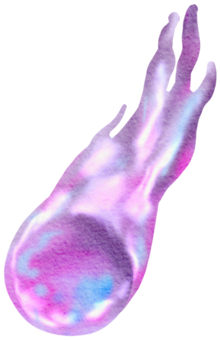
Vega

SPACE JOURNEY



EVERY PLANET IS A POTENTIAL HOME, EVERY STAR IS A DESTINATION, AND EVERY GALAXY, A NEW BEGINNING.

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Introduction

30+
Years of explorations

5500+
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Facilities

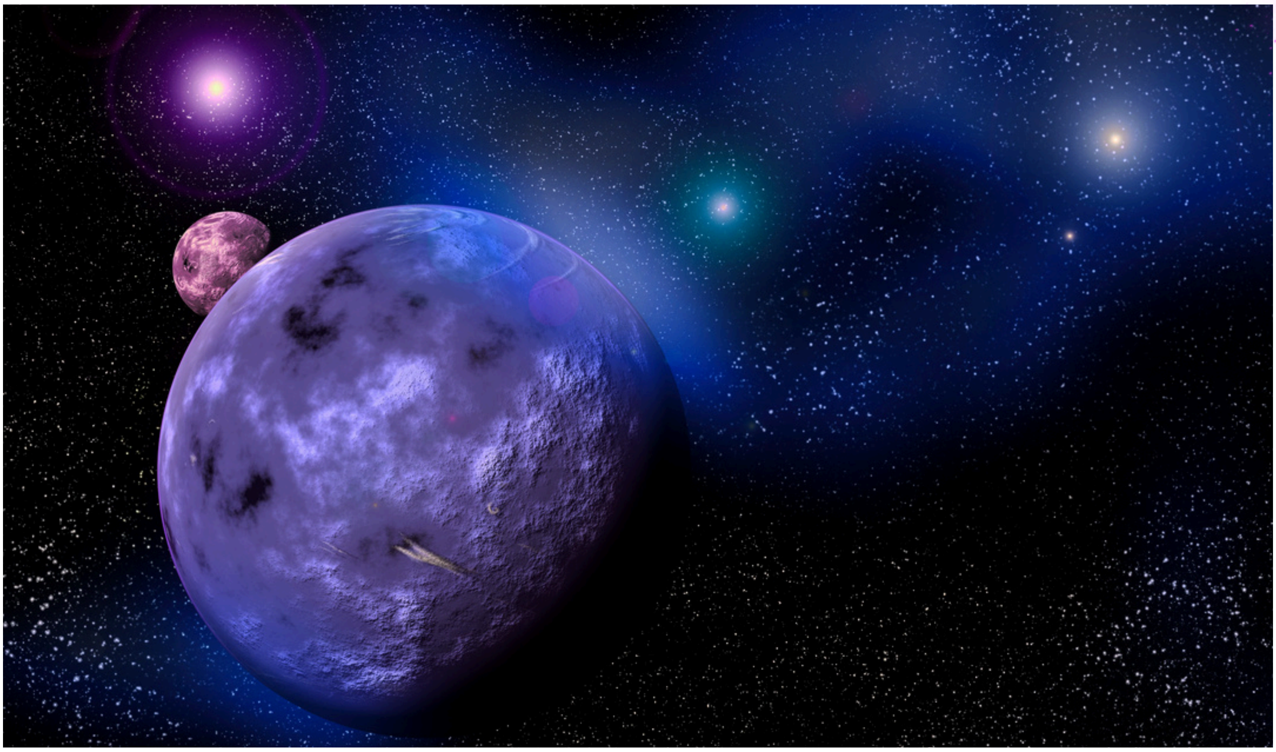
Ever wondered what planets exist beyond our solar system?
Welcome to the fascinating world of exoplanets: planets that orbit stars other than our Sun. With over 5,600 discovered and billions more likely to be found, these incredible worlds offer a cosmic adventure.

In Vega's E-book we'll take you on a journey through the universe to explore these distant planets. We'll discuss how scientists use specialized techniques, like observing the dimming of a star's light, to detect their presence. You'll learn about the diverse characteristics of exoplanets, from scorching hot gas giants to potentially Earth-like worlds.

But the most exciting question of all is: Could there be life on these exoplanets? To help answer this question, we've developed an AI model that can predict the likelihood of life on an exoplanet with over 98% accuracy.

Join us as we immerse into the mysteries of exoplanets and explore the possibility of life beyond our solar system.

Vega's Overview



Vision

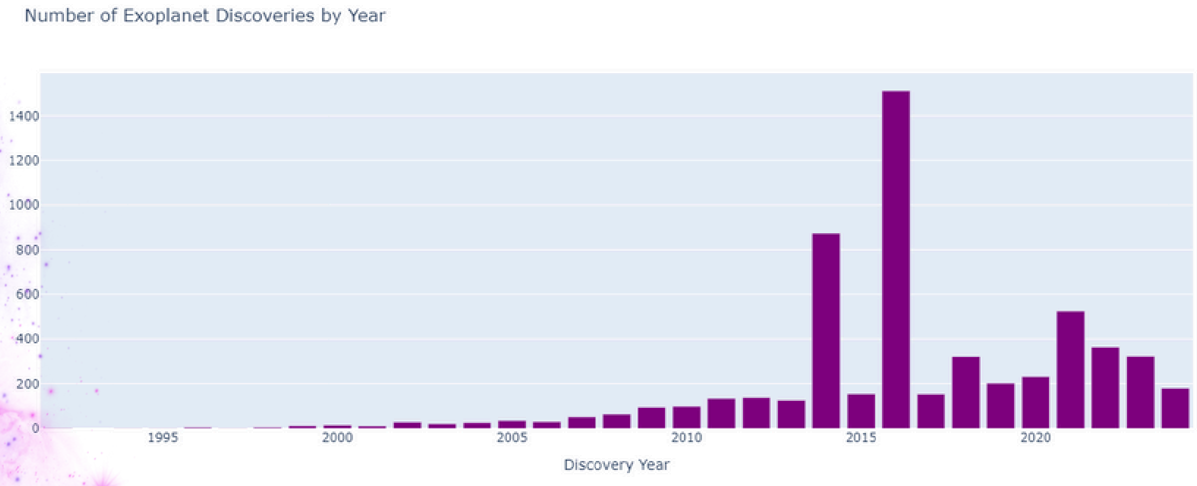
Unlocking the Secrets of the Cosmos One of the most fundamental questions in astronomy is whether life exists beyond Earth. The discovery of exoplanets has ignited our curiosity and brought this possibility closer to reality. We aim to inspire a new generation of explorers to join us in the search for answers.

Mission

Teaching high school students about exoplanets. It involves learning about what exoplanets are, the methods used to detect them, their characteristics, ongoing missions, and creating their own hypothetical exoplanet. The mission aims to provide students with a comprehensive understanding of exoplanets and their significance in space exploration.

