

Seasons of the year

R. Teixeira¹, D.M. Rodrigues¹, L. Lanza², J.P. Delicato¹, M. Fidêncio¹, e M. Paschini³

¹ Universidade de São Paulo, IAG, São Paulo, Brasil e-mail: rama.teixeira@iag.usp.br

² Universidade de São Paulo, IF, São Paulo, Brasil

³ Universidade Metodista, Piracicaba, Brasil

Abstract. The proposal of this work is result of reflections, questions, readings and, above all, the intention to contribute with teaching and dissemination of Astronomy in general and particularly the Seasons of the Year. It is not the goal of the present essay, in any case, to criticise anyone or contents of a particular text, website or any material of scientific outreach. It is simply an invitation to extend the horizons of these reflections and refine our statements when we teach or just talk about Seasons of the Year.

Resumo. A proposta desse trabalho resulta de reflexões, questionamentos, leituras e acima de tudo da intensão de contribuir com o ensino e divulgação da Astronomia em geral e, particularmente, das Estações do Ano. Não objetivamos no presente ensaio, criticar quem quer que seja ou o conteúdo de um determinado texto, "website" ou material de divulgação científica. Trata-se simplesmente de um convite para estender os horizontes dessas reflexões e refinar nossas afirmações quando ensinamos ou simplesmente falamos a respeito das Estações do Ano.

Keywords. Seasons of the year – Earth movements – Solstices – Equinoxes

1. Introduction

In spite of the theme Seasons of the Year be constantly present in science and geography classes and textbooks, Astronomy books, in academic texts aimed at teaching astronomy, in a large number of texts on the internet and in the media in general, there are many students, teachers and people in general, who do not seem to understand this phenomenon in all its extension and some of them may have not reflected enough about it. Although the gross error of explaining this phenomenon according to the variation of the Earth-Sun distance throughout the year is less present in schools and textbooks, there are still inaccuracies, subtle misunderstandings or simply approaches that induce errors that are perpetuating and can be found abundantly. In this case, however, it does not seem to be a great misunderstanding, but rather a little carelessness in using a more accessible or confusing language between what has been taught and learned. Our aim is simply to make explicit and draw attention to some of these subtle points that constitute errors or induce conceptual errors when dealing with the theme Seasons of the Year. We also suggest, with our proposals, some directions or ways to approach the theme. We hope, at least, to awake in our colleagues, some concern and reflection on this topic and even, possibly, with respect to other concepts rooted and that seem totally well understood and assimilated. The following topics illustrate our reflections about some questions and present some suggestions on this subject.

2. Definition

What are the Seasons of the Year?

Are the Seasons of the Year the cyclical changes of the meteorological variables or are they a consequence of this phenomenon? If the Seasons of the Year are the cyclical changes of the meteorological variables does it mean to say that: the Winter in the southern hemisphere in 2018, for exemple, began on June 21 at 07h 07min; in July, we are in the coldest season of the year in Brazil. In other words, can we say that it is Winter across all country? Or even, do we have four Seasons of the Year? Do the Seasons of the Year depend on where we are?

Proposal:

The Seasons correspond to four distinct periods of total solar irradiation which the Earth passes through over a year. In each of the four seasons the total solar irradiation difference between both hemispheres of the Earth increases or decreases, passing through zeros, maxima and minima, sometimes favouring one hemisphere, sometimes favouring the opposite hemisphere. They begin and end when our planet is on one of four remarkable points of its orbit: solstices and equinoxes.

3. Causes

Is the cause of the Seasons of the Year the inclination of the Earth's rotation axis relative to the plane of its orbit around the Sun (ecliptic)?

If the Earth's rotation axis were not tilted relative to the ecliptic, as it is roughly the case of Uranus, would we have Seasons of the Year or not? If the Earth's rotation axis were perpendicular to the ecliptic, as, approximately, is the case of Jupiter, would we have Seasons of the Year or not? Do cyclical changes in weather patterns depend only on the inclination between Earth's rotational and translational movements? Do the Seasons of the Year occur because of the variation at the distance between the Earth and the Sun? Does the variation of this distance not explain the seasons only because it is too small?

