ETH zürich

Transit Exoplanet Detection

Fabian Amherd (KS Stadelhofen), Maximilian Krahn (KS Zug), Nils Müller (Stiftsschule Einsiedeln), Luana Mark (KS Hohe Promenade), Jonathan Vanha (KS Hohe Promenade), Alex Schwentner (BG Dornbirn),

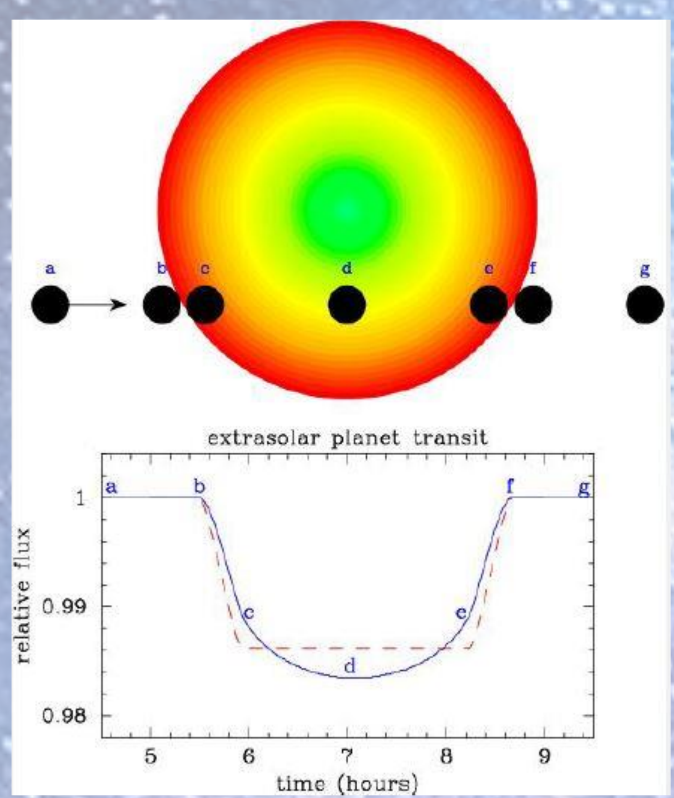
The Project: 12 students from all over Switzerland (and Dornbirn, Austria) came to ETH Zurich to find exoplanets (extra solar planets) that have been found before. With the help of the extraordinary associate professor Sascha Quanz and his team we were able to analyze original Kepler satellite data. During the week we learned different methods to detect exoplanets. With these methods various sorts of exoplanets and different planetary characteristics can be detected. Furthermore, our group had the privilege to have an insight in the daily business of ETH Zurich.

Scientific Motivation: With the discovery of planets outside of our solar system we can have a broader understanding of planets. We can also understand whether or not the properties of our solar system are common in the universe. Moreover, we can set terrestrial life in a universal context by quantifying the frequency of planets that have suitable conditions for hosting life.