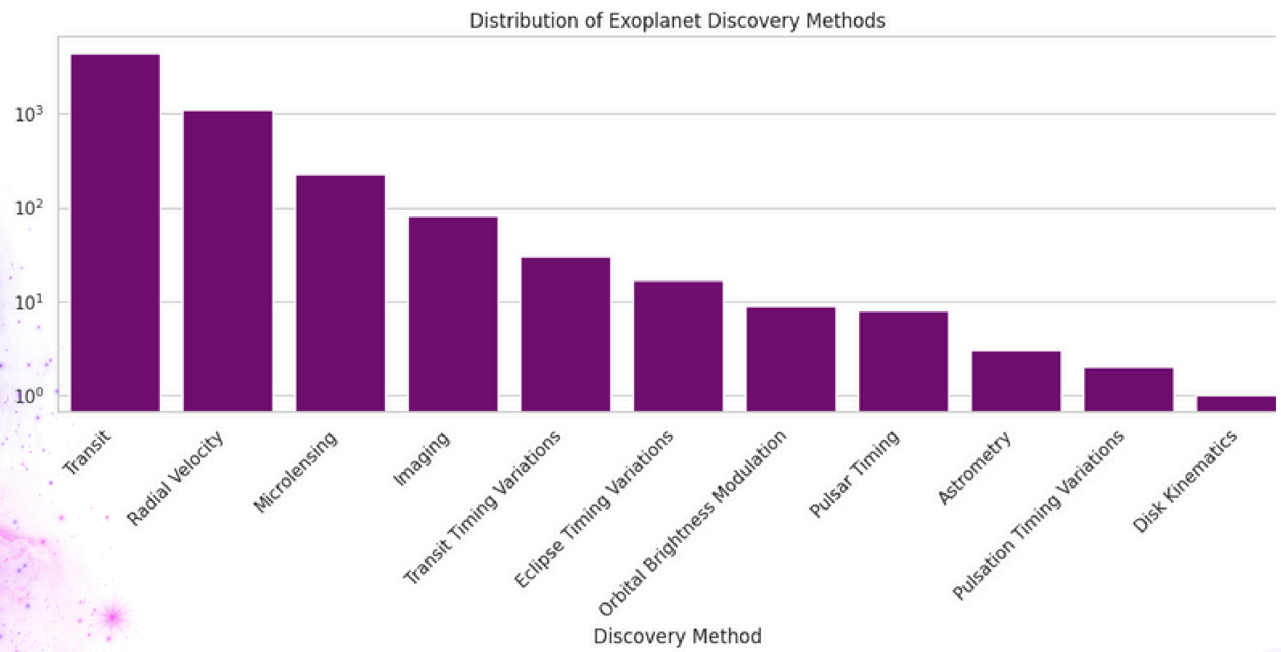
Exoplanet Discovery Trends

Exoplanets, or planets beyond our solar system, have become one of the most exciting fields in astronomy since the first discovery in 1992. That year marked the identification of the first exoplanet, signaling the start of a new era in our understanding of the universe. Until in 2016 the year which is the peak year for exoplanet findings. Interestingly, the discovery rate jumped notably in 2014, before returning to a steadier pace and reaching its highest record in 2016.



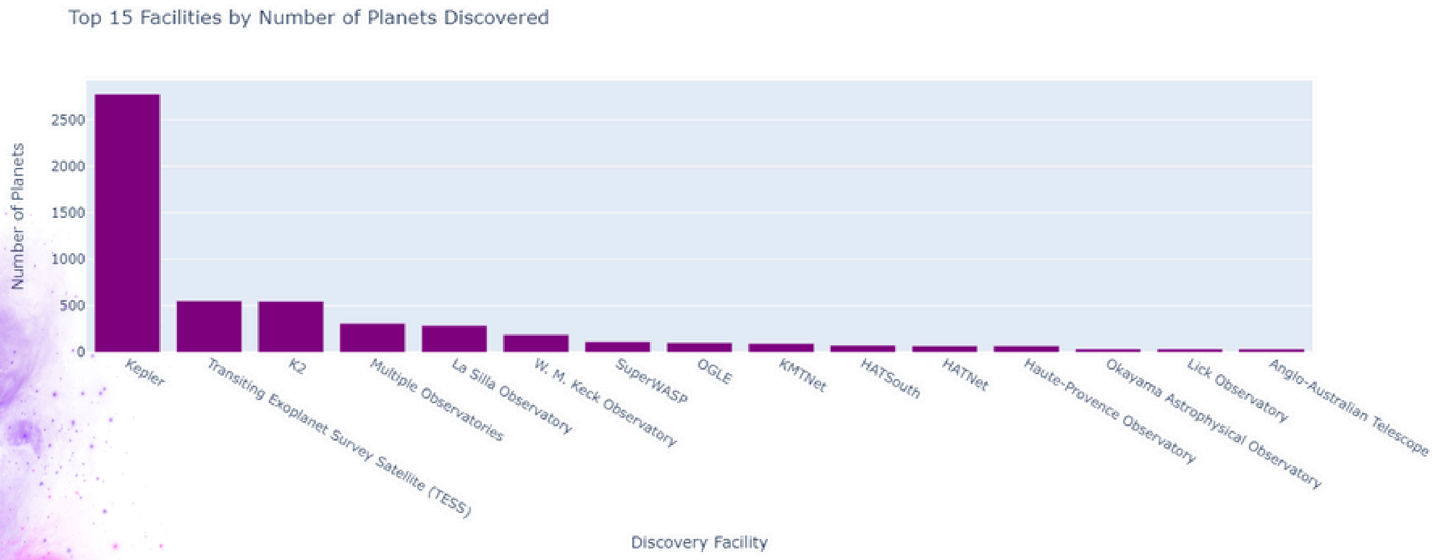
Exoplanet Discovery Trends

When it comes to the techniques used to find these distant worlds, the transit method stands out as the most commonly employed. This method, which involves detecting a planet as it passes in front of its host star, has significantly contributed to the number of discoveries over the years. In contrast, the radial velocity method, though used less frequently, has been applied steadily across various years.



Exoplanet Discovery Trends

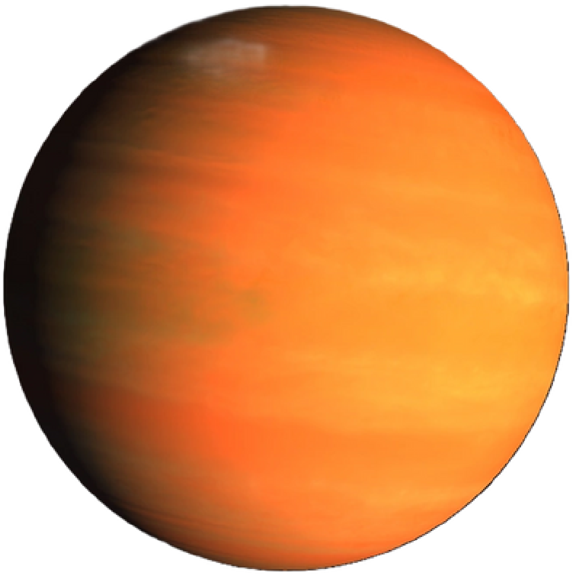
The role of observation facilities has been crucial in advancing exoplanet research. Kepler, for instance, is responsible for discovering an impressive 2,773 exoplanets, more than any other facility.
The Arecibo Observatory, however, holds the distinction of discovering the very first exoplanet, marking a historic milestone in space exploration.



51 PEGASI B

THE FIRST EXOPLANET EVER FOUND
ORBITING STAR LIKE OUR SUN

51 Pegasi b



Imagine a planet that's bigger than Jupiter but orbits its star really close. That's 51 Pegasi b, the first planet ever discovered outside our solar system! It's like a supersized gas giant, floating in space.

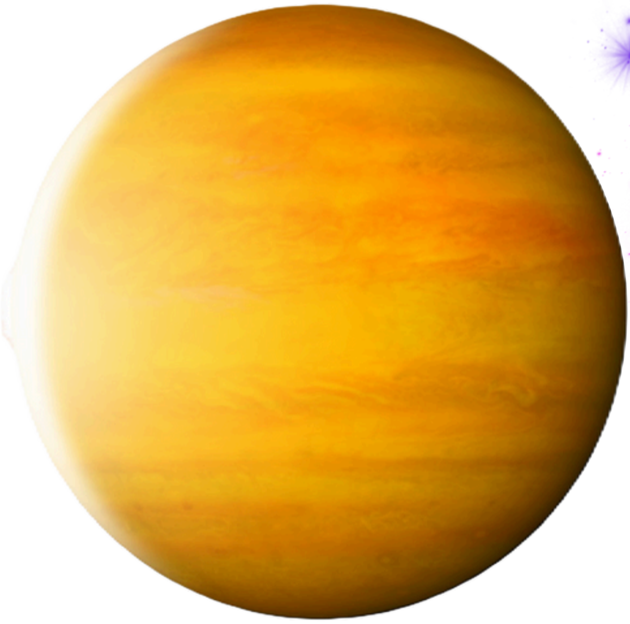
Discovery

Scientists found 51 Pegasi b by watching its star wobble. When a planet orbits a star, it pulls the star slightly, making it wobble. Scientists can measure this wobble and figure out if there's a planet there.

