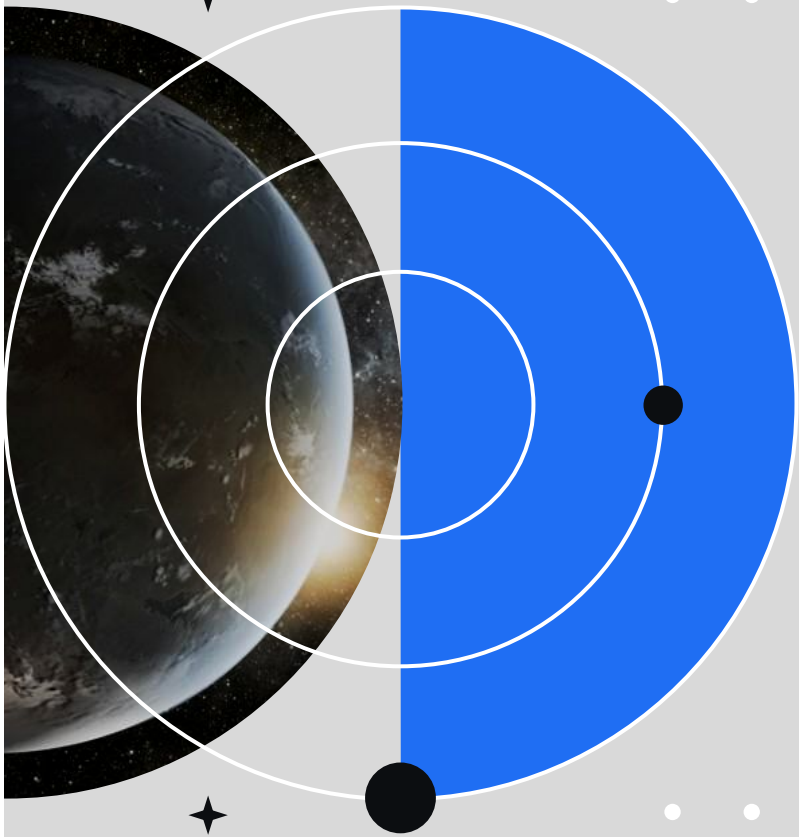
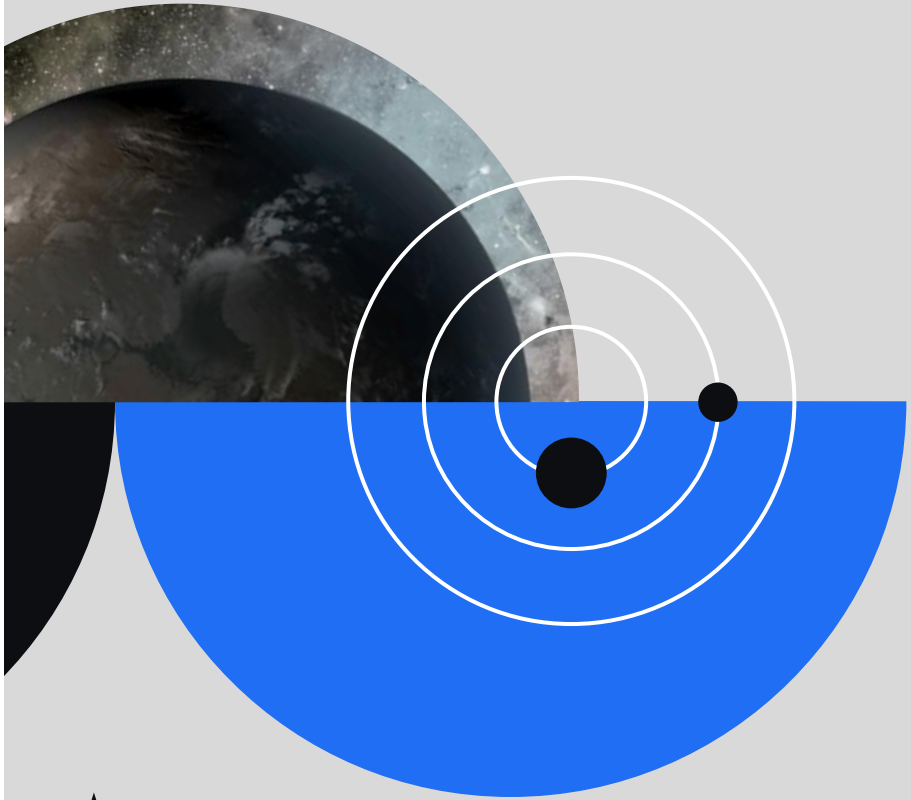


Kepler 62-e

Habitable???

Can we inhabit it?



WELCOME ABOARD

Let’s look, what makes Kepler 62-e particularly habitable and compare the conditions with earth

