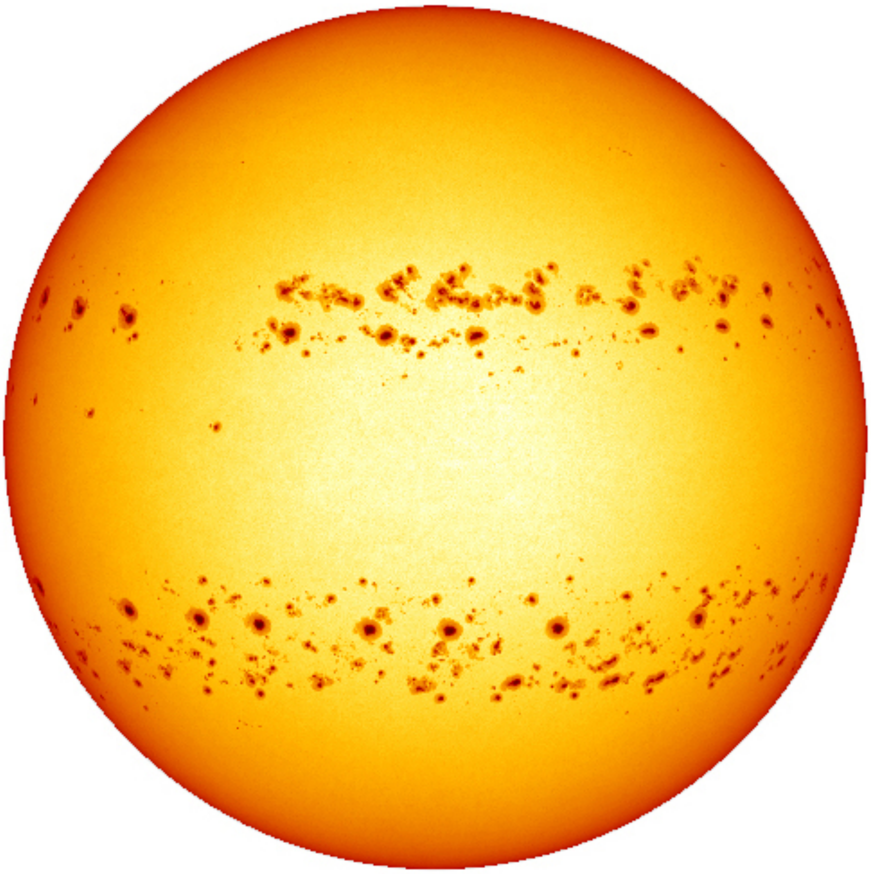
Sun's rotation period

Teacher's Guide – Basic Level

CESAR's Science Case



Introduction

This is the teacher's guide for "Sun's rotation period" CESAR's Science Case. Note that **this guide does not contain full instructions** to successfully develop the science case, those can be found at the student's guide. This guide includes information about the learning purposes of the activity as well as about the material and background needed for it, so that the teacher may decide **weather this laboratory is suitable** for his class or not. This guide is also meant to **help the teacher trough organising the activity**, providing tips and keys for each step, as well as the **solutions** to the case's calculations and the quiz.

In this science case the students are to **calculate the Sun's rotation period** using images from CESO (CESAR's ESAC Solar Observatory). By the end of this laboratory, students will be able to:

- Understand how fast the Sun moves.
- Explain what the rotation period is.
- Track targets in time-separated images.
- Make predictions and prove them with experiments.

By completing this laboratory, students will find out how astronomical pictures can be used to obtain valuable data.

Material

What will they need?

- The Sun's rotation period Student's Guide.
- Computer with Web Browser and Internet Connection.
- Access to CESAR web tools.

Background

The Basic Level Student's Guide requires no background, everything is explained in the guide and nothing is taken for granted. However, you may want to take a look at "Sun" chapter from the CESAR Booklet to teach them about solar flares or sunspots. Also, in at this level, there's no math involved at all. If you want to consider a harder task, take a look at the intermediate level.

Laboratory Execution

All that students ought to do is read their guide and follow the steps. This task is suitable both for doing it alone or in small groups.

If they make no mistake, they should obtain about 26 days for the rotation period. Knowing that the Sun much bigger than Earth, and that it takes one day to the Earth to complete a rotation, they should had estimate a rotation period of 5-100 days for the Sun. Once they do the exercise, the result should be between 24 and 32 days for the rotation period.

Sunspots rarely move in latitude, if they do, they may actually be two different sunspots.

Students should get about 26 days for the Sun's rotation period. If their value is far away from that, they should check if they have precisely mark the sunspots in the web tool.

Once they get the final result, they whole class could discuss how good the result matches their prediction. Even if they weren't able to predict the exact value, both the prediction and the final results should be bigger than the Earths rotation period. It is common in science to predict that some measurement should be bigger or smaller than some other, and to use an experiment to check that and obtain the exact value.

In the "Conclusions" part, they are also asked how long would it take to a solar flare located at the left-edge of the Sun to be pointed at Earth. If it takes 24 days to the Sun to complete a full rotation, then it would take 12 days to the flare to go from one edge to the other, and only 6 days to get to the centre of the Sun where it would point right to the Earth.