Comparison

51 Pegasi b is a gas giant, just like Jupiter. It's a little bit smaller than Jupiter, but it's still much bigger than Earth. It orbits its star really close, and its year is only 4 days long! That's much shorter than our year.

51 Pegasi b



Importance

51 Pegasi b is a really important planet because it was the first planet ever found outside our solar system. It showed us that there are other planets out there, and that they can be very different from the planets we know.

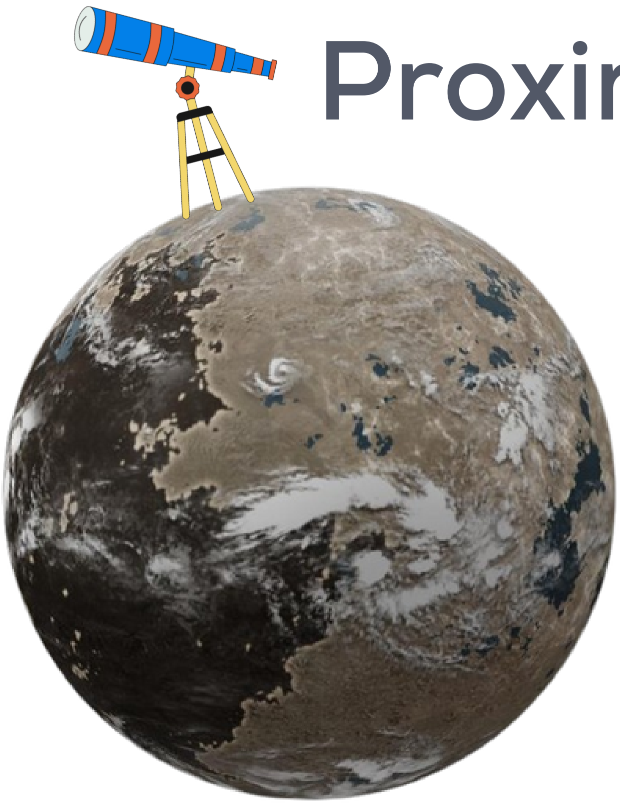
Potential of life based on our ML Model

51 Pegasi b is not considered habitable, primarily due to its close proximity to its host star, resulting in extreme conditions that are unsuitable for life. Our machine learning model corroborates this assessment, reinforcing the inhospitable nature of this exoplanet.

PROXIMA CEN B

OUR CLOSEST NEIGHBOR

Proxima Cen b



Imagine a planet just a stone's throw away from Earth. That's Proxima Cen b, the closest exoplanet to our solar system! It's like having a neighbor right next door in space.

Discovery

Scientists found Proxima Cen b by watching its star wobble. When a planet orbits a star, it pulls the star slightly, making it wobble. Scientists can measure this wobble and figure out if there's a planet there.

Comparison

Proxima Cen b is a little bit bigger than Earth, but it's not as big as Jupiter. It's also not as heavy as Earth. It's a small, rocky planet, just like our home. It's like finding a new friend in a galaxy far, far away!

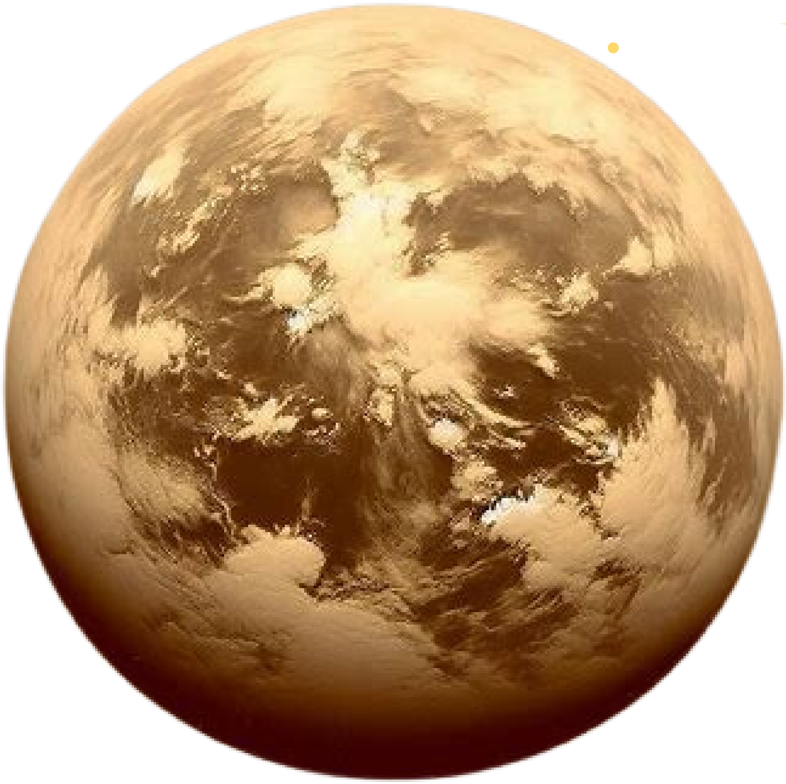
Proxima Cen b

Properties

Proxima Cen b orbits its star really close, and its year is only 11 days long! That's much shorter than our year. It's also pretty cold on Proxima Cen b, even though it's so close to its star.

Potential of life based on our ML Model

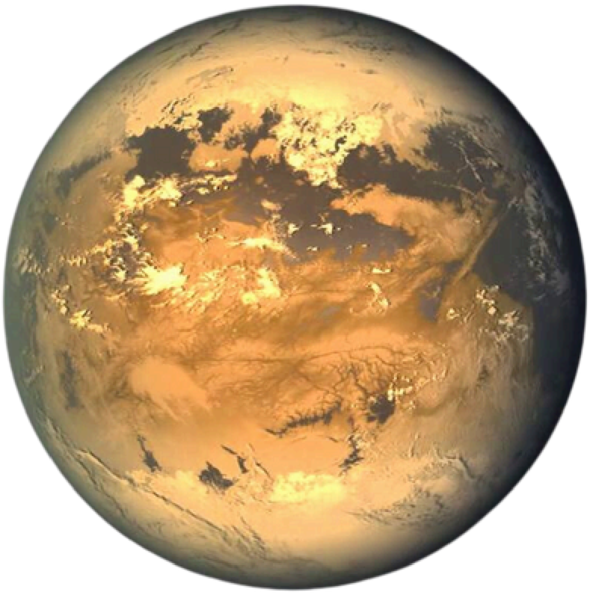
Proxima Cen b is a candidate for habitability, as it lies within the habitable zone of its star, where conditions could allow for liquid water. Our machine learning model highlights its potential as a site for life based on various favorable attributes.



KEPLER-186 F

A POSSIBLE EARTH-LIKE PLANET

Kepler-186 f



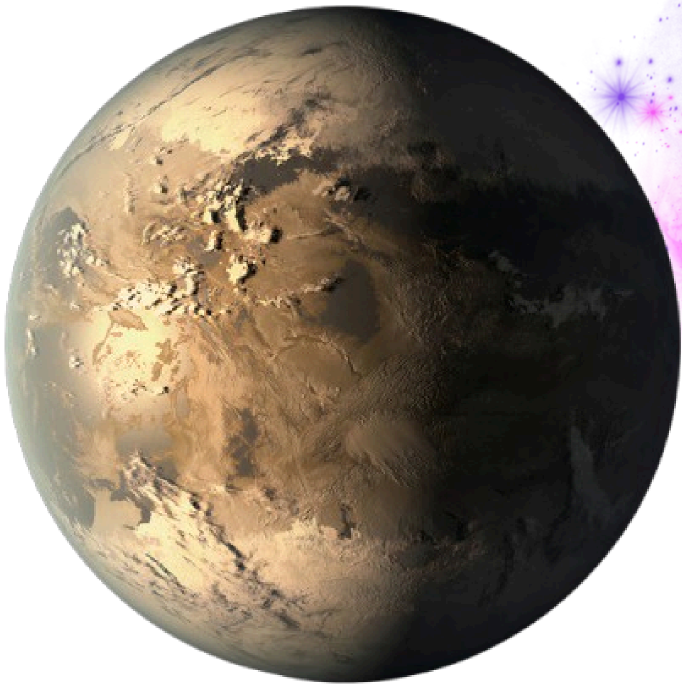
Imagine a planet that's a little bit bigger than Earth, orbiting a star similar to our Sun. That's Kepler-186 f, a fascinating planet that might be able to support life!

