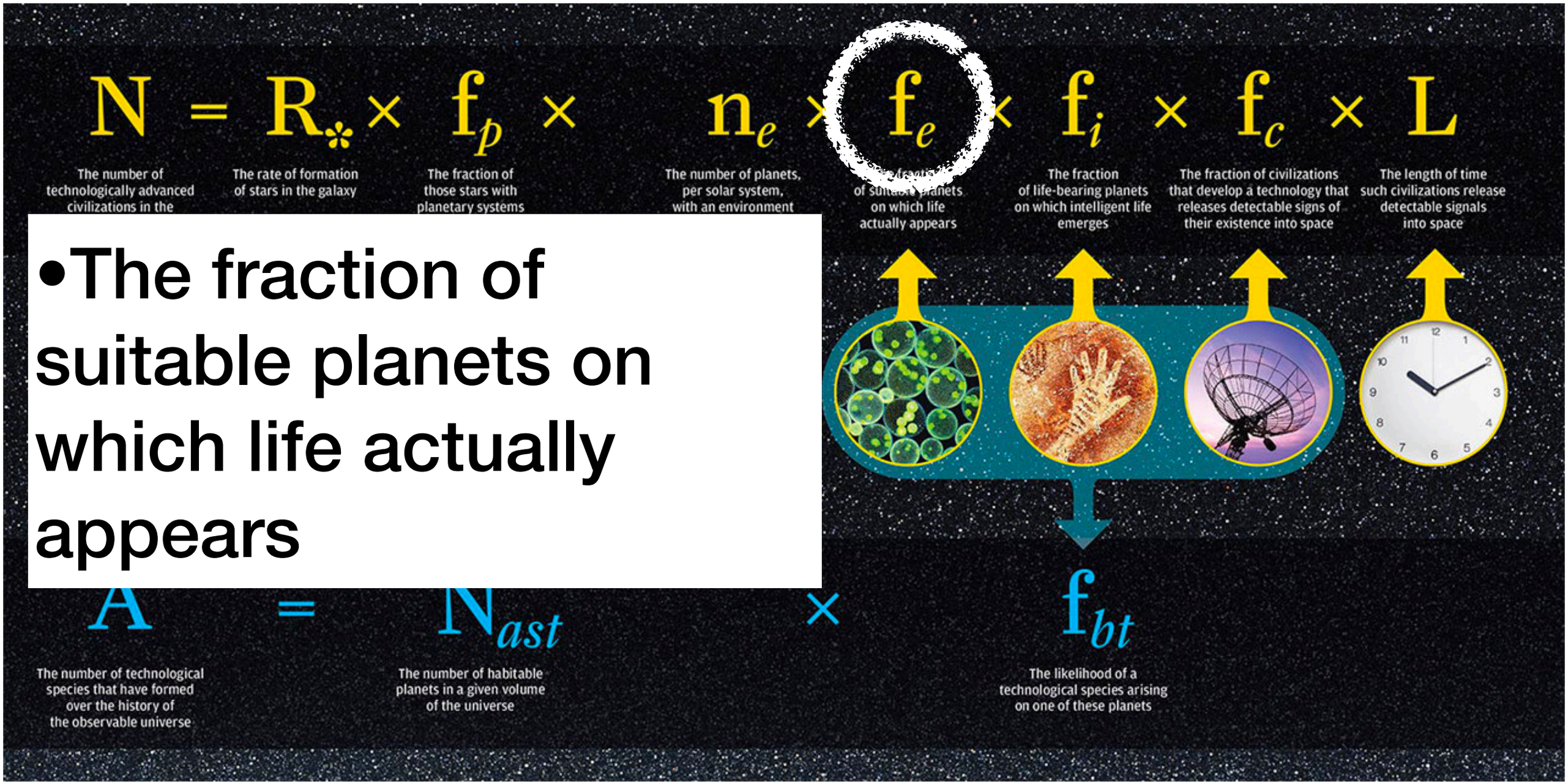

•The fraction of suitable planets on which life actually appears

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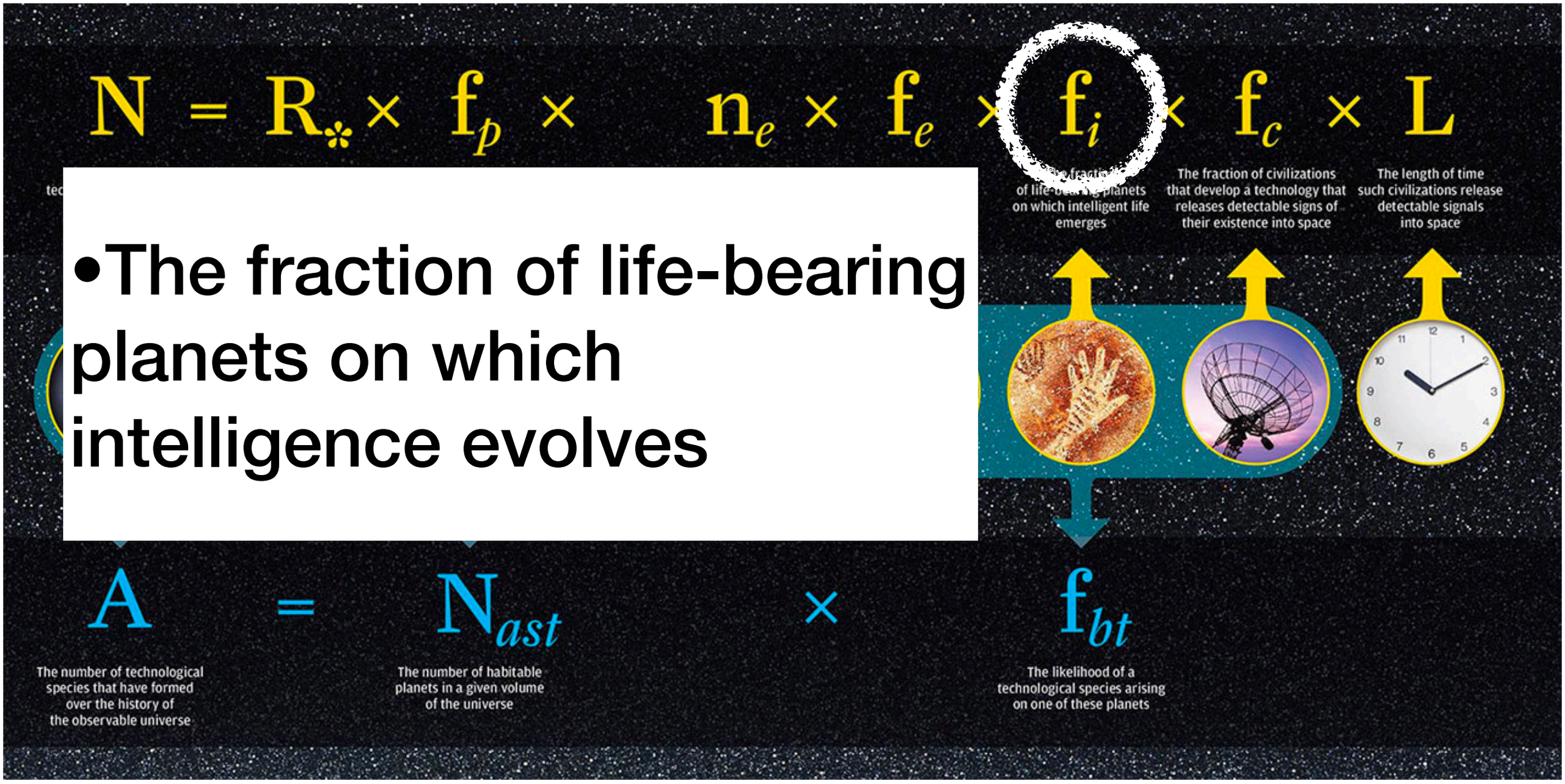