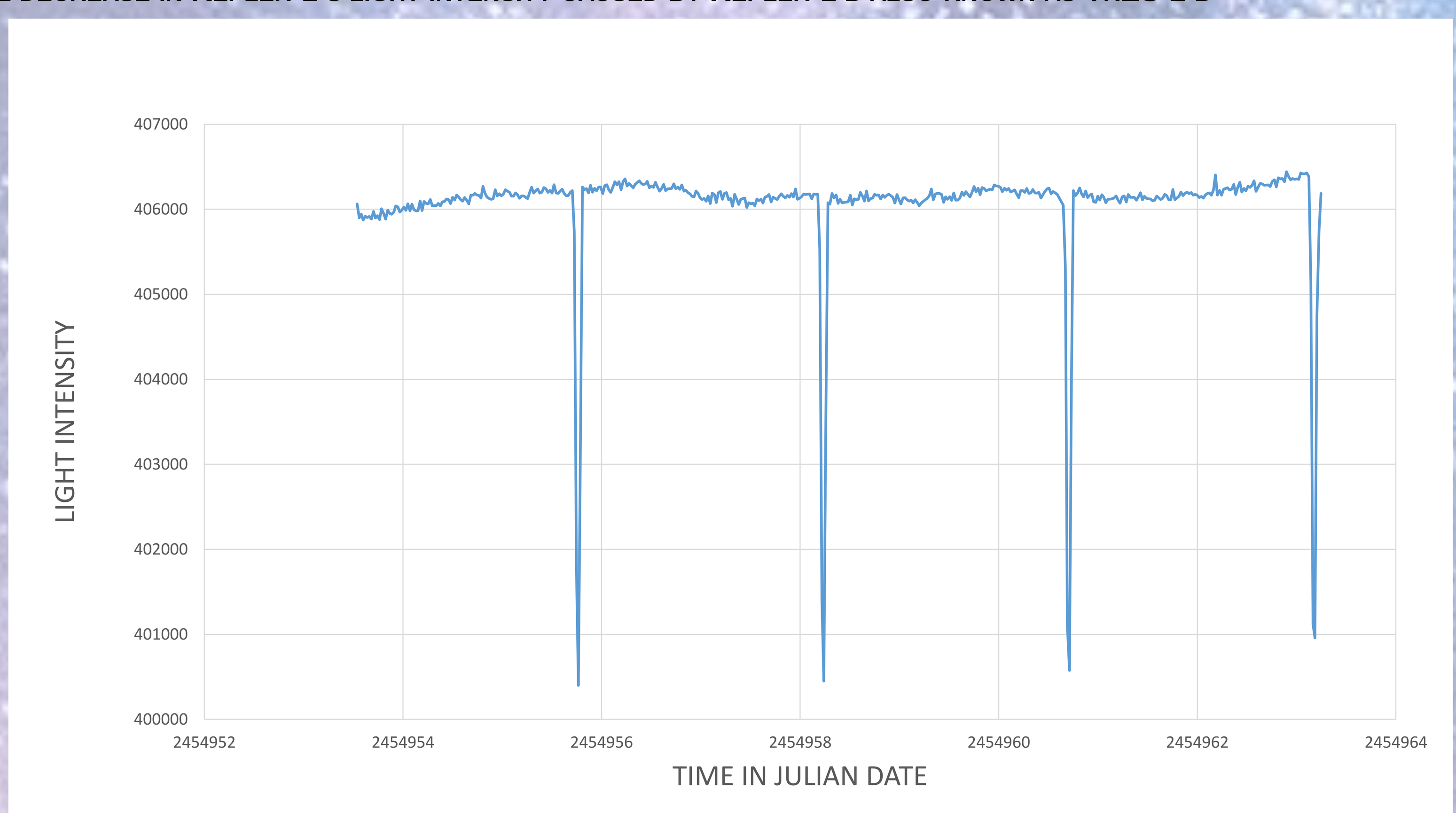
Transit Method

What is the principle?

Kepler, a satellite launched by NASA, had the mission to discover as many exoplanets as possible. The method used was the so-called transit method. The brightness of plenty of stars was measured every 30 seconds. When an exoplanet passes a star the light received by Kepler decreases in intensity. Based on this reduction we can calculate the radius of the exoplanet using the radius of the host star and its proportionality to the radius of the exoplanet. When measuring several drops the period can be defined. Finally we can figure out the orbital radius using Kepler's third law and the information found out beforehand.



The decrease in Kepler-1's light intensity caused by Kepler-1 b also known as TrES-2 b



Planet	Name	Period (days)	ΔP	Orbit (AU)	Δa	Radius (R_J)	$ΔR_J$
1	Kepler-1 b	2.47	0.001	0.035	0.0160	1.130	0.025
2	Kepler-2 b	2.16	0.167	0.033	0.0001	1.194	nan
3	Kepler-4 b	3.20	0.049	0.045	0.0056	0.384	nan
4	Kepler-9 b	19.25	0.020	0.142	0.0002	0.743	nan
5	Kepler-9 c	38.88	nan	0.225	nan	0.786	nan
6	Kepler-10 b	0.83	0.030	0.017	0.0010	0.147	0.015
7	Kepler-10 c	45.24	0.200	0.241	0.0020	0.225	0.02
8	Kepler-25 b	6.20	0.029	0.069	0.0002	0.260	nan
9	Kepler-25 c	12.70	0.034	0.110	0.0002	0.433	nan

What exoplanets did we discover

Why are hot Jupiters easily detected?