Discovery

Scientists found Kepler-186 f using a special telescope called Kepler. It's about 579 light-years away from Earth, which is a really long distance.

Comparison

Kepler-186 f is a rocky planet, just like Earth. It's a little bit bigger and heavier than Earth, but it's still pretty similar. It orbits its star much closer than Earth orbits the Sun, but the star is smaller and cooler, so it's not too hot for Kepler-186 f.



Kepler-186 f

Properties

The year on Kepler-186 f is much shorter than our year. It takes only 129 days to go around its star once! That's like having a really short summer and winter. Kepler-186 f is a really exciting planet because it's one of the first Earth-like planets ever discovered. It shows us that there might be other planets out there that could support life, just like Earth.

Potential of life based on our ML Model

Kepler-186f is considered potentially habitable due to its location within the habitable zone of its star, where conditions may allow for liquid water. This assessment is based on a machine learning model developed by our team, which analyzes various planetary characteristics.

55 CANCRI E

A SUPER-HOT PLANET

55 Cancri e

Imagine a planet that's twice the size of Earth but orbits its star so close it's incredibly hot. That's 55 Cancri e, a fascinating planet that's very different from anything in our solar system.

Discovery

Scientists found 55 Cancri e by watching its star wobble. When a planet orbits a star, it pulls the star slightly, making it wobble. Scientists can measure this wobble and figure out if there's a planet there.

Comparison

55 Cancri e is a super-Earth, which means it's bigger than Earth but smaller than a gas giant like Jupiter. It's really close to its star, and its year is less than 18 hours long! That's much shorter than our year.

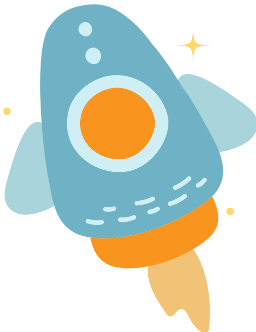
55 Cancri e

Properties

55 Cancri e is incredibly hot because it's so close to its star. It's one of the hottest planets ever discovered. It's so hot that it might be covered in lava!

Features

55 Cancri e is a really interesting planet because it shows us that there are all kinds of different planets out there, and they can have very extreme conditions. It's like a fiery ball of rock, floating in space.



COCONUTS-2B

THE PLANET WITH THE LONGEST YEAR

COCONUTS-2b

Imagine a planet that takes over a million Earth years to go around its star. That's COCONUTS-2b, the planet with the longest year ever discovered! It's like a supersized gas giant, floating in space.

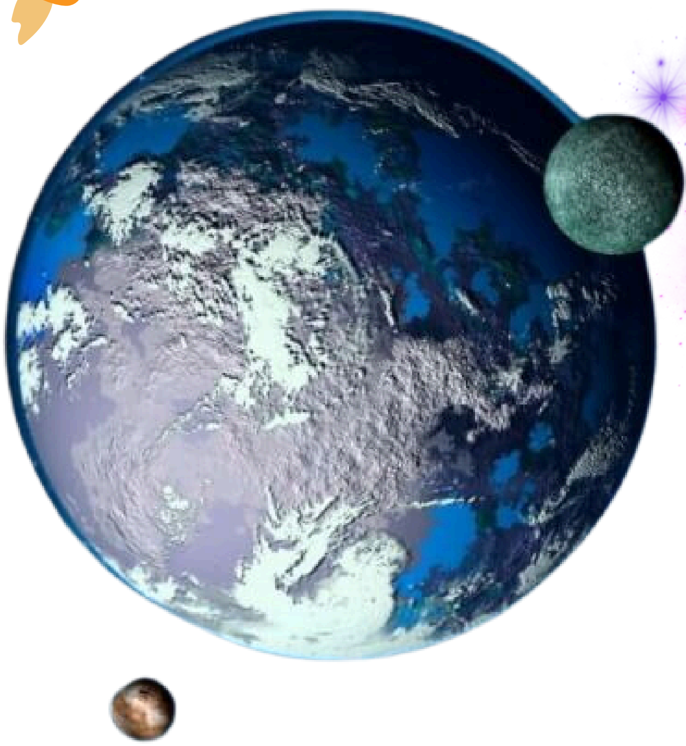
Discovery

Scientists found COCONUTS-2b using a special telescope that can see heat. It's so far away from Earth, it's about 35.5 light-years away. That's a really long distance!

Comparison

COCONUTS-2b is a massive gas giant, even bigger than Jupiter. It's so big that it could fit 2000 Earths inside it! It's also really far from its star, which is why it's so cold.

COCONUTS -2b



Properties

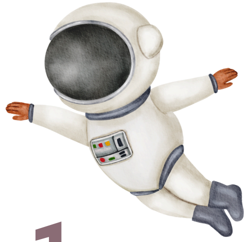
The year on COCONUTS-2b is incredibly long. It takes over a million Earth years to go around its star once! That's like waiting a million years for a birthday! It shows us that there are all kinds of amazing planets out there, waiting to be discovered.

Potential of life based on our ML Model

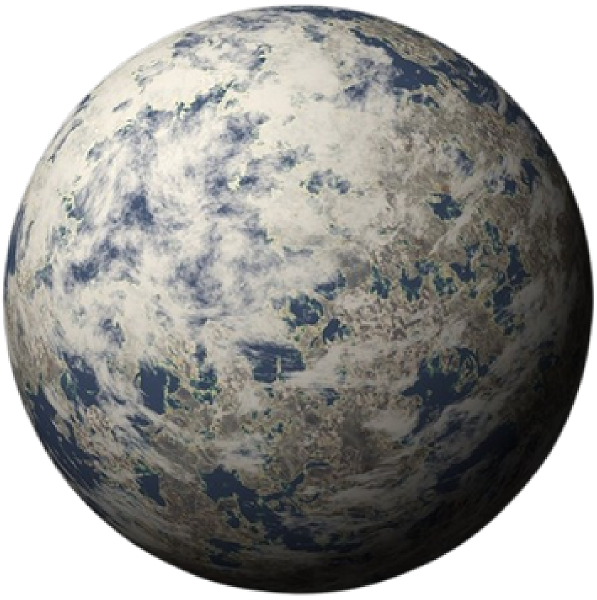
COCONUTS-2b is classified as non-habitable, with its large distance from its host star and gas giant composition making it unsuitable for life. Our machine learning model has determined that this exoplanet does not meet the necessary conditions for habitability.

TRAPPIST-1E

A POSSIBLE EARTH-LIKE PLANET



TRAPPIST-1e



Imagine a planet that's almost the same size as Earth, and might have liquid water. That's TRAPPIST-1e, a fascinating planet that could be a great place for life!

Discovery

Scientists found TRAPPIST-1e by watching its star wobble. When a planet orbits a star, it pulls the star slightly, making it wobble. Scientists can measure this wobble and figure out if there's a planet there.

Comparison

TRAPPIST-1e is a rocky planet, just like Earth. It's a little bit smaller and lighter than Earth, but it's still pretty similar. It orbits its star really close, but the star is much cooler than our Sun, so it's not too hot for TRAPPIST-1e.

