SUBJECT 10: EXTRASOLAR PLANETS

Task 1: Definition

Tick the correct answers.

An extrasolar planet is:

- ☐ a planet bigger than the Sun.
- ☐ a planet outside the Solar System.
- ☐ a planet that revolves around the Sun.

The first extrasolar planet was discovered:

- ☐ By Jacob in the XIXth century.
- ☐ By Giordano Bruno in the XVIth century.
- ☐ By Mayor and Queloz in 1995.

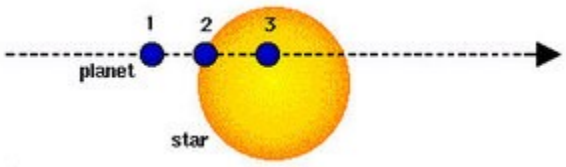
The following tools are used to find extrasolar planets:

- ☐ Radial velocity measurement
- ☐ Sky observation at new moon
- ☐ Decrease of the brightness of a planet
- ☐ Satellites

Task 2: 💻 Astronomical transit

When one planet is moving across the face of a star, the brightness of this star is decreasing. The aim of this exercise is to draw the curve representing the brightness in terms of the time. The shape of this curve depends on the size and trajectory of the planet in front of the star.

We assume the star and the planet are two disks, the motion of the planet is a straight line and its speed constant, the brightness of the star is uniform (proportional to the visible area of the disk).



1. <u>A special case:</u>

An alien is observing the transit of Jupiter in front of the Sun from a far-off star. Compute the brightness decrease given Jupiter's radius is 10% of the Sun's radius.

2. <u>Computing areas:</u>

On the following diagram, colour the area corresponding to the occulted part of the star.

The distance PS is noted d.

a. Use the triangle SAP to find the angle $\widehat{ASP}$.
b. Find the area of circular sector ASB in terms of the angle $\widehat{ASP}$.
c. Work out the area of triangle ASB in terms of AH and SH.
d. Likewise, calculate the areas of circular sector APB and triangle APB.
e. Deduce the expression of the occulted area.

3. <u>Evolution</u>

Let A_v be the visible area of the star and t the time the planet took from P to C. h is the shortest distance from S to the planet's centre and s the speed of the planet.

a- Explain why CP=st.
b- Express d in terms of h and t.
c- Compute A_v if $d \geq R + r$.
d- Compute A_v if $d \leq R - r$.

4. <u>Graph💻</u>

Draw the curve representing the brightness of the star in terms of the time.

We give t from -10 to 10 , R=6, r=2, h=3, s=1.

Suggestions: write a program or use a spreadsheet program.

Task 3: Statistics 💻

Use the attached spreadsheets to answer the questions.

Data available from the website : http://exoplanet.eu/.

Planets discovered with the transit method :

Frequency

a. When was the first planet by the transit method discovered?
b. Compute the number of discoveries by the transit method.
c. Summarize the data in a table: find the number of extrasolar planets discovered each year.
d. Draw a histogram to represent this distribution. Comment.

Radii

a. Determine the extrema, the median and the quartiles.
b. Find the mean radius of those extrasolar planets and compute the standard deviation.
c. Right or Wrong? Justify your answer.
   The radius of a quarter of the extrasolar planets is 29% more than Jupiter's.
   The radius of less than half the extrasolar planets is smaller than Jupiter's.
d. Plot the evolution of the average radius year after year.

Period

Same questions.

Radii Class intervals

a. Put the data into classes of range 0.1 Jupiter radius: draw a frequency table.
b. Plot this distribution.