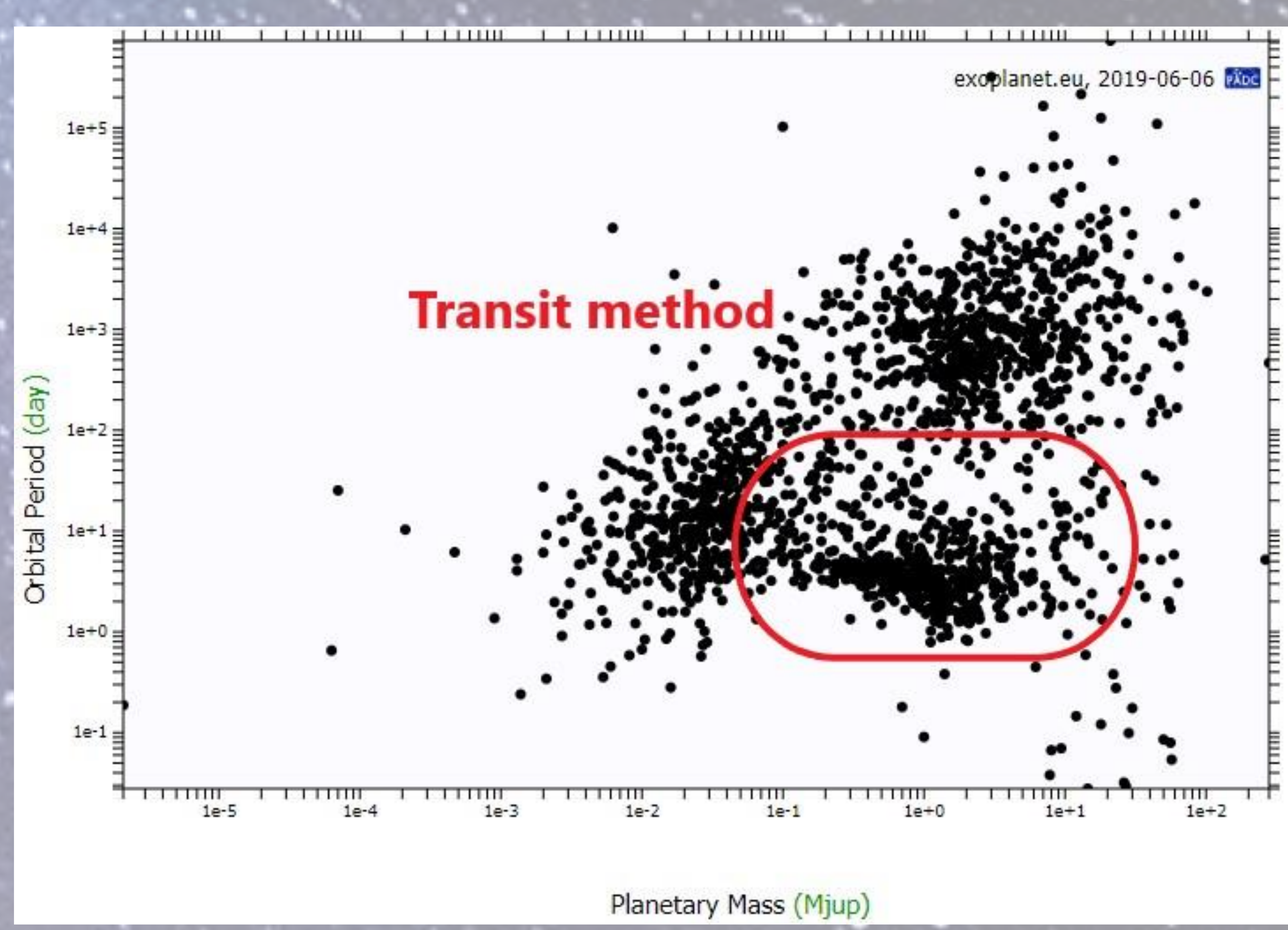
The exoplanets found by Kepler do not represent the diversity and frequency of exoplanets in the universe. As an example, the Earth would be difficult to detect from another solar system and Mercury would be beyond our technical abilities. Even though Hot Jupiters are very rare in our universe, they are the most probable to be found with the transit method. This is due to their massive size and their close distance to their star. A close distance is an advantageous characteristic as the time gap between to transits is short. Furthermore, bigger planets are more easily detected as their remarkable size causes a bigger difference in light intensity during a transit.

[1]

The Significance of The transit method

Even though most of the exoplanets (2950) have been found using this method, we are still far away from finding all exoplanets existing in space. A big disadvantage is that exoplanets can only be detected if they pass in front of the star from our point of view. Secondly, we could not find any exoplanets outside of our galaxy because we do not have the technologies to measure the difference in light intensity from stars not included in our galaxy yet.

In the following picture we can see all exoplanets discovered up to now sorted according to their mass and orbital period. Please note that the scales are logarithmic.



Conclusion

Exoplanets are very interesting. We found a planet even bigger than Jupiter but ten times closer to its own star than Mercury to our sun. The transit method is only useful for discovering a small percentage of all exoplanets. Analyzing this data was a giant leap for us but a small step in getting to know the universe.

References:
[1] ESA/ATG medialab, CC BY-SA 3.0 IGO