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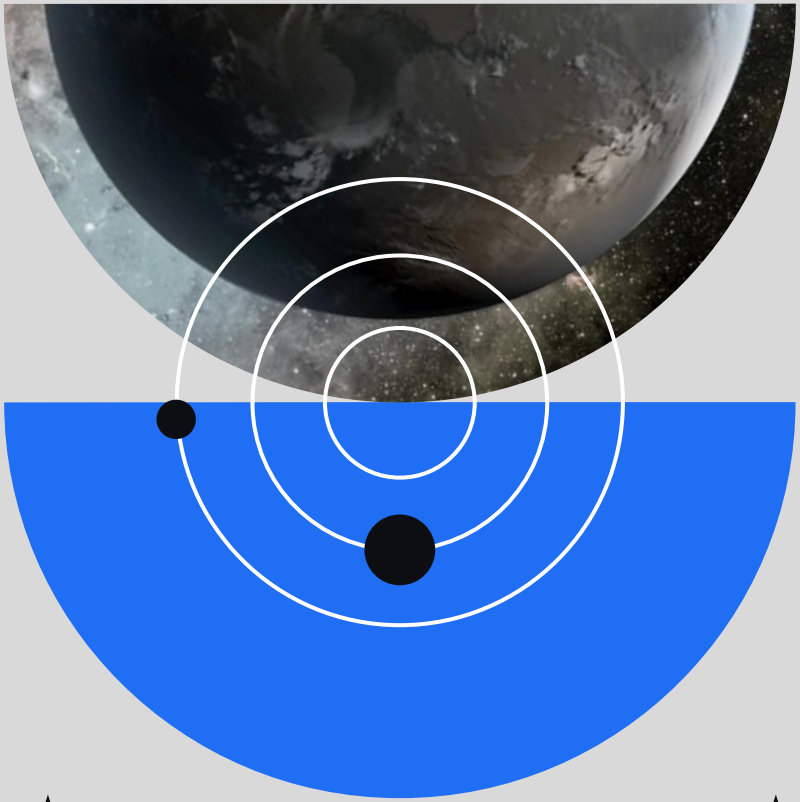


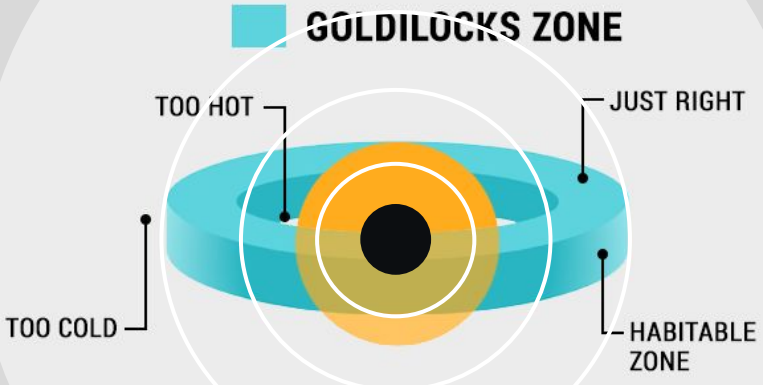
01

Introduction

What makes a planet
Habitable???

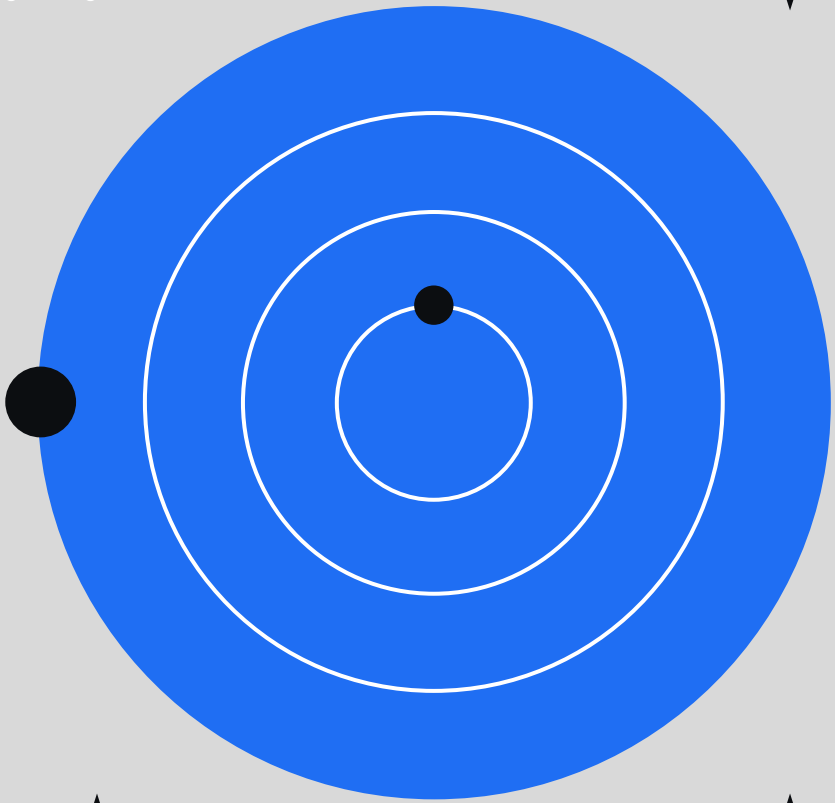
Goldilocks Zone

The '**Goldilocks Zone**,' or **habitable zone**, is the range of distance with the right temperatures for water to remain liquid. Rocky exoplanets found in the habitable zones of their stars, are more likely targets for detecting liquid water on their surfaces.