Even if the student's guide ends up here, the activity may continue with the quiz. Although this quiz can be used as a qualifiable exam, it is not only meant to be so. Even if the students have successfully obtained Sun's rotation period, if they don't fully understand the whole procedure, the quiz questions may make them doubt (some of them might be really tricky). Besides than examining them, it is a good idea to give them some time to do the test by their own, and then group them for discussing their answers. It is likely that they have different answers for some of the questions, and **by discussing them, they will achieve a much better comprehension of the whole process** they used. In the last pages of this guide, all the questions from the quiz are answered. For each question the correct answer is provided, and just in case it's not clear why, it's also indicated why the others are wrong. Finally, for each question there is a completely absurd possible answer, if one of this answers is given, you can be sure the student is randomly answering.

Quiz

The correct answers for the quiz are a d b d c b b d a c.

The absurd answers for each question are c c d a b a c b d a.

In case of doubt, the discussion of each question follows next:

1. The Sun rotates

- ☐ slower than Earth.
- ☐ faster than Earth.
- ☐ happier than Earth.
- ☐ once every 24h.

It takes more than two weeks to the Sun to complete a rotation and only one day to the Earth to do so.

2. The rotation period is

- ☐ how fast the Sun rotates.
- ☐ the time that takes to a sunspot to move from one edge of the Sun to the other.
- ☐ how fast the Sun rotates about an alien spacecraft.
- ☐ the time that an object needs to complete one full rotation.

No clarifications needed, answer **d** is the definition for rotation period.

3. If an object rotates very fast it

- ☐ must have a long rotation period.
- ☐ must have a short rotation period.
- ☐ must be very small.
- ☐ must be powered by a computer.

Objects that rotate fast are usually small, buy they do not necessarily have to. If an object is rotating very fast, it takes very little time to complete a rotation, hence it has a short rotation period.

4. We can calculate the rotation speed of the Sun by measuring the speed of sunspots because

- ☐ sunspots want to help us and they whisper the Sun's differential rotation.
- ☐ sunspots are located in the Sun's core, so we can measure their speeds with no disturbance.
- ☐ sunspots move through the surface.
- ☐ sunspots are located at the Sun's surface, whose speed we want to measure.

Sunspots don't move through the surface, they move with the surface, whose speed we want to measure.

5. In the final picture, the sunspot is seen in two different positions because the sunspot

- ☐ is duplicated by CESAR's web tool to do the measurements.
- ☐ reproduces and duplicates itself like cells.
- ☐ moves with the Sun's surface, and the Sun's surface constantly rotates.
- ☐ moves through the Sun's surface towards the right edge.

The sunspot does not duplicate, neither by itself nor by the CESAR web tool. The sunspot is seen twice because the final picture is a mixture between two pictures taken at different days. As the sunspot moves with the Sun's surface, and the Sun's surface constantly rotates, the sunspot is in two different places each of the days, hence its seen twice.

6. In the final picture, you marked the position of the sunspot in each day because

- ☐ the computer told you so, and computers are very smart.
- ☐ if we know how much the sunspot moved between those days, we'll know how fast it moves.
- ☐ if we know where sunspots are, we automatically know Sun's rotation period.
- ☐ you wanted to increase the precision of the measurement.

If we know where sunspots are, we can not automatically know Sun's rotation period, we would just know where sunspots are. But, if we know how much one sunspot moved between a few days, we'll know how fast it moves, and once we know the rotation speed we could obtain the rotation period.

7. Earth's rotation is the reason for day and night, Sun's rotation is the reason for

- ☐ Sun's day and night.
- ☐ the movement of Sun features.
- ☐ life in Earth's core.
- ☐ Sun's short rotation period.

Day and night are produced by Earth's rotation, because as the Earth is moving, the dark side and the side lighted by the Sun change over time. The Sun is always lighted because it is the light-source in the Solar System, so it does not have day and night. The Sun has a long rotation period, so only possible answer is b.

8. To calculate the speed of a sunspot you

- ☐ measured the distance between two sunspots.
- ☐ used a chronometer.
- ☐ looked at two different sunspots.
- ☐ tracked the sunspot in time-spaced images.

To calculated the speed of a sunspot we only looked at one single sunspot, that was seen twice as explained in question five.

9. In science its common to

- ☐ have predictions before measuring.
- ☐ ignore the predictions only when you finished the measurement.
- ☐ use the results of an experiment to predict the value that you measured.
- ☐ ignore other scientist, because scientist know nothing.

In science you should never ignore nor predictions nor scientist. It makes no sense to use the results of an experiment to predict the value that you measured, because if the values are already measured there's no need for a prediction. In science its common to have predictions before measuring.

10. The Sun rotates

- ☐ so fast that it is flat.
- ☐ clockwise, like the Earth does.
- ☐ counter-clockwise, like the Earth does.
- ☐ faster in the poles.

With the North orientated upwards, the Sun rotates counter-clockwise. Check the movement of the sunspots when you choose images of the same feature with a few days of difference, the sunspot moves to the right (counter clock-wise as seen from above).