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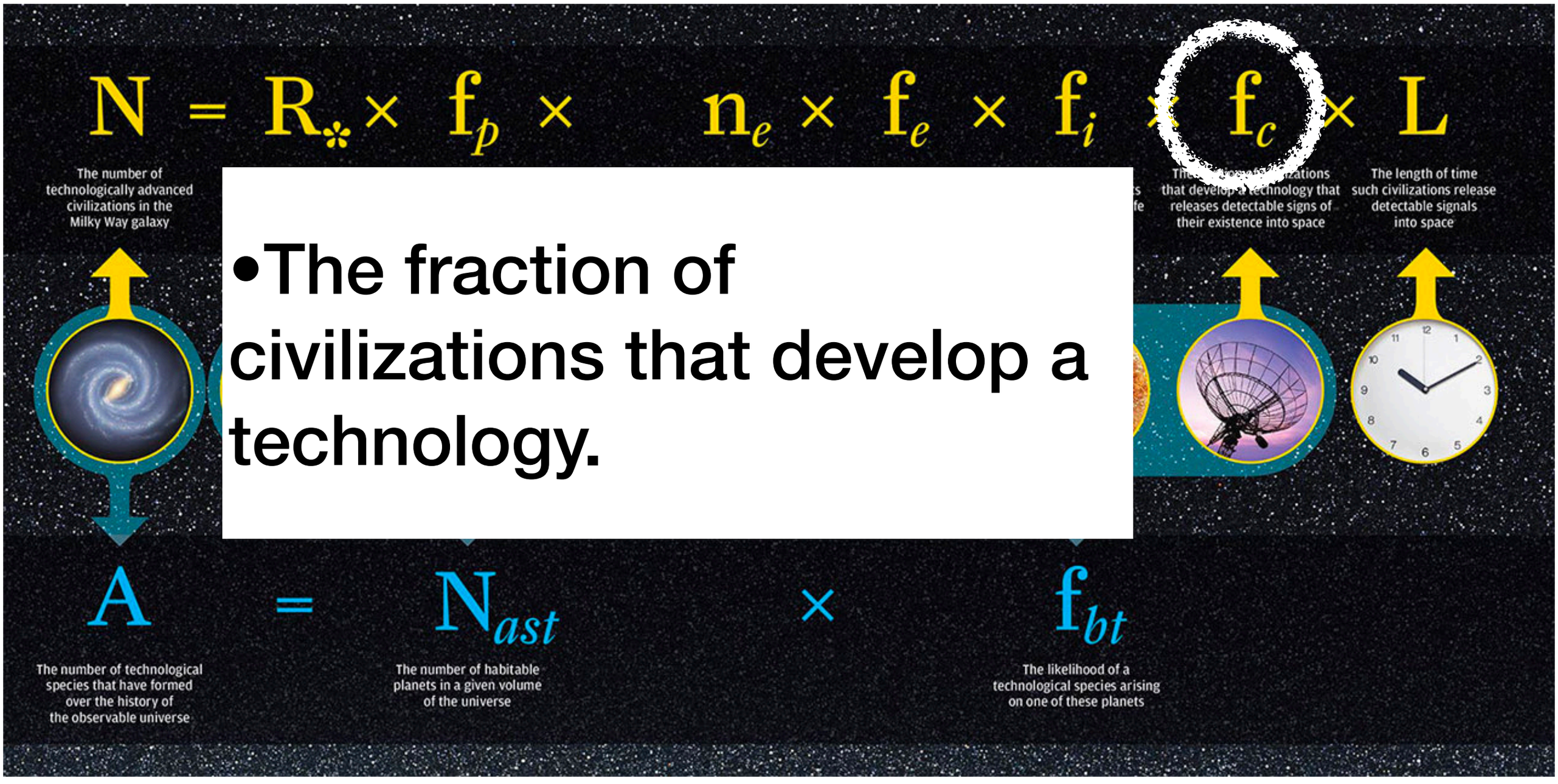

•The fraction of civilizations that develop a technology.

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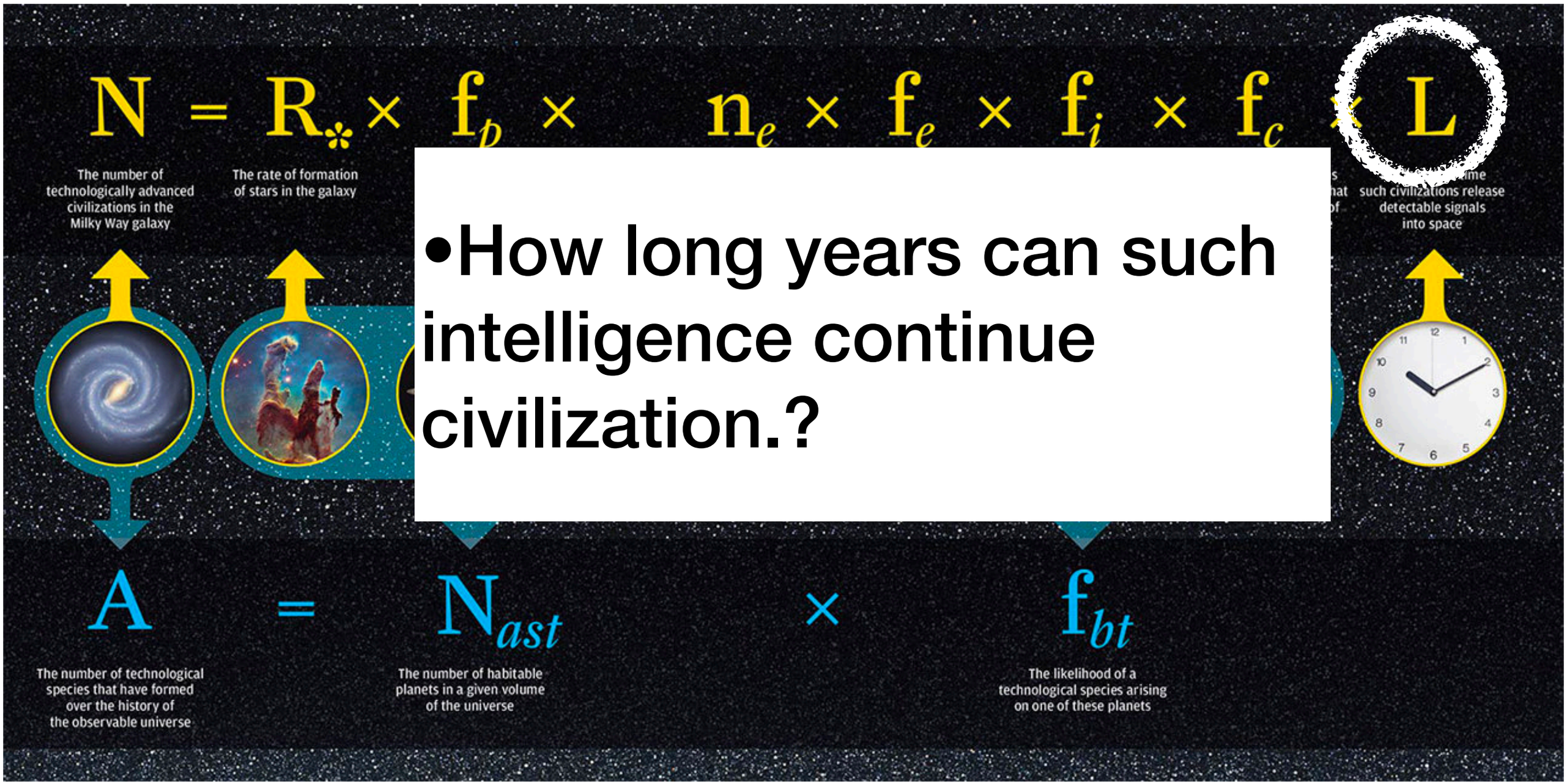