TRAPPIST-1e

Properties

The year on TRAPPIST-1 e is only 6 days long! That's much shorter than our year. It's also possible that there could be liquid water on TRAPPIST-1 e, which is really exciting because liquid water is important for life. TRAPPIST-1e is a really interesting planet because it's one of the best places we've found so far that could have life. It shows us that there might be other planets out there that are like Earth, and that could be home to other creatures.

Potential of life based on our ML Model

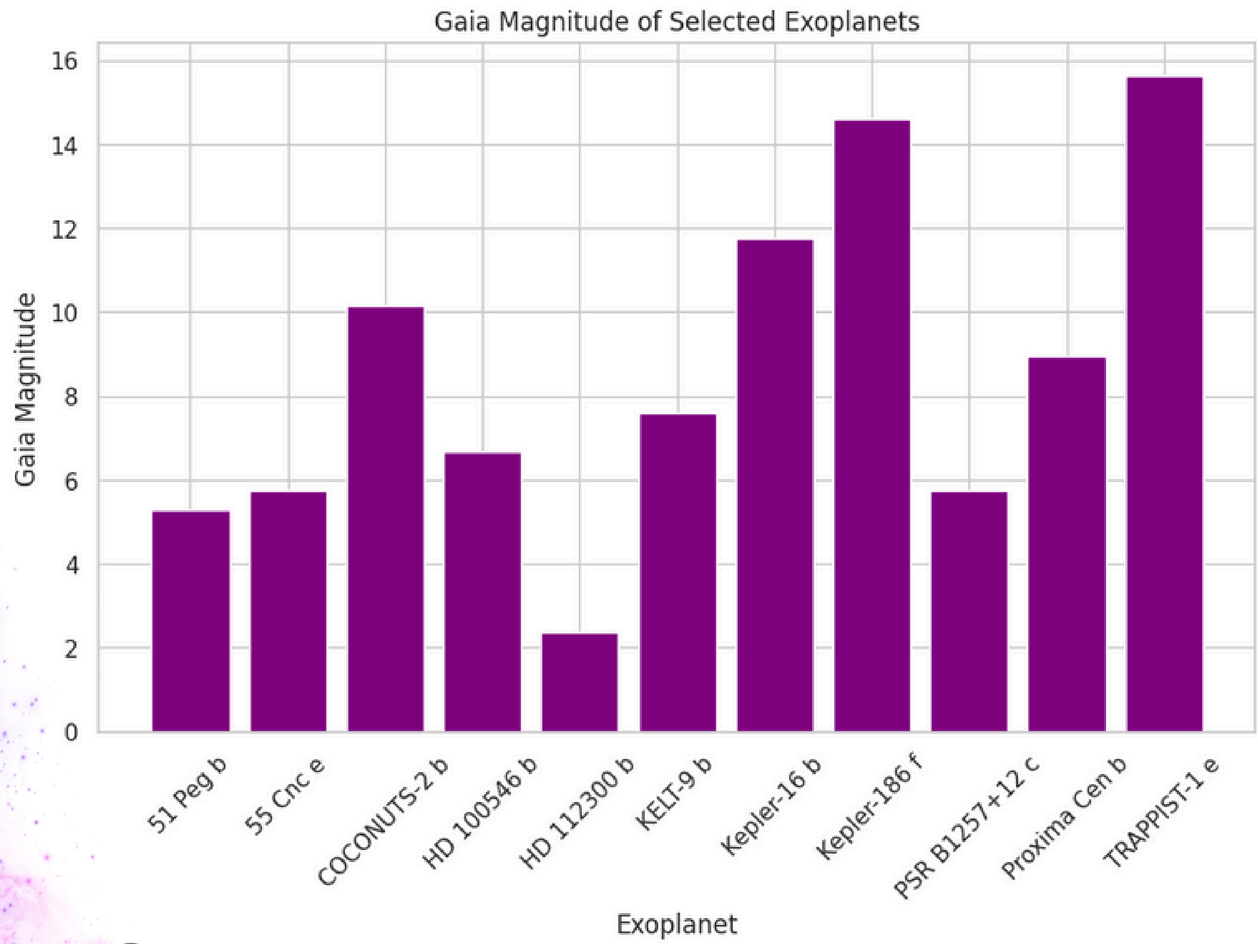
TRAPPIST-1e is regarded as potentially habitable, with conditions that may support liquid water and, by extension, life. This evaluation is derived from our advanced machine learning model, which assesses its environmental parameters.

Overall Comparison

After we have looked at each planet separately now, we'll examine how these exoplanets compare to each other in terms of their Gaia magnitude, mass relative to Earth, radius, temperature, and distance from Earth. Each chart gives us insights into how these planetary bodies vary across key characteristics, shedding light on the diversity of exoplanetary systems.

Gaia Magnitude Comparison

Gaia magnitude helps measure the brightness of these exoplanets as seen from Earth. Below is a comparison of the 11 exoplanets based on their Gaia magnitude.

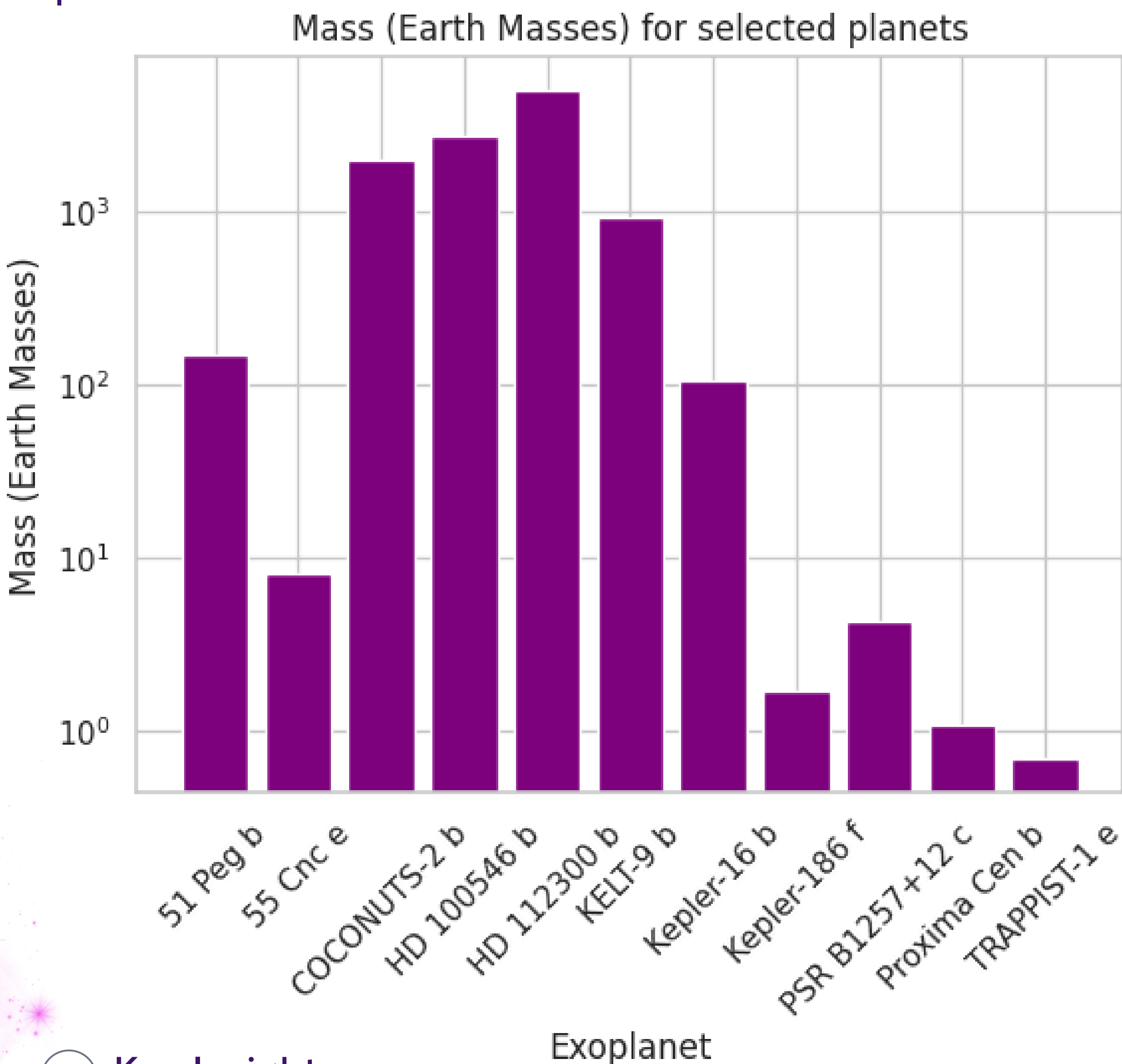


Key Insights

- Exoplanet TRAPPIST-1 e and Exoplanet Kepler -186 f exhibit the highest magnitudes, indicating their low brightness.
- Exoplanet HD 112300 b, with a lower magnitude, appears much bright compared to the rest.