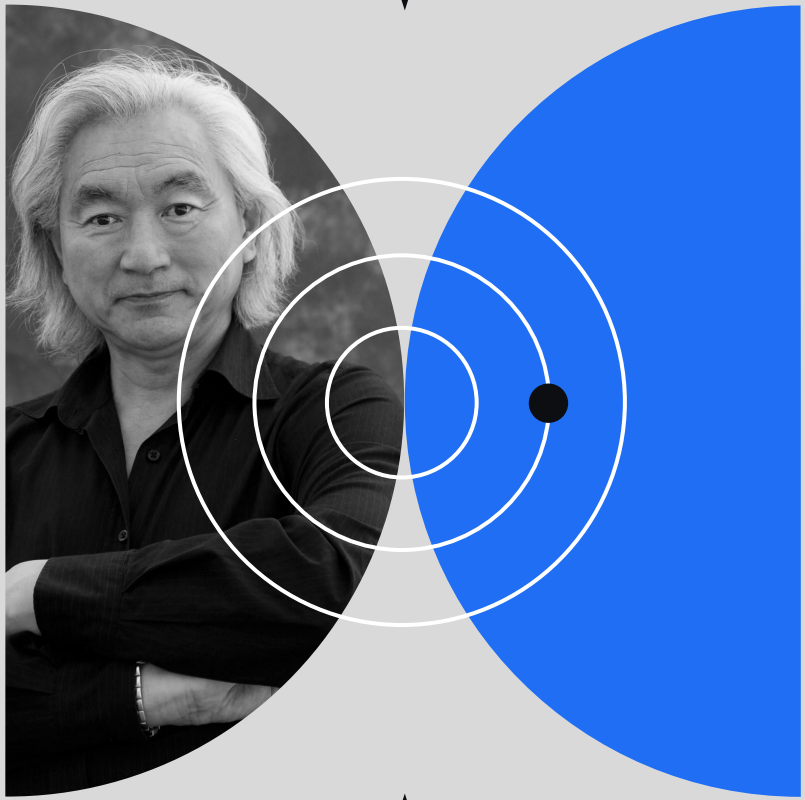
Parameters for Habitability

- Distance from host star
- Size of the Planet
- Temperature
- Magnetosphere
- Chemical composition of the planet
- Climatic and Planetary conditions
- Tilt, Moon etc.....



“One in 200 stars has habitable Earth-like planets surrounding it – in the galaxy, half a billion stars have Earth-like planets going around them – that’s huge, half a billion. So when we look at the night sky, it makes sense that someone is looking back at us.”

- MICHIO KAKU

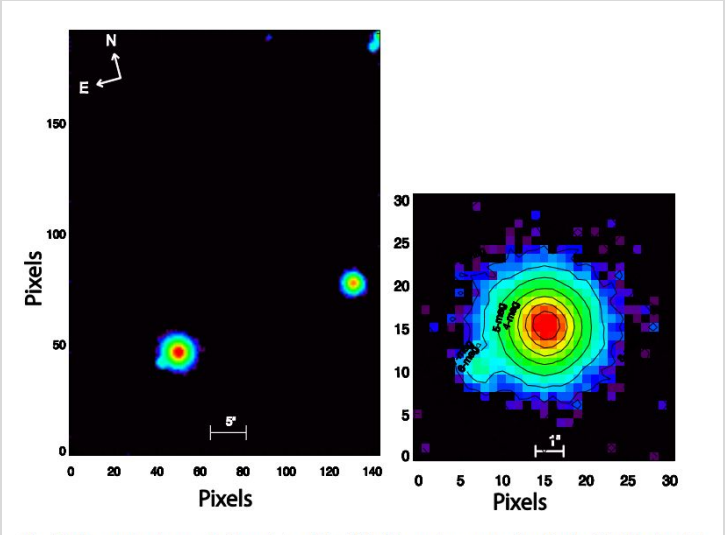


02 INSIDER INFO

Data on Kepler 62e

Kepler-62

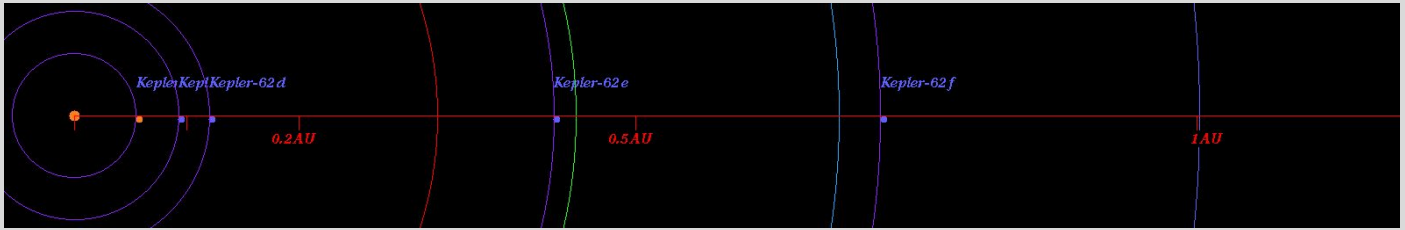
- Kepler 62-e is in the habitable zone of its host star Kepler-62.
- Star info:
  - Kepler-62 is a K-type main-sequence star and is approximately 69% the mass of and 64% the radius of the Sun.
  - It has a temperature of 4925 K (Sun - 5778 K) and is 7 billion years old (Sun - 4.6 billion years)
  - Kepler-62 is located about 1200.3 light-years away from our Solar System.
  - It was discovered by the Kepler Spaceship in its first expedition from 2009-2012, in search of stellar systems.



Permitted distance for habitability calculation (img attached in the next slide) - The Star Kepler-62 's habitable zone is located at the following distance:

- Inner Boundary (the orbital distance at Venus's Equivalent Radiation) : 0.336 AU (50309564.3 km)
- Earth Boundary (the orbital distance at Earth's Equivalent Radiation) : 0.465 AU (69540965.3 km)
- Outer Boundary (the orbital distance at Mars's Equivalent Radiation) : 0.708 AU (105965041.8 km)
- Snow Line (the orbital distance at Snow Line Equivalent Radiation) : 1.042 AU (155932201.0 km)