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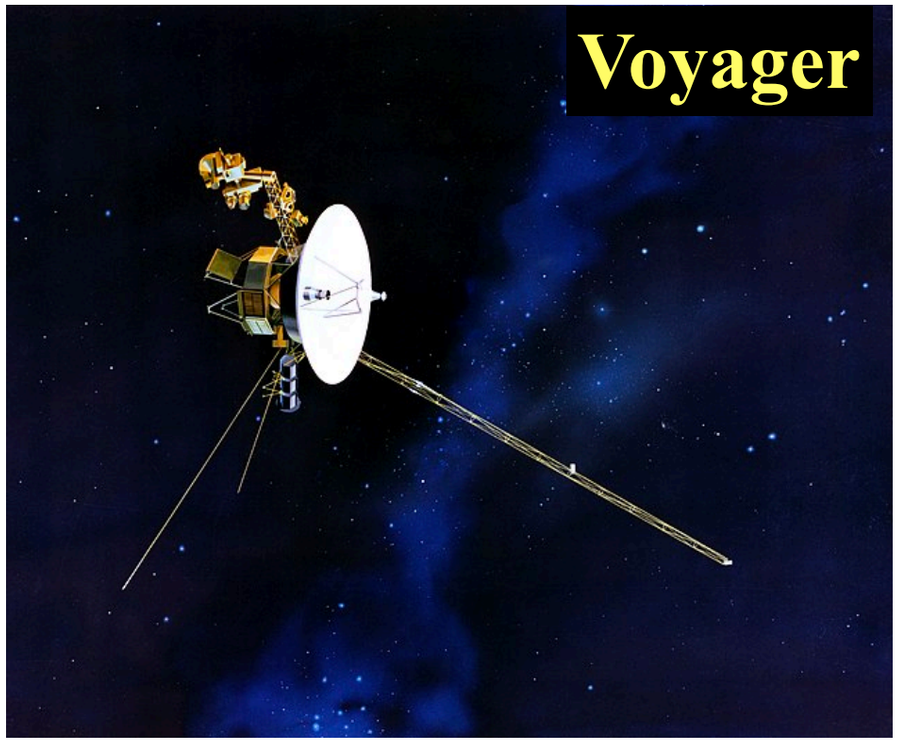
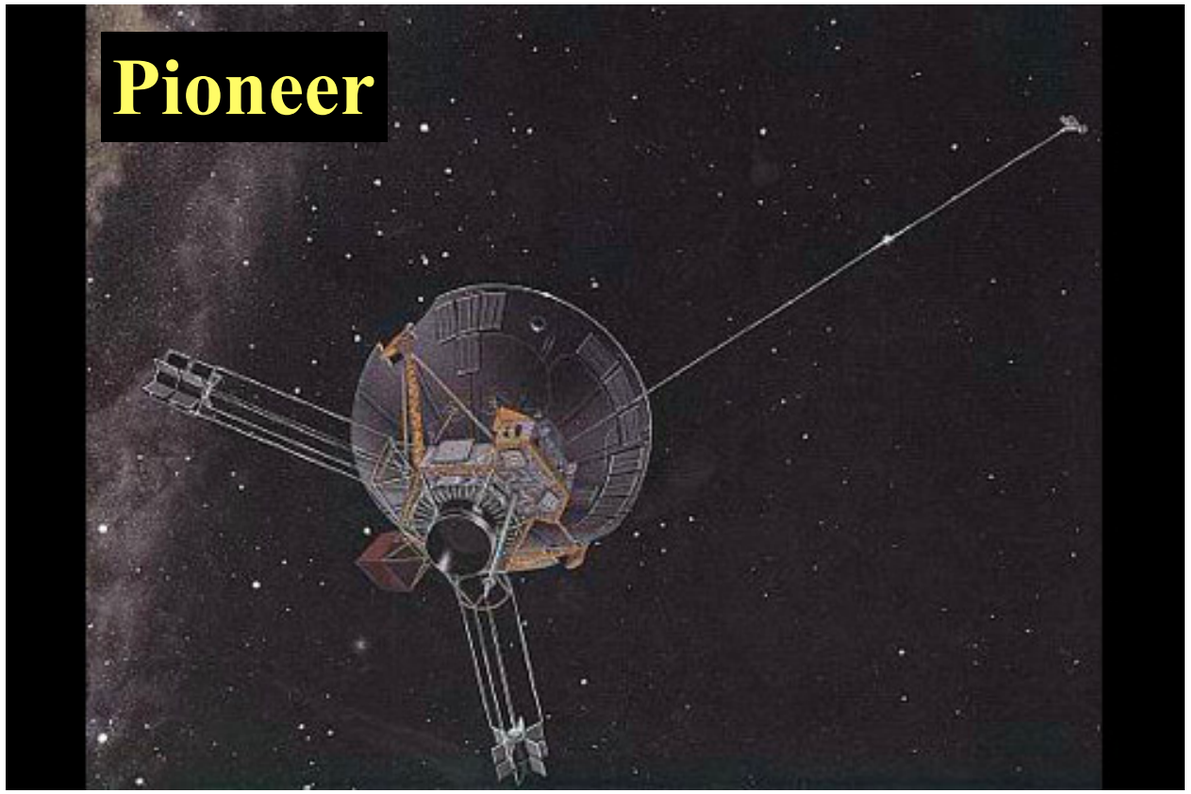
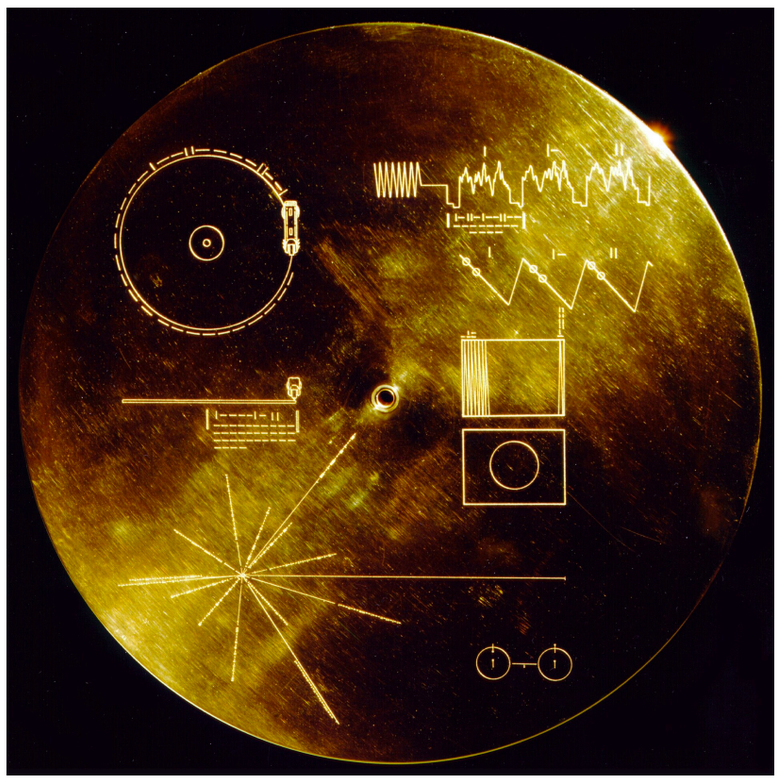
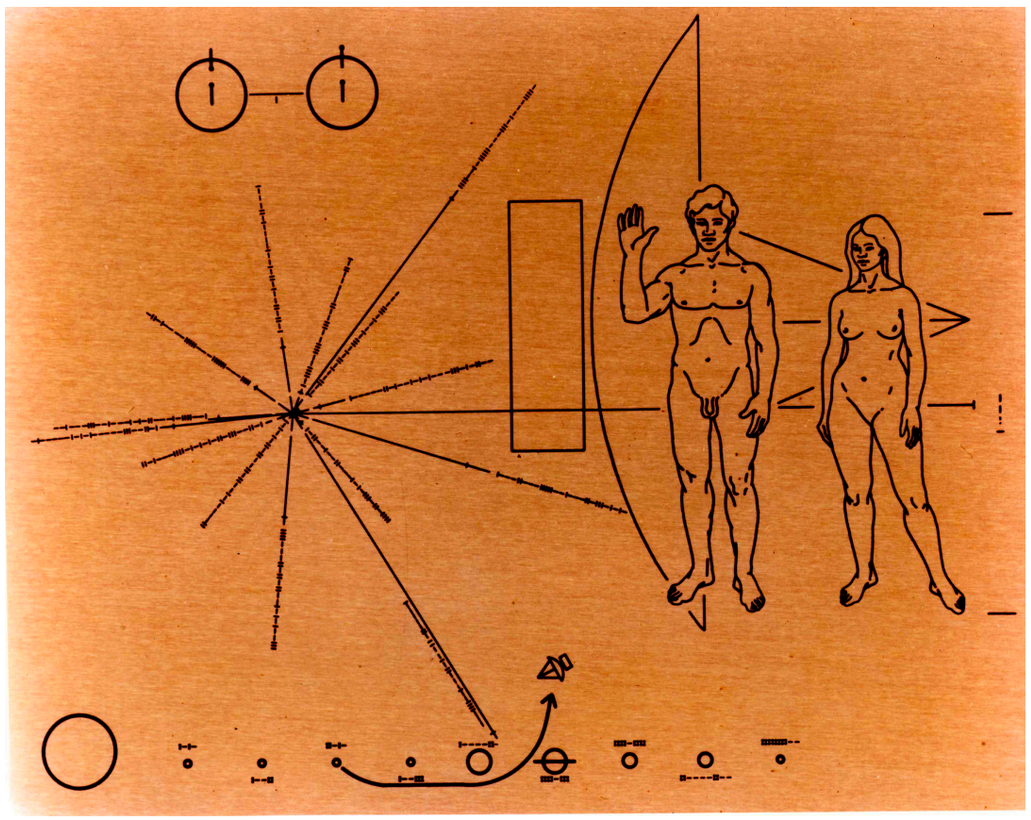
Messages to extraterrestrial life