Mass Comparison (Relative to Earth)

The mass of an exoplanet relative to Earth is crucial in understanding its gravitational pull and potential to support life. The visualization below compares the mass of these 11 exoplanets.

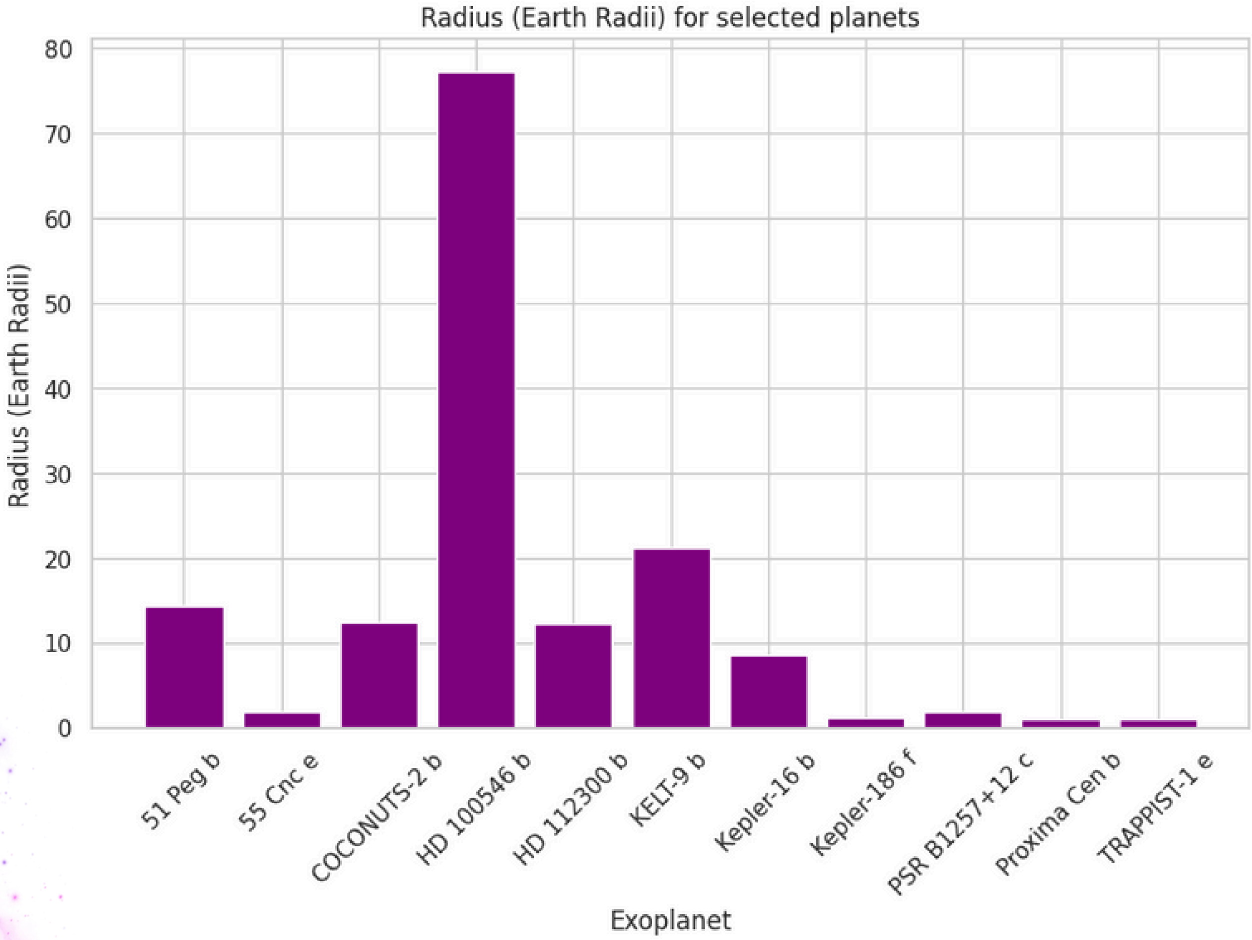


Key Insights

- Exoplanet HD 100546 b is significantly more massive than the others, indicating a gas giant-like structure.
- Exoplanet TRAPPIST-1 e is the least massive exoplanet among them.

Radius Comparison

Radius gives us a sense of the size of the exoplanet. A comparison of the radii of the 11 exoplanets is shown below.