Kepler-62E

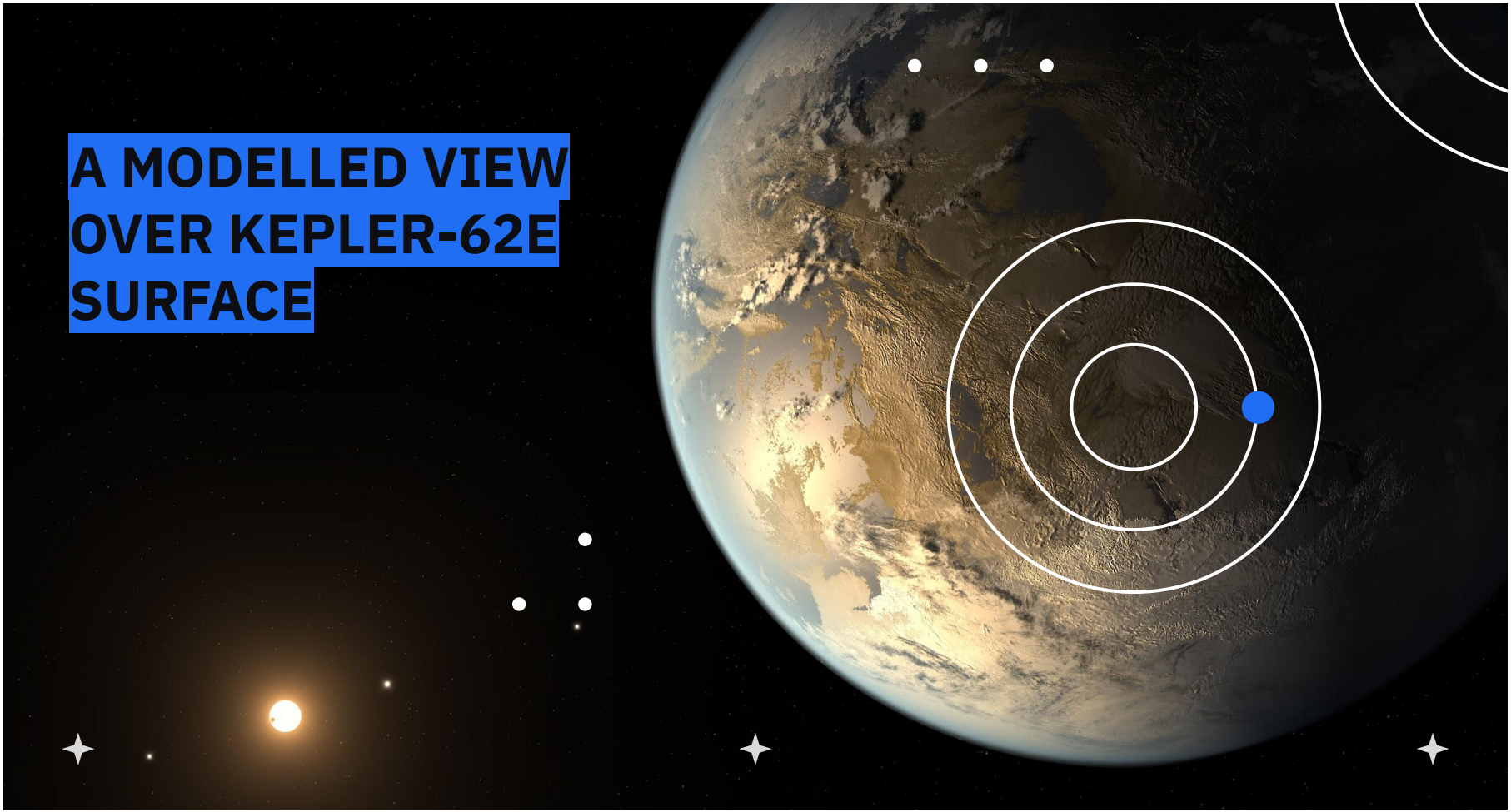


Solar System and Position

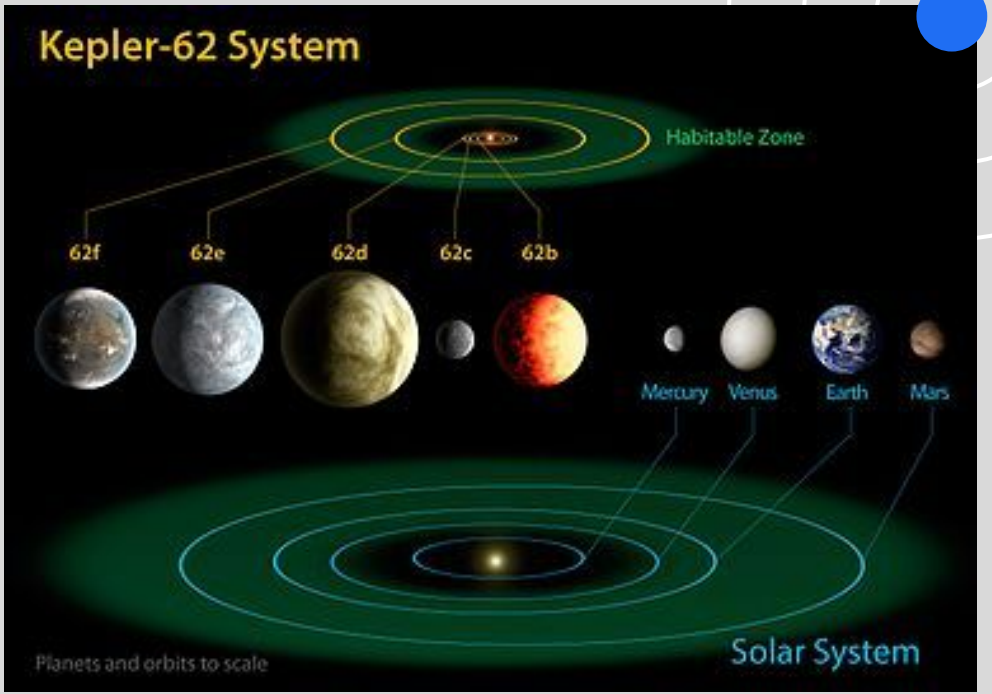
Kepler 62E is the 4th planet in the five-planet system about 1,200 light-years from Earth in the constellation Lyra