Don't just wait and see! Let's go and listen to the aliens' "voice"!

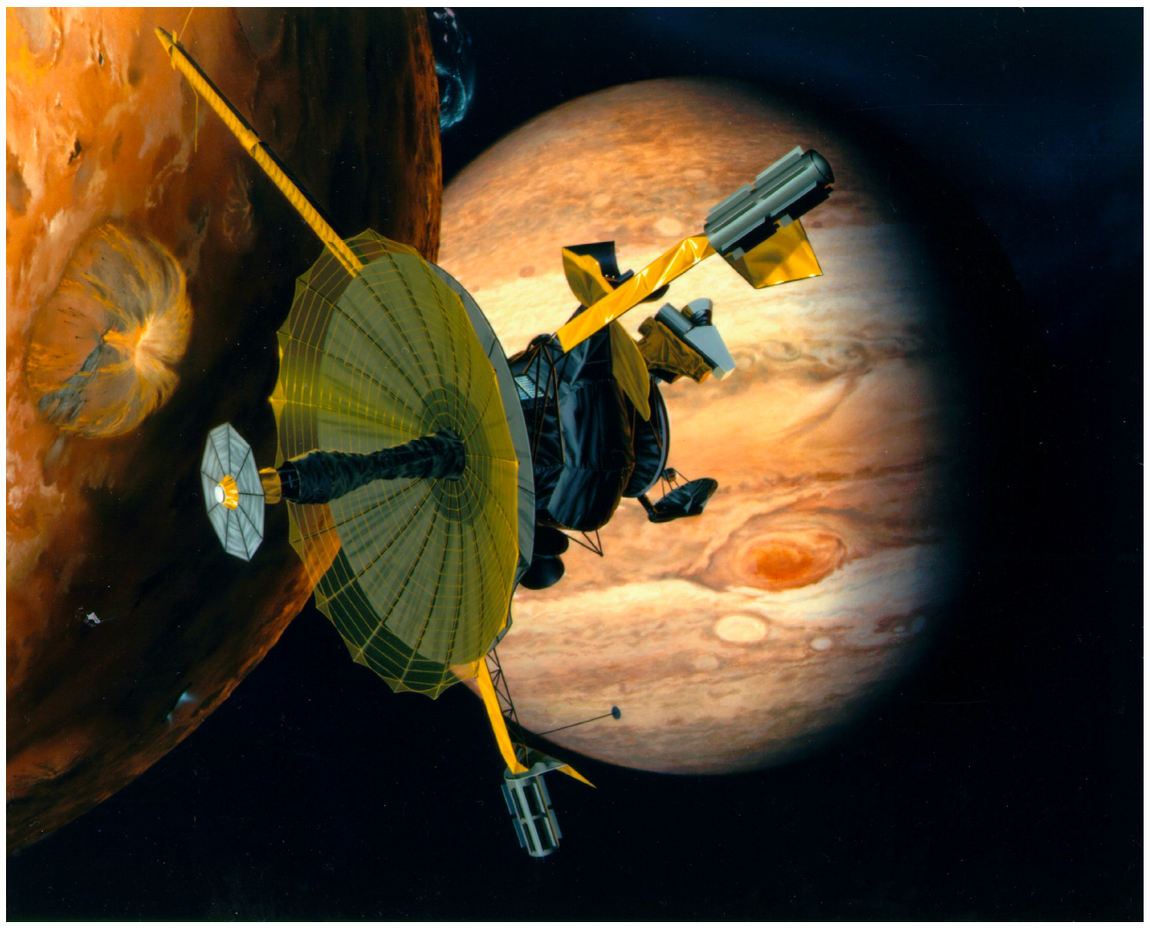
"Searching for Extraterrestrial Intelligence (SETI)"

