# The Discovery

In November 1995, the two Swiss astronomers Michel Mayor and Didier Queloz published measurement data they had carried out using the radial velocity method on a sun-like star "51 Pegasi" about 50 light years away. The evaluation revealed that the star is orbited on an extremely narrow path by a planet that should have about the mass of Jupiter. This was the first exoplanet to be discovered – many hundreds were to follow in later years. For the first detection of an exoplanet and subsequent further research, Mayor and Queloz were jointly awarded half of the 2019 Nobel Prize in Physics[1].
The lower diagram from the publication by the two scientists shows the measured radial velocities of the star "51 Pegasi". The curve represents the best fit of the model to the measured data.

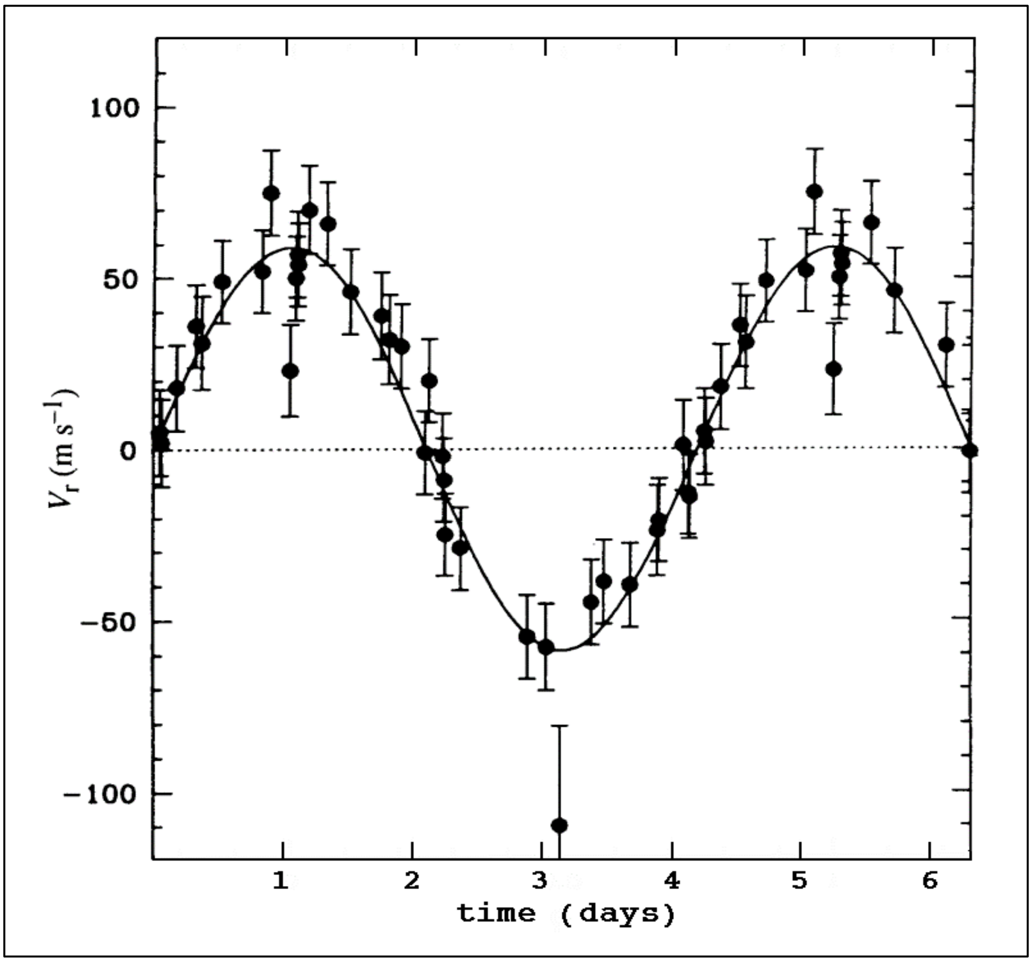


*Figure 1. Radial velocities of the star "51 Pegasi". Source: https://web.pa.msu.edu/courses/2011spring/AST208/mayorQueloz.pdf*

[1] Poster: https://www.mediatheque.lindau-nobel.org/GetFile?id=38546

**Task 1:**
Determine the orbital period of the exoplanet "51 Pegasi b" from the curve.

**Task 2:**
For circular orbits, the following formula gives the mass of the exoplanet:

$$m_P = \sqrt[3]{\frac{T \cdot M_S^2}{2 \cdot \pi \cdot G}} \cdot v_{Rad}$$

The formula applies to the situation in which the observer is looking at the edge of the plane of planetary motion. They thus determine a minimum value for the mass because we must assume that the orbital plane is inclined; this would lead to a smaller amplitude. The mass $M_S$ of the central star can be determined from spectroscopic investigations and is here: $M_S = 2.21 \cdot 10^{30}$ kg. G is the gravitational constant[2], and T is the orbital period of the planet. Use the value T = 4.23 days.
Now determine a value for the amplitude $v_{Rad}$ of the radial velocity curve from the diagram, and calculate the mass of the exoplanet. Note that, in the formula, it is the third root and you must insert the circulation time T in seconds.

**Task 3:**
The masses of exoplanets are usually given in multiples of the mass of Jupiter. This amounts to $M_J = 1.898 \cdot 10^{27}$ kg.
Give the mass of the exoplanet "51 Pegasi b" in the "unit" Jupiter mass, and compare your value with the literature value (internet research).

**Task 4:**
The extremely short orbital period of the planet (4.26 days) indicates an exceptionally small distance between the star and the planet. You can calculate this distance exactly with the help of Kepler's third law. Because the following applies: $\frac{T^2}{a^3} = \frac{4 \cdot \pi^2}{G \cdot (m_P + M_{Star})}$
Calculate the distance a using Kepler's third law and the known data.

**Task 5:**
Comment on the question of whether conditions that would allow the formation of life could prevail on the exoplanet "51 Pegasi b".

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[2] $G = 6.674 \cdot 10^{-11} \frac{m^3}{kg \cdot s^2}$