Companion (in order from star)	Mass	Semimajor axis (AU)	Orbital period (days)	Eccentricity	Inclination	Radius
e	$4.5^{+14.2}_{-2.6}\ M_\oplus$	0.427 ± 0.004	122.3874 ± 0.0008	—	89.98 ± 0.02°	1.61 ± 0.05 $R_\oplus$
f	$2.8^{+7.4}_{-1.6}\ M_\oplus$	0.718 ± 0.007	267.29 ± 0.005	—	89.9 ± 0.03°	1.41 ± 0.07 $R_\oplus$

A MODELLED VIEW OVER KEPLER-62E SURFACE



Kepler-62 System

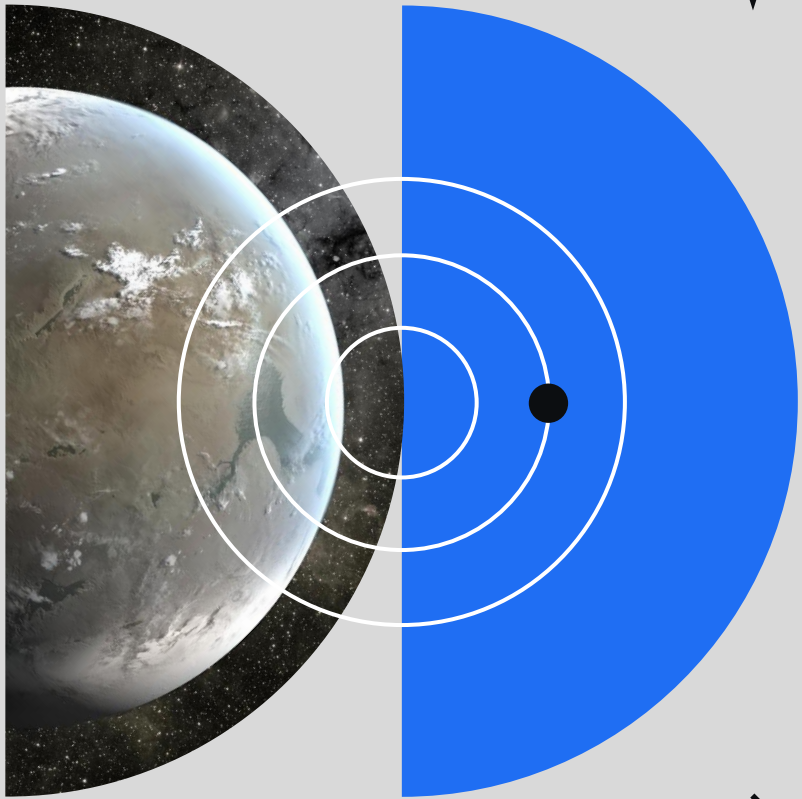


Comparison of Kepler-62 system with our own solar system

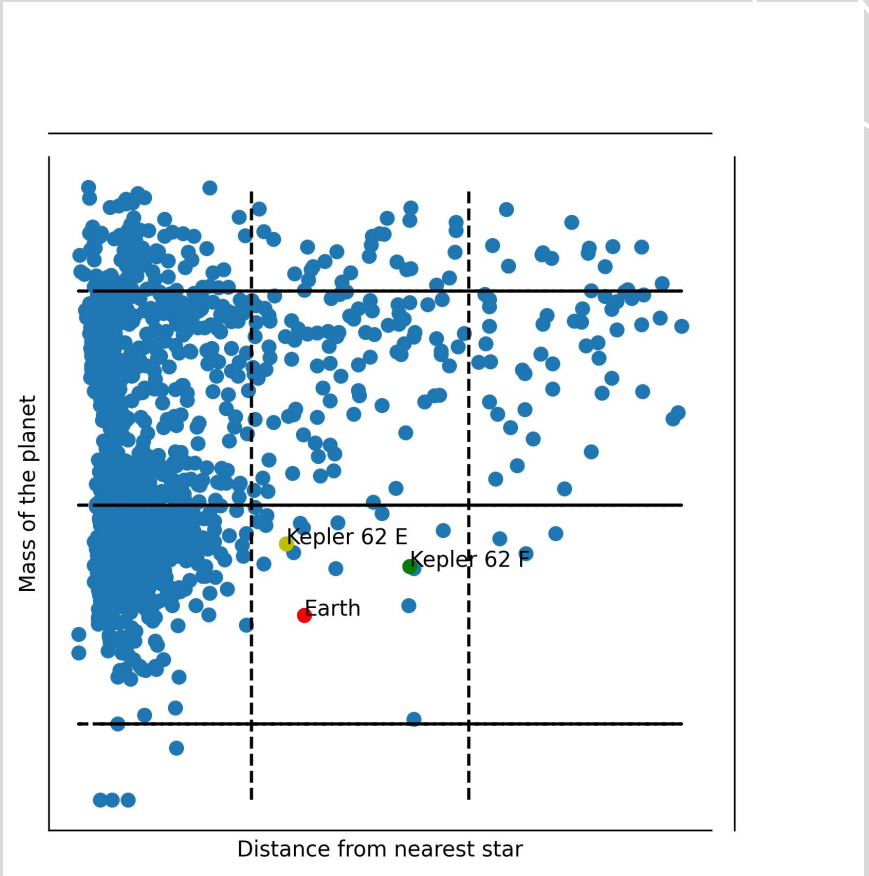
03

ANALYSIS

Comparison with other habitable planets



Habitability wrt the almighty EARTH!