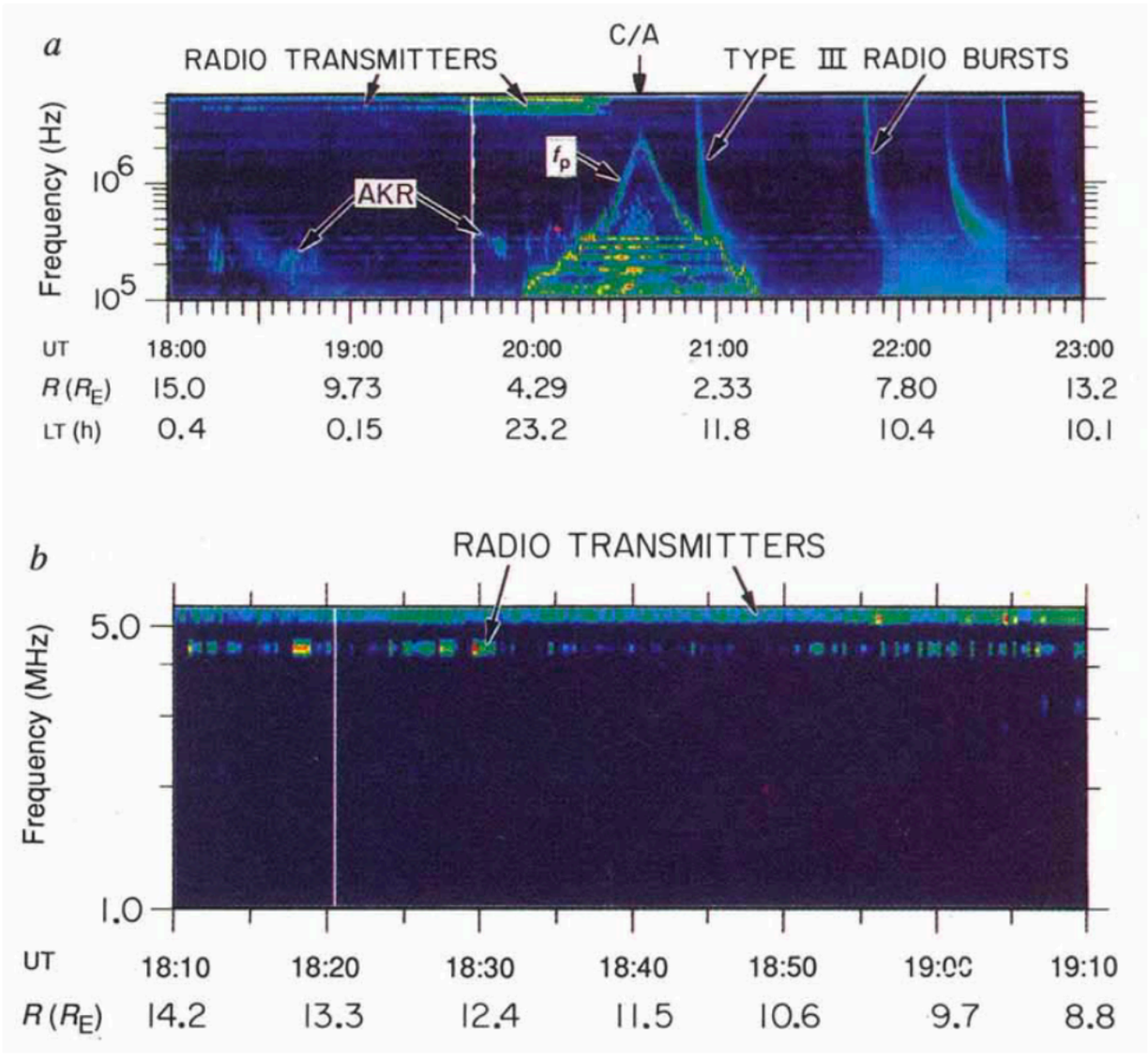
SKAO

Artificial radio emission

•***Galileo spacecraft*** is an American robotic space probe that studied the planet Jupiter and its moons.

•Galileo spacecraft discovered radio waves **on the earth**.