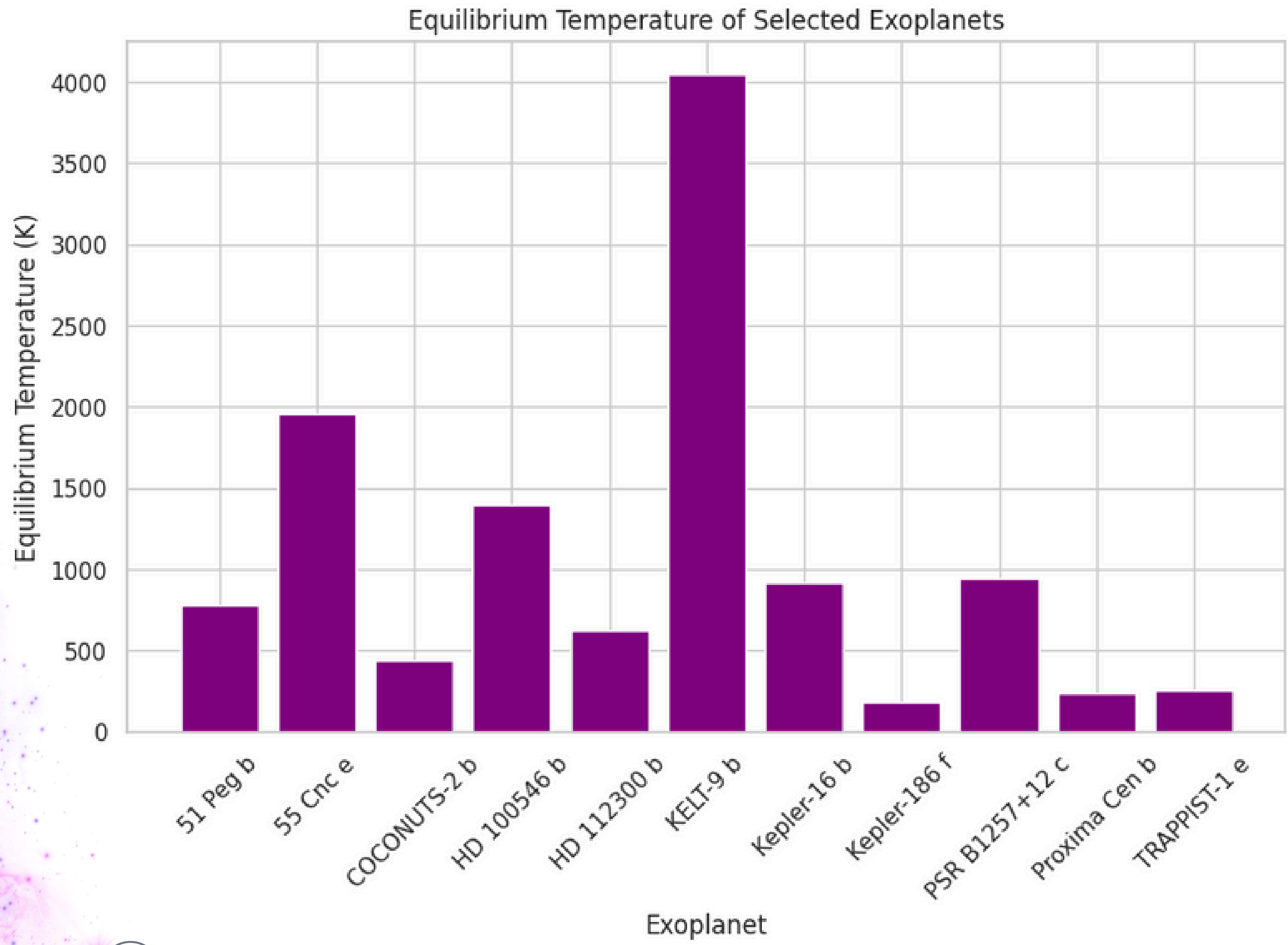


Key Insights

- Exoplanet HD 100546 b has the largest radius, suggesting it may be a gas giant
- Exoplanet TRAPPIST-1 e has a radius similar to Earth's, indicating potential for Earth-like conditions.

Temperature Comparison

Temperature plays a major role in determining the habitability of an exoplanet. Here's how the temperatures of the 11 exoplanets compared.

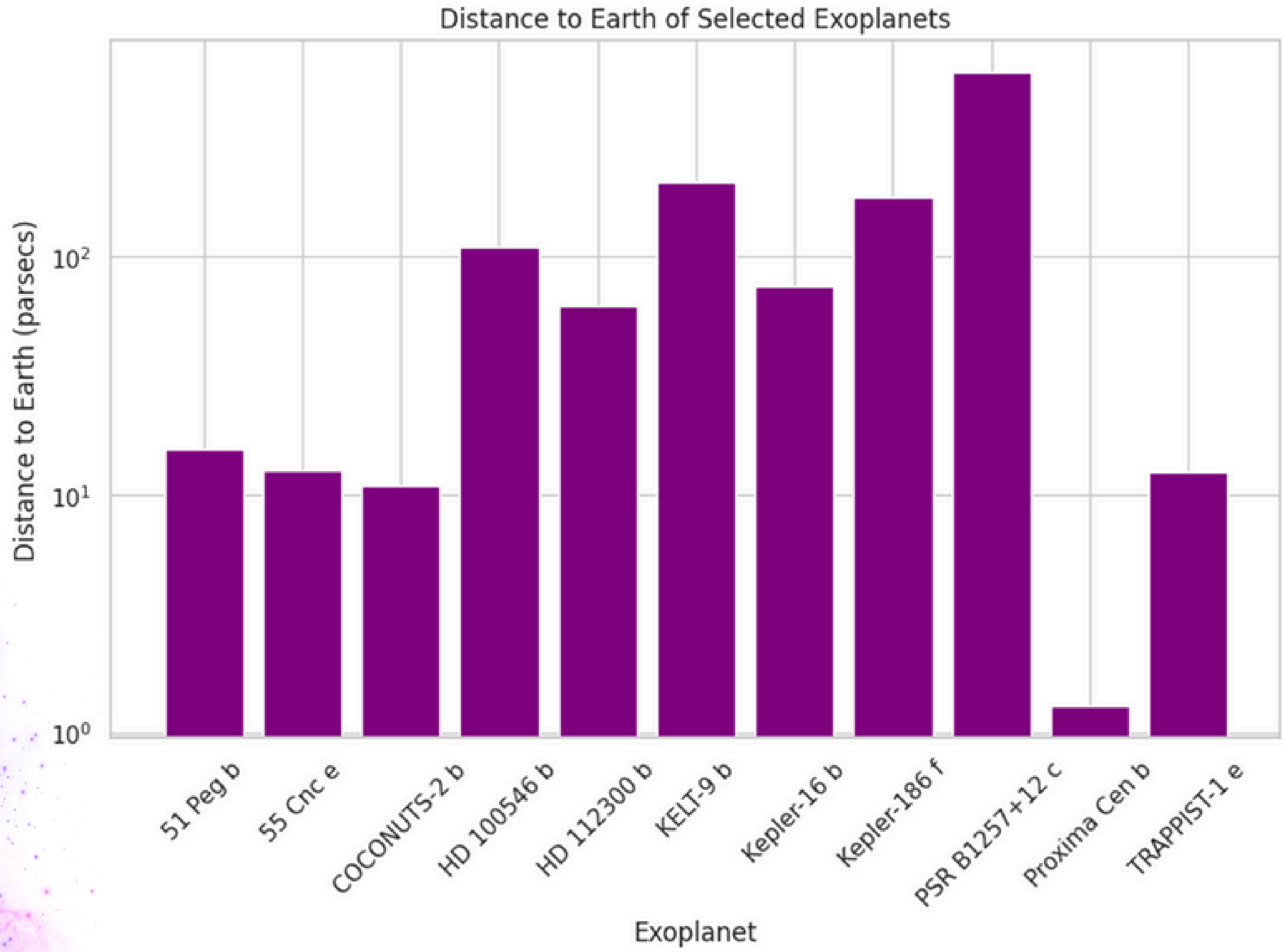


Key Insights

- Exoplanet KELT-9 b is extremely hot compared to the others, possibly due to its proximity to its host star.
- Exoplanet Kepler-186 f's lower temperature might place it within its star's habitable zone.

Distance from Earth Comparison

Distance from Earth is an important factor for future exploration. Below is a visualization showing how far these exoplanets are from us.