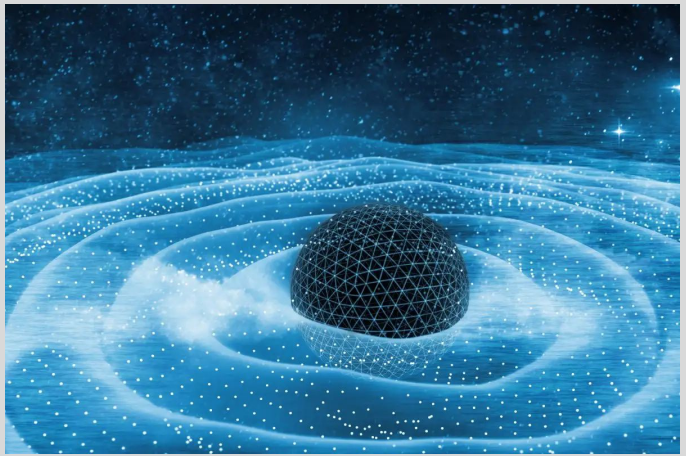
Why do we think 62E is Habitable?

- **Distance from the host star**
  - Kepler 62E falls in the circumstellar habitable zone of its star, Kepler 62.

- **Chemical composition**
  - The distance range where, for a given chemical composition (significant amounts of carbon dioxide for Kepler-62f, and a protective cloud cover for Kepler-62e), these two planets could have liquid water on their surfaces,perhaps completely covering them

Why do we think 62E is Habitable?

- **Gravity:**
  - Gravity depends on the mass and the density of the planet, which in turn makes low mass planets in-habitable as they have weak gravity.
  - Simulations revealed that a balanced state for a given stellar irradiation (found out by analysing the star) requires radius to be comparable to the Earth's radius.
  - Inner edge of the goldilock zone which is affected by the maximum value of OLR(infinity) is also in turn directly affected by the gravitational field.



ORL$\infty \alpha$ Gravitational field

Why do we think 62E is Habitable?

- **Magnetosphere**

Protection against EM waves

Acts as a barrier towards solar flares and other outbursts like gamma radiation

Atmospheric factors

Atmospheric position and its composition is also affected by the strength of magnetic field

Decline with age

Core mantle interactions and core solidification weakens the magnetic field

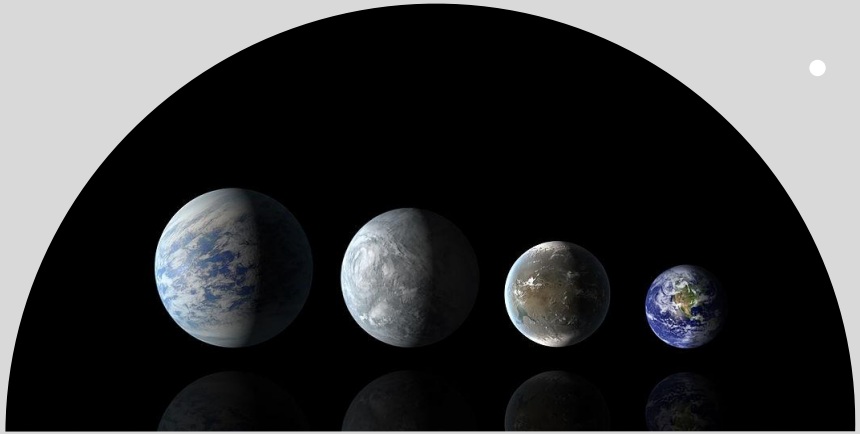
Why do we think 62E is Habitable?

- **Stability w.r.t Solar System:**
  - To keep this ,highly sensitive to perturbations planetary system stable, no additional giant planets can be located within 30 AU from the parent stars.

- **Rotation:**
  - The day night cycles are important to maintain a certain temperature.

- **Temperature:**
  - The modeling study suggests that Kepler-62e would have a very hospitable climate for life, as it would be a damp and warm environment even up to the area around its poles.
  - Being at the right distance from its sun, Kepler 62E has an average temperature of **T_{avg}: 270 K (–3 °C; 26 °F)**

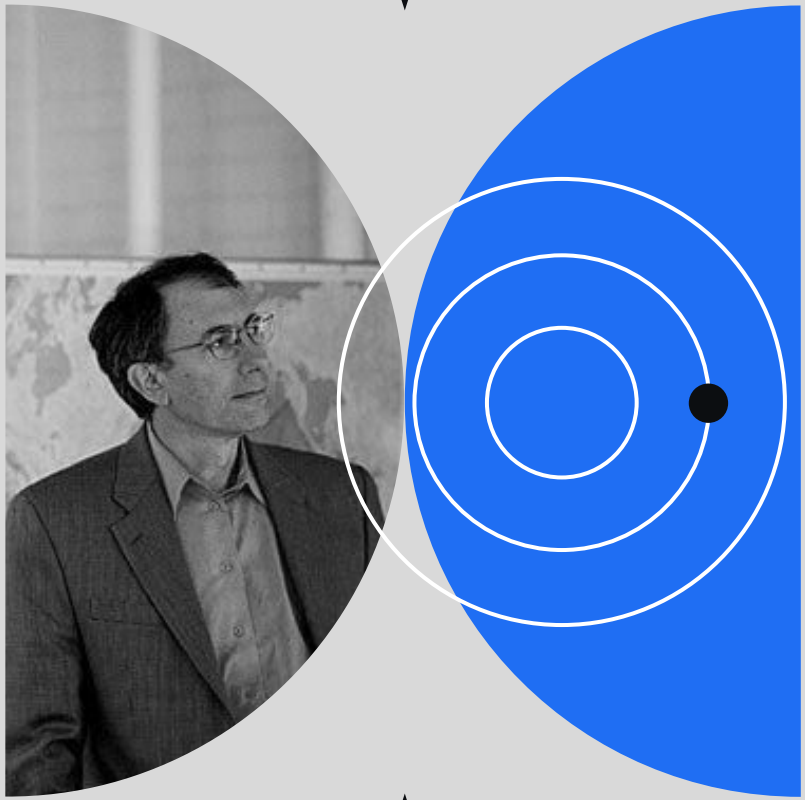
Size comparsion



Comparison of the sizes of planets Kepler-69c, Kepler-62e, Kepler-62f, and the Earth

“Kepler-62e probably has a very cloudy sky and is warm and humid all the way to the polar regions,Kepler-62f would be cooler, but still potentially life-friendly.”