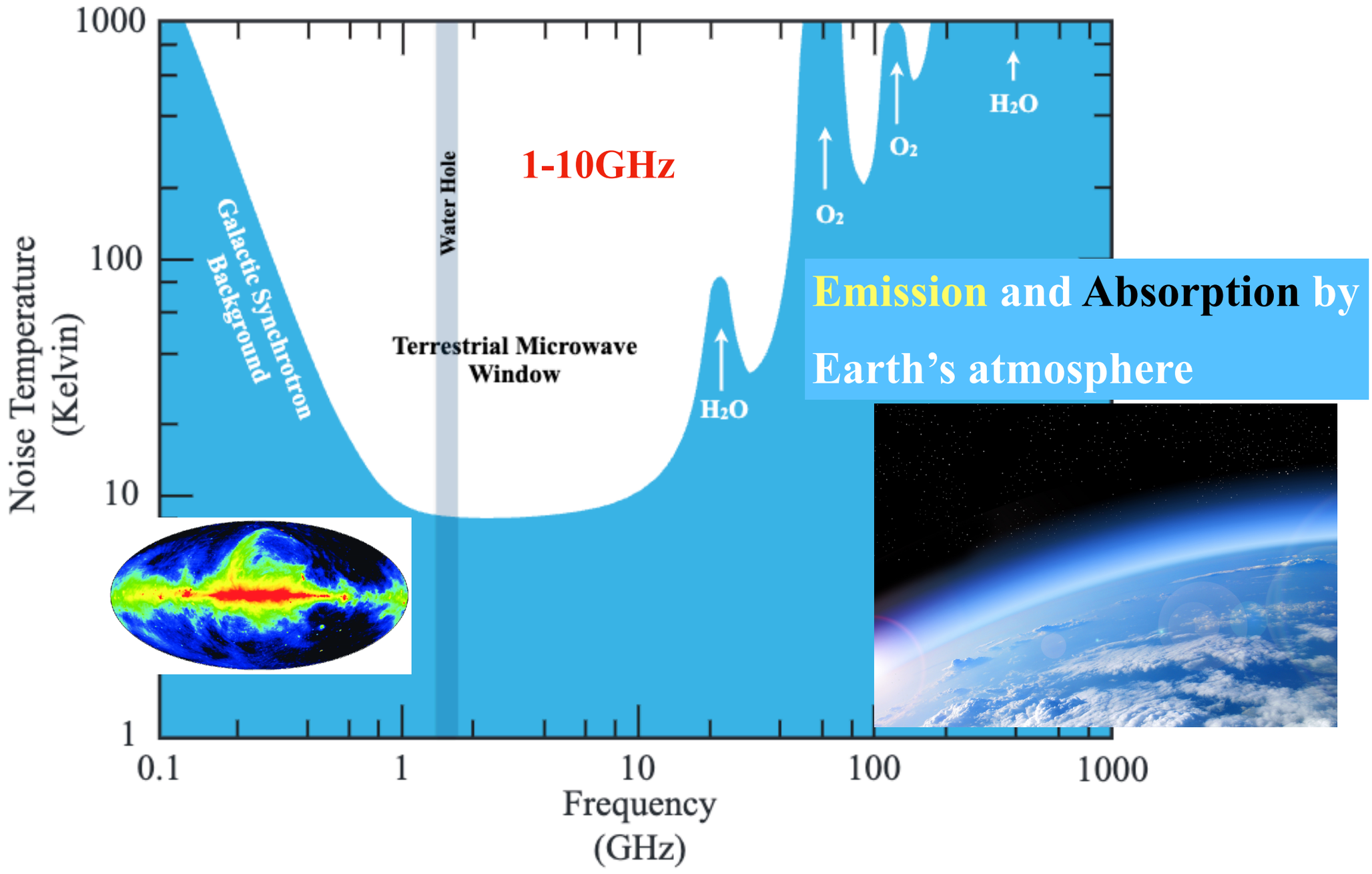


Sagan et al (1993)

→ ***It is the evidence of civilization*** （文明）

Which radio frequency is preferred for SETI??

•The so-called "**terrestrial microwave window (TMW)**" is the spectral region of relatively low natural noise.



Fundamental problem for SETI

•The SETI search space (frequency and sky location) is so broad!

Which frequency?

Which sky potion?

But,

Observing time dedicated to a single science project is limited.

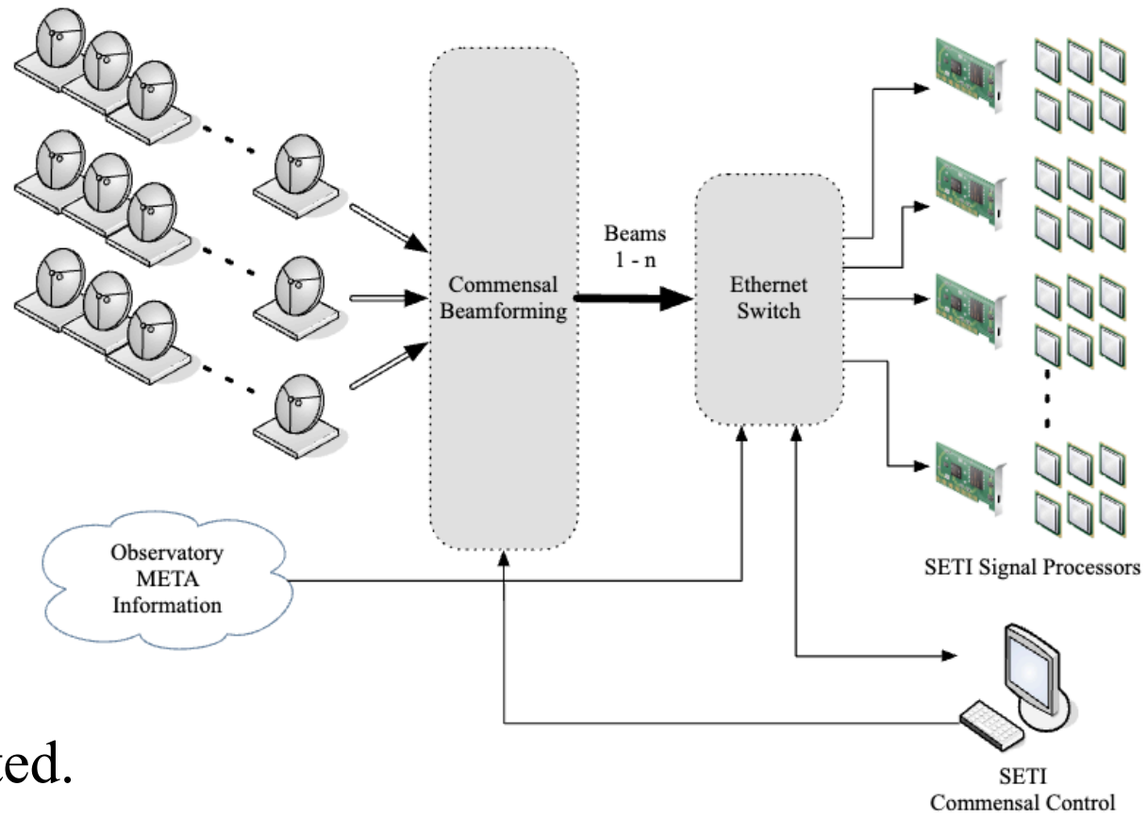
Idea to solve this problem

"Commensal observation（共生观察）"

•SETI astronomers could "piggy-back" on other users' observations.
(e.g. JVLA,GBT, LOFAR)

•Distributed compuitng（分布式计算）

•More than 5.2 million ordinary citizens participated.