Proposal: The Seasons of the Year are a consequence of the inclination between the rotational and translational movements of the Earth. Or, in other words, they occur due to non-perpendicularity of the axis of rotation of the Earth in relation to the plane of its orbit around the Sun.

4. Graphic representation

Is Figure 1 below a good strategy to show the beginning and the end of Winter and Summer?

Is the scale a problem? Is the exaggerated "ellipse" a problem? Do Winter and Summer begin in perihelion or aphelion?

Proposal:

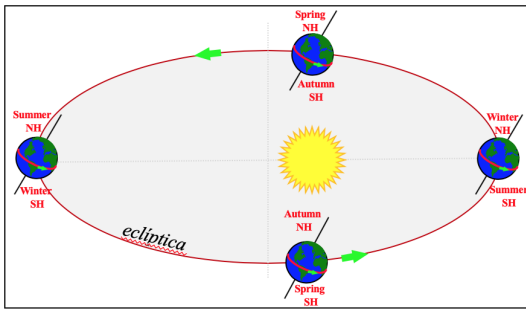


FIGURE 1. Usual graphic representation of the Earth on the vertices of the ellipse at the solstices.

Of course, we must always be aware of the problem of representation and scale, but above all, we do not suggest to place the Earth at the vertices of the ellipse at the beginning of Winter or Summer to avoid inducing the misconception that these seasons are associated with the perihelion and aphelion.

What about Figure 2?

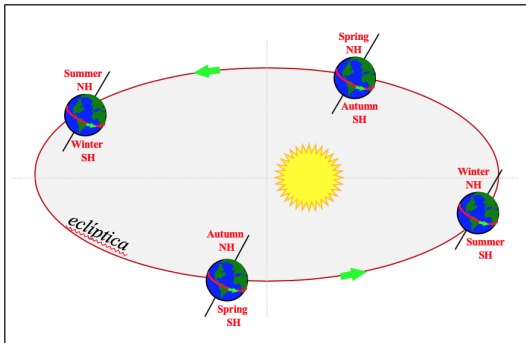


FIGURE 2. Representation of the Earth outside the vertices (perihelion and aphelion) of the ellipse at the solstices.

Why not Figure 3?

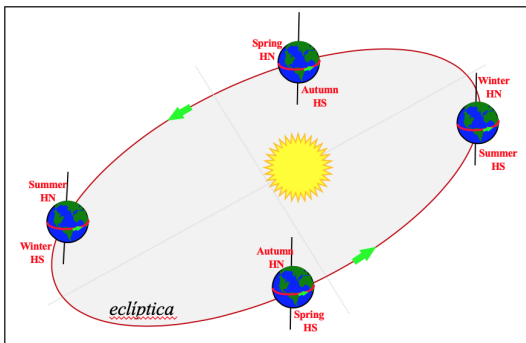


FIGURE 3. The same representation of Figure 2, but now, with the Earth's rotation axis in a "vertical" direction.

5. Final considerations

At the present essay we tried to draw attention and discuss some aspects related to the theme Seasons of the Year where we find inaccuracies that become more relevant in view of the great frequency with which they appear. They are subtleties that induce errors, which confuse and contribute negatively to the good teaching of Astronomy.

We believe that in most cases it is carelessness or lack of reflection. Another possible cause is because many authors of texts may have consulted directly or indirectly the same sources that for some reason already presented these inaccuracies.

In one way or another, we are dealing with a relevant fact that involves the fidelity of how an important scientific concept is translated into a simpler language.

The seasons of the year are a very rich theme that can and should be approached and explored more carefully. Its good understanding is possible for everyone. Such inaccuracies in many other domains can be also frequent and in this sense this work should serve as a warning to alert researchers to be always careful about others "very well known" subjects.