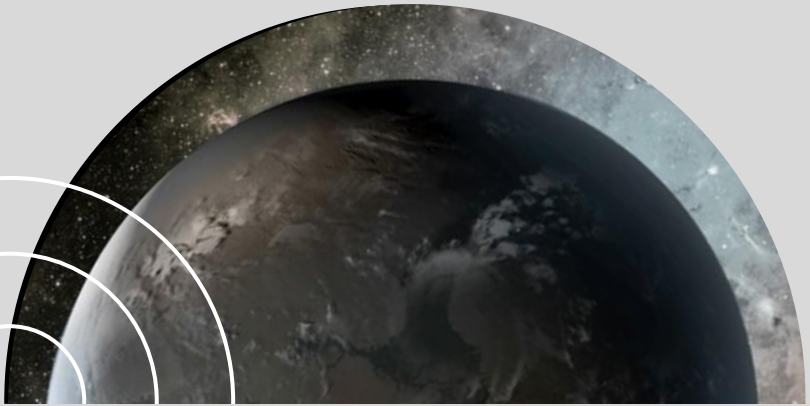
- Dimitar Sasselov



Conclusions

04

We make a few inferences based on the previous data



Other Habitable Planets

Kepler 62f

It belongs to the same solar system as Kepler 62E

Kepler 69*

It is thought to be habitable but recent studies state otherwise

Kepler 442b

Kepler-442b is a confirmed near earth sized exoplanet orbiting within the habitable zone of star Kepler-442

Tau ceti f

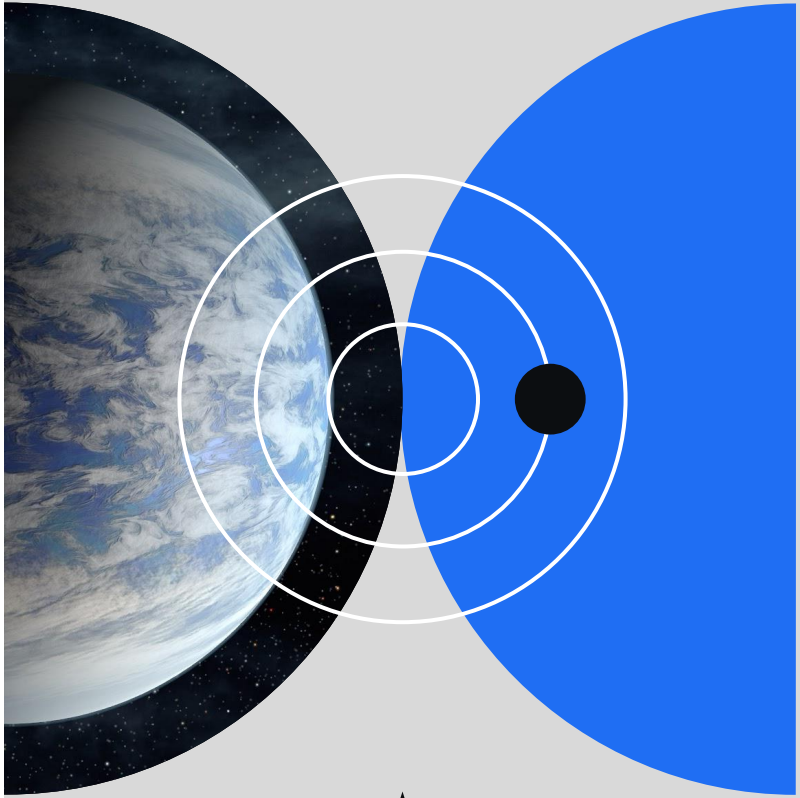
Tau Ceti f is a super earth or mini-Neptune orbiting Tau Ceti, discovered in 2012

Kepler 9D

Kepler-9d is a planet in orbit around the sun-like star Kepler-9

Mars

Belonging to our own solar system Mars is considered to a Habitable planet



Kepler 69

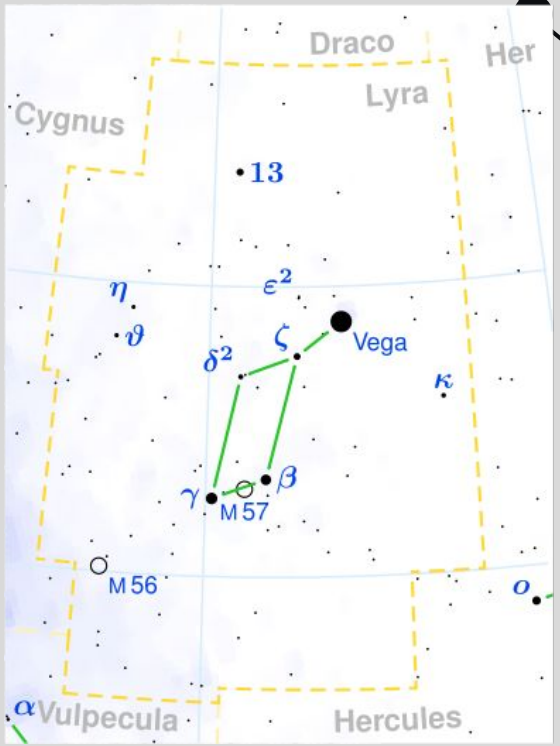
Initially it was considered habitable, then we found that it was too hot to handle