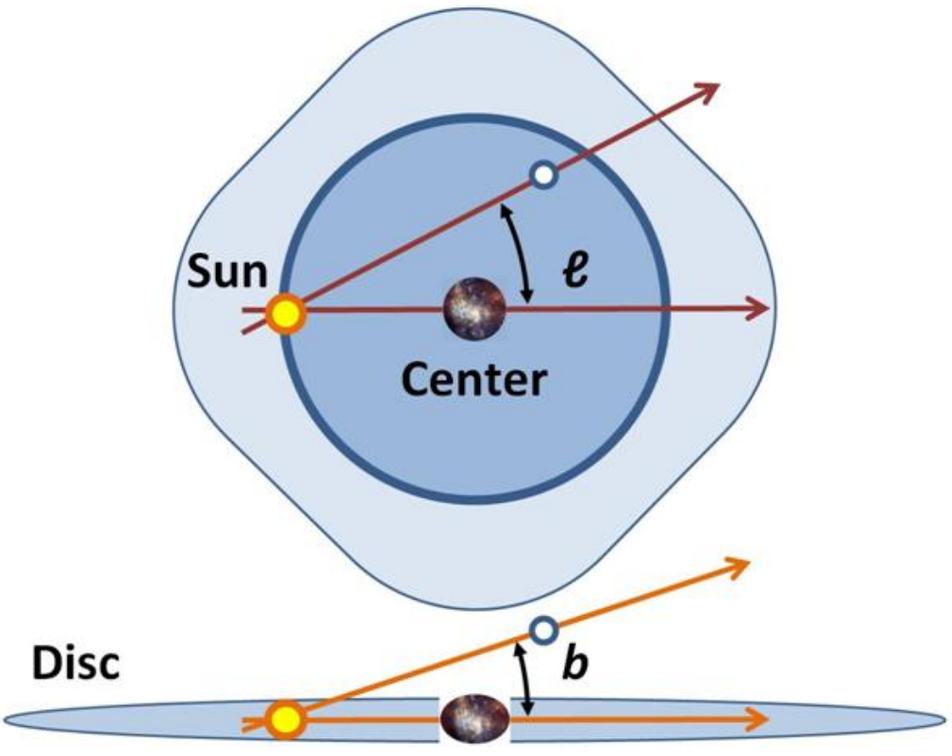
Target selection

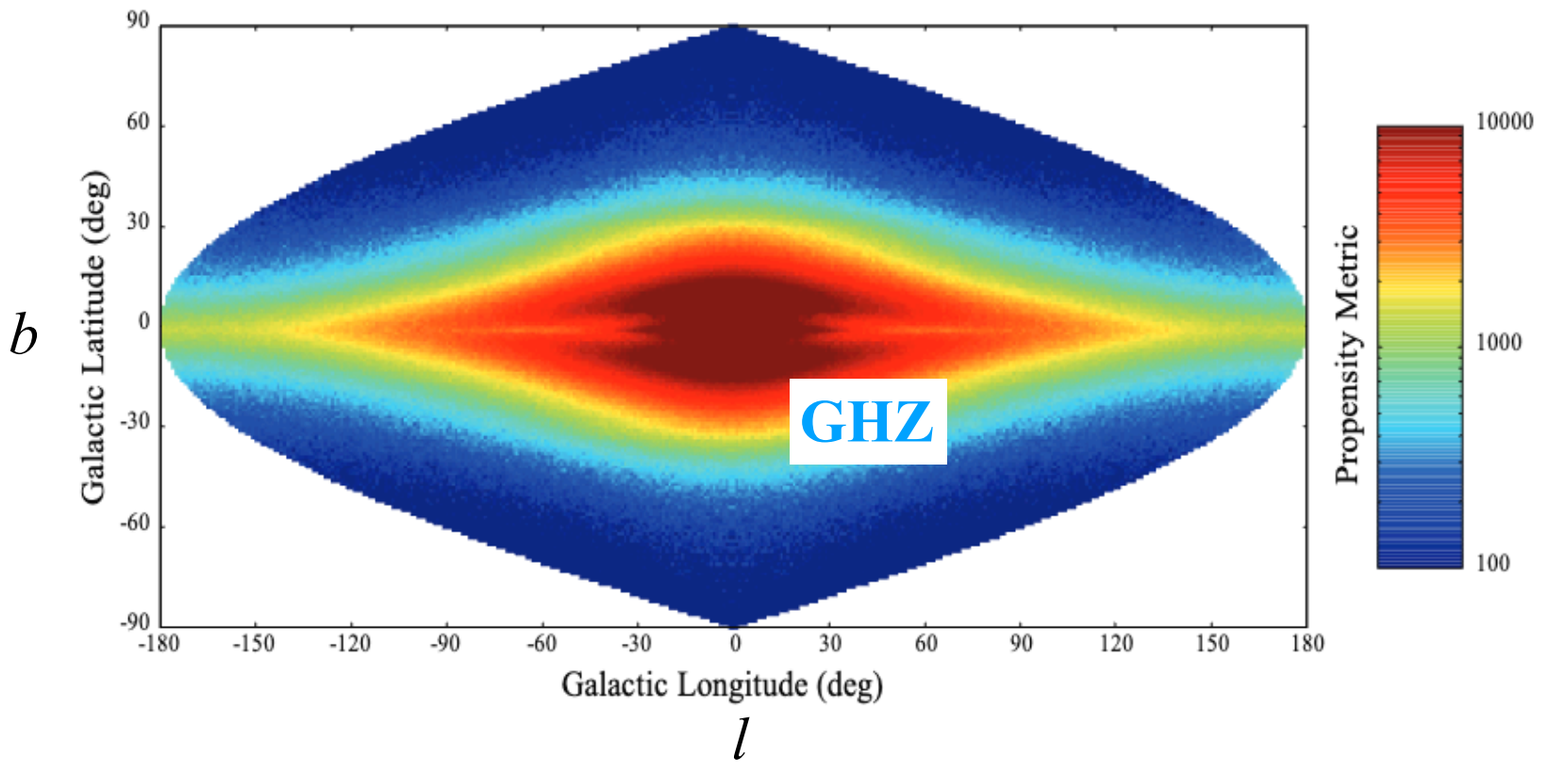
- There are **two** possible SETI observing strategies

1. Select and observe regions where **life is likely to be born** (areas with many sun-like stars and few supernova explosions, it is called “galactic habitable zones (**GHZ**)”)

2. Blind surveys of large area of the sky

The region of the sky centered on the galactic center and spanning approximately 60° of longitude and 30° of latitude is especially attractive





Sensitivity

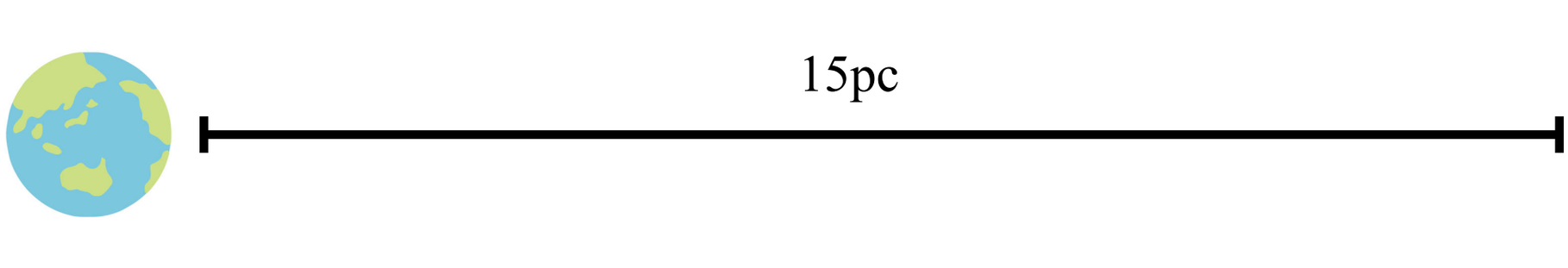
Artificial extraterrestrial radio sources on the earth (they have bands probed by SKA)

Transmitter Type	Luminosity (EIRP) (ergs/sec)	Number on Earth
 Interplanetary Radar	~2 x 10^{20}	Few
 Long Range Aircraft Radar	~1 x 10^{17}	Dozens
 High Power TV and Radio	~5 x 10^{12}	Hundreds