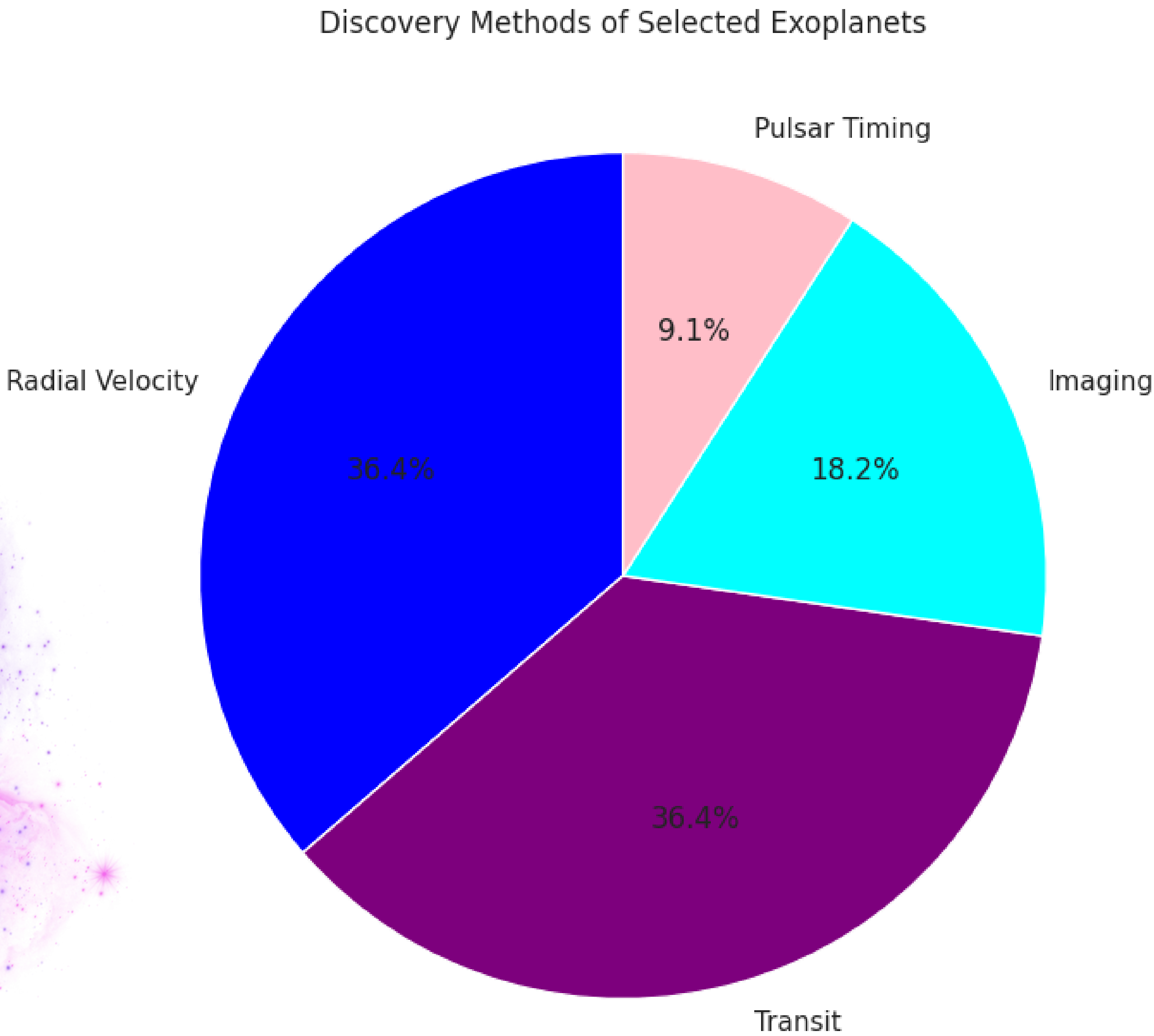


Key Insights

- Exoplanet Proxima Cen b is the closest to Earth, making it an ideal candidate for further study.
- Exoplanet PSR B1257+12 c and PSR B0329+54 b, being much farther, present greater challenges for exploration.

Discovery Method

Understanding how these exoplanets were discovered gives insight into the techniques and technologies used in exoplanet research. Below is a comparison of the discovery methods employed for these 11 exoplanets.



Key Insights

- Most of the selected exoplanets were discovered using the Transit Method, which detects dips in brightness as a planet passes in front of its star.
- A few exoplanets were discovered using Radial Velocity methods, which measure the wobble of stars caused by the gravitational pull of orbiting planets.
- The Direct Imaging and methods also contributed to the discovery of some exoplanets, showcasing the diversity of techniques in use.

Overall Summary

By comparing these 11 exoplanets across key characteristics, we can see the vast range of planetary conditions that exist beyond our solar system. Some planets are bright and massive, while others are small, cool, and distant. These visualizations provide a comprehensive view of how diverse exoplanets can be and set the stage for further research and exploration.

Now Let's see What what ACCURACY our Machine Learning Model Is.

The Quest For Life

Imagine being the first person to discover a planet that could potentially harbor life. That's the dream of many astronomers and scientists. But with billions of stars and planets out there, how do we find these habitable worlds?

Machine Learning to the Rescue

Enter machine learning. This powerful tool can help us analyze vast amounts of data and identify patterns that might not be obvious to humans. By studying exoplanets (planets outside our solar system), we can use machine learning to predict which ones are most likely to be habitable.

Our Machine Learning Model

Our machine-learning model works a bit like a planet detective. It uses a technique called Clustering to group planets based on their similarities. Planets in the same group are likely to have similar characteristics. Once the planets are grouped, we choose the group that seems most habitable based on what we know about Earth. This group becomes our "habitable zone." Any new planet that falls into this zone is considered a potential candidate for life.

```python
n_clusters = 3
kmeans = KMeans(n_clusters=n_clusters, random_state=42)
exo_final['cluster'] = kmeans.fit_predict(exo_clustering_scaled)

for i in range(n_clusters):
    print(f"Cluster {i}:")
    print(exo_final[exo_final['cluster'] == i][features_for_clustering].mean())
plt.scatter(exo_final['pl_rade'], exo_final['pl_bmasse'], c=exo_final['cluster'], cmap='viridis')
plt.xlabel('Planet Radius (Earth Radii)')
plt.ylabel('Planet Mass (Earth Masses)')
plt.title('Exoplanet Clusters')
plt.show()
```

```
Cluster 0:
pl_orbper     73429.226968
pl_orbsmax       53.763402
pl_rade          13.033849
pl_bmasse      1509.978106
pl_insol       1715.921405
pl_eqt         1315.912195
st_teff        5860.438401
st_rad            3.237699
st_mass           1.203450
dtype: float64
Cluster 1:
pl_orbper     19729.855898
pl_orbsmax        0.755927
pl_rade           3.106150
pl_bmasse        64.856988
pl_insol        242.043133
pl_eqt          783.541151
st_teff        5212.960613
st_rad            0.910413
st_mass           0.854254
dtype: float64
Cluster 2:
pl_orbper     4.020000e+08
pl_orbsmax    7.506000e+03
pl_rade       1.244200e+01
pl_bmasse     2.002319e+03
pl_insol      4.223740e+02
pl_eqt        4.340000e+02
st_teff       3.406000e+03
st_rad        3.900000e-01
st_mass       3.700000e-01
dtype: float64
```

Testing Our Planet Detective Model

Now that we've trained our "Planet Detective" model, it's time to see how well it can identify potential homes for life. This process, called Validation, involves testing the model's performance on data it hasn't seen before.

```
[183] exo_final['habitable'] = exo_final['cluster'].apply(lambda x: 1 if x == 1 else 0)
      X = exo_final[features_for_clustering]
      y = exo_final['habitable']
      X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
      model = RandomForestClassifier(n_estimators=100, random_state=42)
      model.fit(X_train, y_train)
      y_pred = model.predict(X_test)
      print(f'Accuracy: {accuracy_score(y_test, y_pred):.2f}')
      print(confusion_matrix(y_test, y_pred))
      print(classification_report(y_test,y_pred))
```

```
Accuracy: 0.98
[[306  13]
 [  8 825]]
              precision    recall  f1-score   support

           0       0.97      0.96      0.97       319
           1       0.98      0.99      0.99       833

    accuracy                           0.98      1152
   macro avg       0.98      0.97      0.98      1152
weighted avg       0.98      0.98      0.98      1152
```

The Future of Space Exploration

With a machine learning model like this, we can narrow down our search for habitable planets and focus our resources on the most promising candidates. It's an exciting time for space exploration, and who knows what we might discover next!

Vega

Vega's Team

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"Bringing the science of exoplanets to life through every article."

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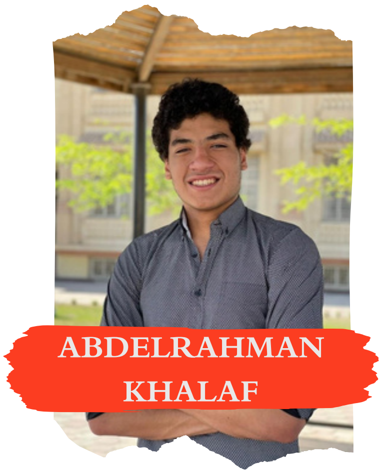

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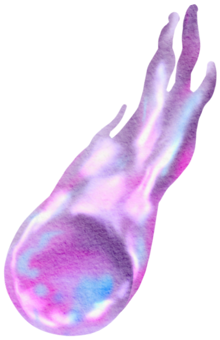
HOPE YOU HAVE ENJOYED YOUR JOURNEY.



NOW LET'S TEST WHAT YOU'VE LEARNED SO FAR?