Lesson outline

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SuperEarths - searching life beyond Solar System

Key words:
Super-Earths
exoplanets
life
space
ecosphere

Topic: Searching life beyond Solar System

Students' age: 15-19

Time: 2 lessons

Subjects:
physics
computer science

LESSONS IDEA - Teacher's guide

Super-Earths are extrasolar planets larger than Earth, but smaller than Neptune. They usually move very close to their home star. Their orbit resembles that of Mercury or may be smaller Some of them move much further, in particular inside the habitable zone, i.e. in a place where water, if it occurs on its surface, may be in a liquid state. Given the fact that they are probably planets made up of components similar to Earth, they can be a potential place for life.

The purpose of this lesson is to familiarize students with the methods of discovering extrasolar planets, to indicate those exoplanets (in particular Super-Earths) where favorable conditions for the existence of life may occur. The proposed lesson will consist of the theoretical introduction necessary to work in the practical part. In particular, students will learn how to define the (circumstellar) habitable zone, what it is characterized by, and what are the problems associated with it.

The students will use the acquired theoretical knowledge to analyze real information about known exoplanets and stored in relevant databases. Students will search in these databases bodies on which there may be potential conditions for the development of life.

✍ Lesson objectives

- Stimulating interest in space, the celestial bodies and some methods of studying these bodies.
- Active participation in the analysis of real scientific data.

✍ Results

- Students will know what exoplanets are, especially Super-Earths, will know a few methods to detect these celestial bodies.
- Students will know the concept of the habitable zone and be able to determine which of the real exoplanets are inside habitable zones. The result of students' work will be a list of exoplanets on which life could potentially exist.

✍ Preparation for the teacher

The teacher should examine the lesson plan and proposed additional online materials and decide which can be used in the class. He/she should also test the proposed experiments in practice.

ADDITIONAL MATERIALS:

Introduction to the topic:

- Presentation: Super-Earths and searching life beyond Solar System ⇒link
- Worksheet: Exoplanets in ecospheres ⇒link
- Examples of exoplanets in ecosphere are listed, and where one can calculate the boundaries of ecosphere ⇒link

- **A database of exoplanets that the students will work with ➲ link**

- What is the Habitable Zone? (1) ⇒link
- What is the Habitable Zone? (2) ⇒link
- What is a Super Earth? ⇒link
- Exoplanet habitable zones ⇒link

DESCRIPTION OF THE LESSON

✍ Theoretical part

Presentation, which contains important information needed to understand and work of students in the practical part (Examples of issues discussed: what are exoplanets, super-Earths, ways to detect them, discussion of databases containing information about exoplanets and used in the practical part).

Before starting the 2nd lesson, the teacher asks students to watch the movie(s) (links to the movies are in the part "Additional materials (online)". The first lesson in the series begins with comparing students' answers to questions about the film(s). This can be done in the form of a quiz.

✍ *Time required to complete this part of lesson: 2x20 min.*

✍ Practical part

During the first lesson in the practical part, students will learn about the exoplanet database. They learn the meaning of different fields, etc.

During the second lesson, students will search for super-Earths in real exoplanet databases and will verify if the exoplanet is a super-Earth or in the habitable zone. The database can be found at: http://exoplanets.org/table

This part can be accomplished e.g. in such a way that the teacher will provide students with a list of exoplanets and these are to find among them those that are in the habitable zone (several such planets are provided to the teacher in the xls file Ecospheres).

➲ Experimental part: a demonstration of the Inverse Square Law for Light

In this activity, students learn how light is spread throughout space. This is an optional material. These experiments may be performed while discussing topics related to "The search for exoplanets in habitable zones".

✍ *Time required to complete this part of lesson: 2x20 min.*

✍ Summary of the lessons

Discussion of student work results. It is worth remind during the discussion what an habitable zone is and that if a planet moves in the habitable zone, it does not determine that there are favorable conditions for life. Such conditions may exist.
In this case, it is worth giving an example of Earth and the Moon. Both bodies are almost the same distance from the Sun, and the conditions (eg. temperature, atmosphere) on these bodies are different.

It may happen that the student finds an exoplanet near the border of the habitable zone. For example, students will find that the habitable zone around a star is between 0.34 au and 1.41 au while the planet moves at a distance of 1.42 au from this star.

In this case, it is worth explaining to the student that the boundaries of the habitable zone that the student has calculated are approximate. Physical conditions on an exoplanet close to the border of the habitable zone (in this case 1.42 units) depend on many factors such as the structure of the planet, the composition of the atmosphere (if it has one), the magnetosphere, etc.

✍ *Time required to complete this part of lesson: 10 min.*

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