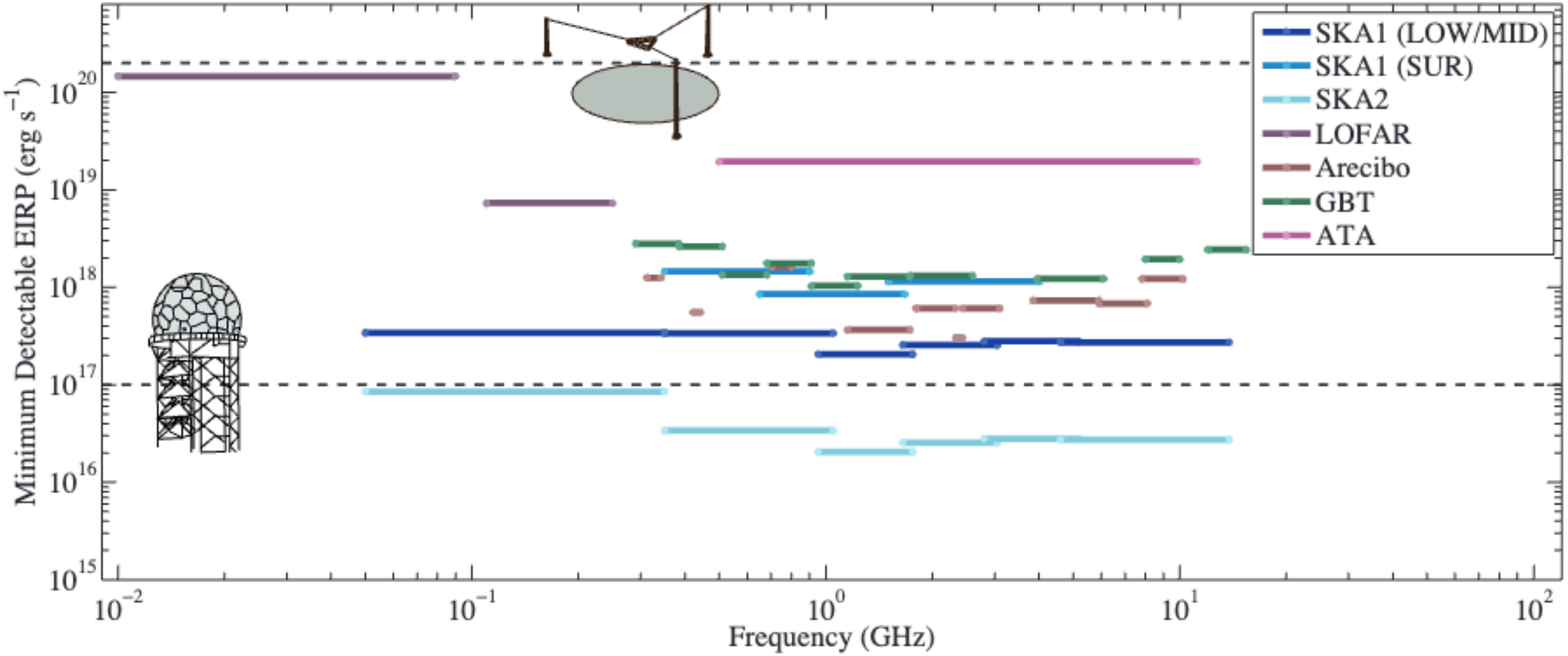
If ET also uses such radio sources, can we detect their signals??

Sensitivity

- Sensitivity of SKA (and other) telescopes for transmitters at 15 pc



- Maximum integration time is 10 mins.

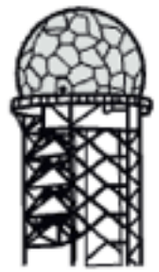


Sensitivity

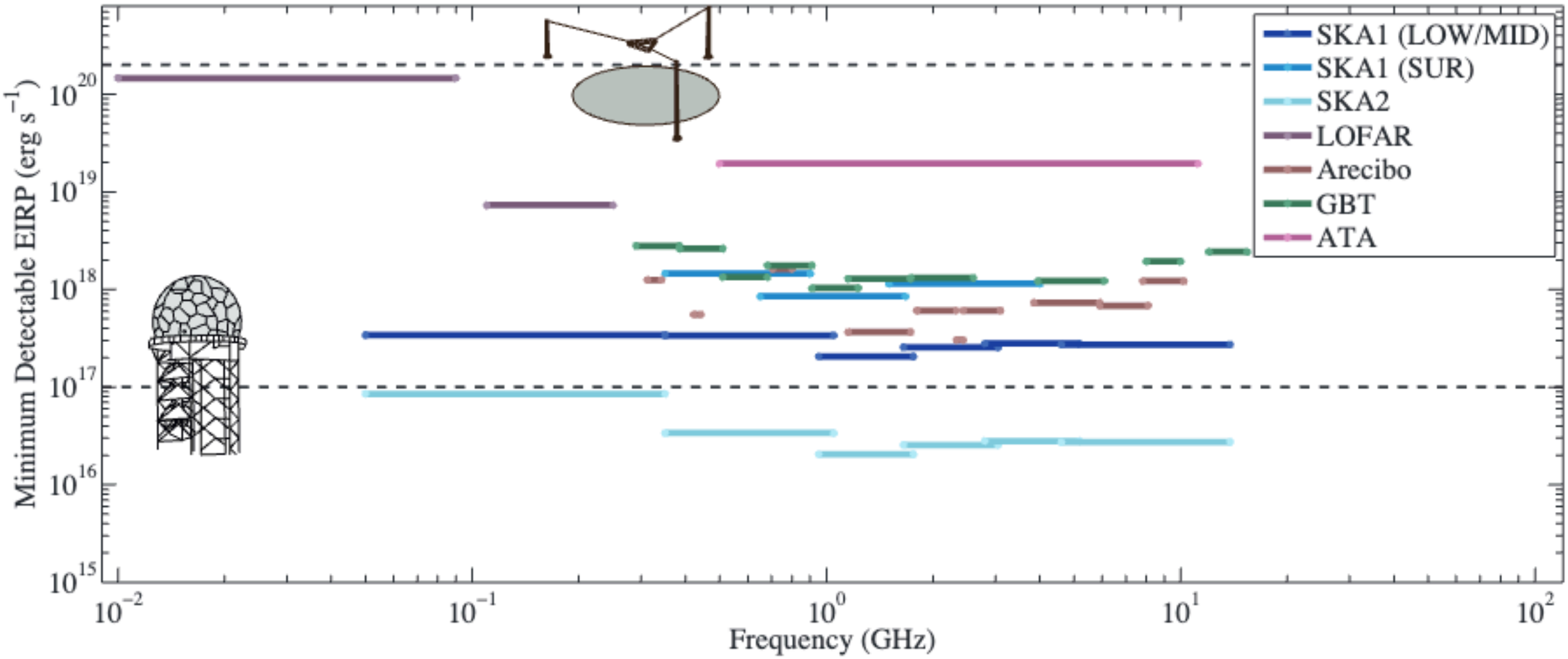
Interplanetary Radar

•All telescopes listed here can detect radio signal which has EIRP $\geq 2 \times 10^{20}$ erg/s

•SKA2 can detect radio signal which has EIRP $\leq 10^{17}$



Long Range Aircraft Radar



If intelligent life exists within 15 pc of Earth and they are using aircraft, SKA2 potentially can detect their signals!

SETI at FAST in China

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Abstract. Since the commencement of the first SETI observation in 2019, China's Search for Extraterrestrial Intelligence program has garnered momentum through domestic support and international collaborations. Several observations targeting exoplanets and nearby stars have been conducted with the FAST. In 2023, the introduction of the Far Neighbour Project(FNP) marks a substantial leap forward, driven by the remarkable sensitivity of the FAST telescope and some of the novel observational techniques. The FNP seeks to methodically detect technosignatures from celestial bodies, including nearby stars, exoplanetary systems, Milky Way globular clusters, and more. This paper provides an overview of the progress achieved by SETI in China and offers insights into the distinct phases comprising the FNP. Additionally, it underscores the significance of this project's advancement and its potential contributions to the field.

Summary

- The SKA will enable the most sensitive and comprehensive search for SETI, using its vast collecting area, and sensitive receivers.

- Most SETI observations will be done commensally, where SETI programs share telescope time with other scientific observations, maximizing the use of SKA's capabilities.

- A multi-faceted approach to target selection includes focusing on stars and exoplanets most conducive to life, and other astronomical features of interest like galactic habitable zones.

- The SKA will be the most sensitive SETI system, capable of detecting signals from advanced extraterrestrial civilizations with the ability to detect transmitters with various power levels.