SOME INTERESTING FACTS

- Although Kepler-62f may be an ocean-covered planet possessing rock and water at the surface, it is the farthest out from its star, so without a supplementary amount of carbon dioxide (CO_2), it may be a planet covered entirely in ice.
- Some researchers believe that Kepler-62E can be a water world and given it's distance from its host and a possibility of atmosphere, it is highly likely it might be true.
- There are planets outside the habitability zone of stars which are assumed to be habitable.
    - Outside the CHZ, tidal heating and radioactive decay are two possible heat sources that could contribute to the existence of liquid water

62e vs 62f

- Both 62e and 62f belong to the same planetary system and yet they differ in a lot of aspects
- 62f being further away from it's star receives a lot less energy and thus has to rely on its own atmosphere to maintain a habitable temperature
- 62e is larger in size when compared to 62f and thus have a higher gravitational pull which increases the chances for an atmosphere.
- As the warmer of the two worlds, Kepler-62e would have a bit more clouds than Earth according to computer models. More distant Kepler-62f would need the greenhouse effect from plenty of carbon dioxide to warm it enough to host an ocean. Otherwise, it might become an ice-covered snowball.



The solar system around Kepler 62

How to make a planet habitable?

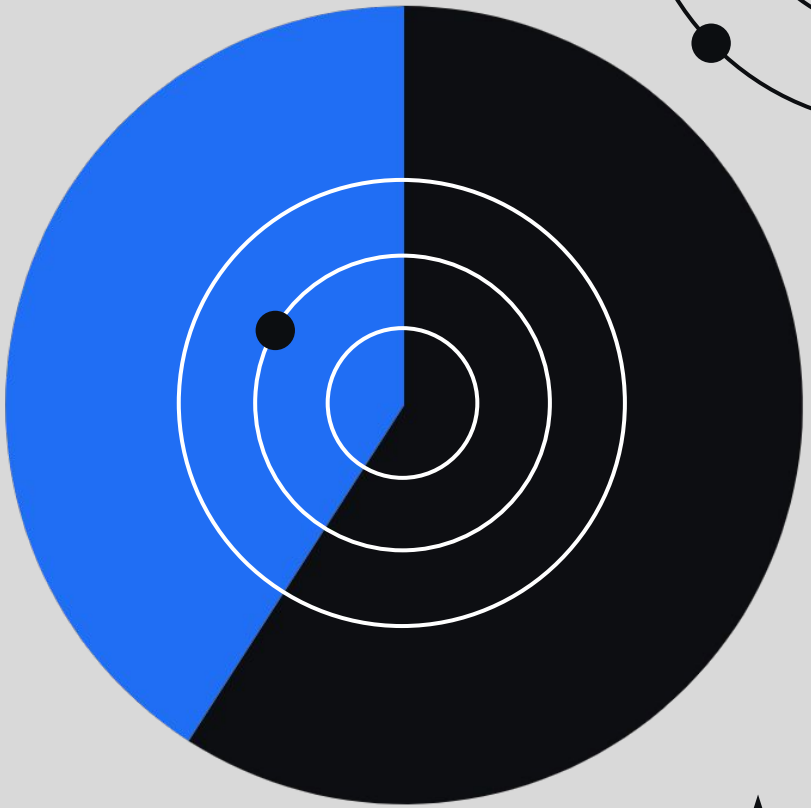
Too cold?

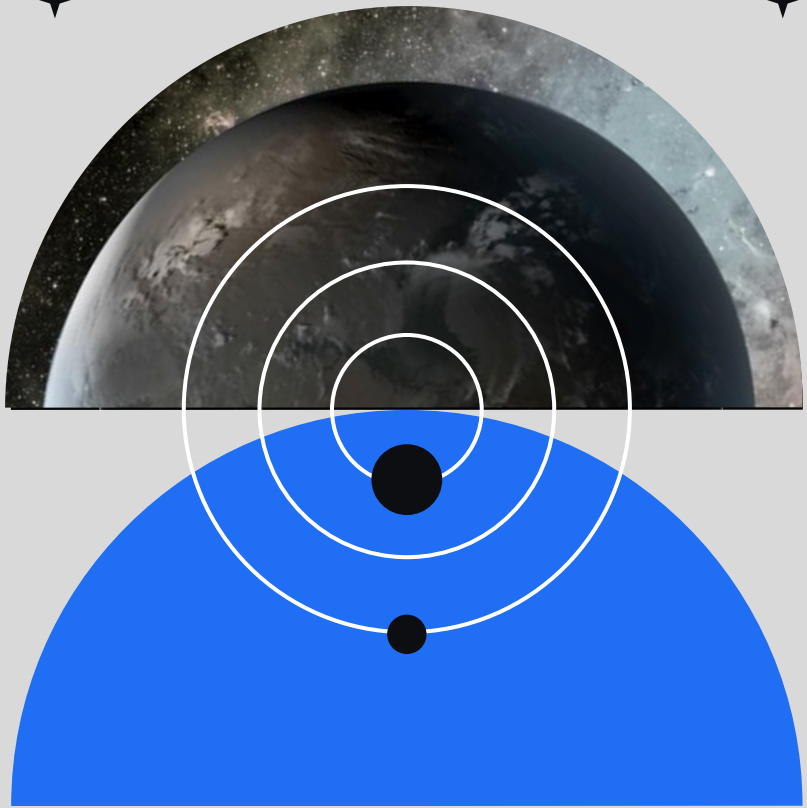
Too Hot?

No Liquid water?

No Atmosphere?

No Magnetosphere?





THANKS!

Kautilya, E-Block,
IIT Hyderabad