The pc concept

E. Marín
Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada
Instituto Politécnico Nacional
Legaria 694, Col. Irrigación, C.P. 11500, México D.F., México

E-mail: emarin63@yahoo.es , emarinm@ipn.mx

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Abstract

This paper is about the reasons of why the parsec is a useful astronomical length unit, although it is of the same order of magnitude of the better known light year. We will describe some concepts related to the definition of this magnitude with the aim of motivate teachers to introduce them since the first approximations of students to the theme of length units and conversion factors between them.

Keywords: Astronomy, parsec, units, parallax.

Resumen

Este artículo trata sobre las razones de por qué el parsec es una unidad astronómica de longitud útil, pese a que es del mismo orden de magnitud que el año luz, unidad que es mucho mejor conocida. Describiremos algunos conceptos relacionados con la definición de parsec con el objetivo de motivar su introducción desde las primeras aproximaciones de los estudiantes al tema de las unidades de la longitud y de los factores de conversión entre ellos.

Palabras clave: Astronomía, parsec, unidades, paralaje.

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I. INTRODUCTION

Several physics text books and courses begin with an introductory chapter dedicated to physical magnitudes, units and conversion factors between them [1, 2, 3, 4]. Sometimes teachers use this theme to mention some units that are related to the basic SI units, such as the electron volt ($1eV=1.602\times10^{-19}$ J) and the atomic mass unit ($1u = 1.660\times10^{-27}$kg). This paper will deal with other example of such units: The **parsec** (symbol **pc**), a unit of length often used in astronomy and cosmology that is equal to about 3.2616 light-years (ly), another length unit (not time unit, as many people belief). People learning for the first time about that, often ask why one uses the former if both units are of the same order of magnitude. Or why one uses a pc if, apparently, a ly unit is easier to understand: it corresponds to the distance in vacuum that the light crosses in a year, i.e. 9.461.000.000.000 Km, while the **parsec** comes from "**par**allax of one arc**sec**ond", so that it is defined as the distance an object has to be from the earth so that its parallax is one arcsecond. Thus the reason why the parsec is very useful to scientists is that the estimation of the distance of a celestial object from the earth must involve the concept of parallax angle. This assertion deserves special attention and its explanation should be presented to students since their very first approximations to these questions. Thus in this paper we will briefly describe what a pc is and how a simple analysis allows the derivation of the relationship or conversion factor between it and 1 ly given above. The way in which this subject can be experimentally treated in schools will be discussed too.

II. PARALLAX

Parallax is what happens when we hold our thumb at arm's length from our face and look at it against the background of our room first with the right eye open and the left eye closed and then with the left eye open and the right eye closed. We will note different backgrounds to our thumb as a result of the slight difference in the relative position of it and each eye. The parallax angle is defined as the half of the angle formed between the right eye, the reference thumb and the left eye, and depends on two things: the distance between both eyes (we will call it the baseline) and the distance to which we locate the finger. If the eyes are quite separated the one of the other, this angle becomes greater; if we moved away the finger, the angle becomes smaller. The word parallax comes from the Greek παράλλαξις (parallaxis), meaning "alteration". Parallax can be exploited to determining the distance of a nearby object: The length of a baseline can be accurately measured and from both ends of it the angle to the nearby object is determined and basic trigonometry is applied to determine the distance to the object, as we will see later.